

**A DIAGNOSTIC ANALYSIS OF THE CAUSES OF LOW
LOCAL CONTENT IN THE SOUTH AFRICAN
AUTOMOTIVE INDUSTRY**

by

**Lulama Pertunia Sibiya
62925687**

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University of South Africa**

Supervisor: Dr H.S. Phuluwa

Co-Supervisor: Dr S. Chikumba, Mr. B.N. Mdlolo

Date: May 2026

DECLARATION

Name: Lulama Pertunia Sibiyi
Student number: 62925687
Degree: Master Of Engineering (90121)

Topic: A diagnostic analysis of the causes of low local content in the South African automotive industry

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ABSTRACT

The low localisation of automotive components remains one of South Africa's challenges despite decades of local industrial policy support. The South African automotive industry lags behind other countries like India, Thailand and Mexico in high levels of local content due to unaddressed structural and policy shortcomings with limited incentives and technology transfer, low levels of production, tight supplier financing, skills shortages and poor logistics. This research seeks to investigate the reasons behind the low local content in the locally manufactured automotive components and the feasibility of potential interventions to optimize the level of localisation in line with the South African Automotive Masterplan 2035's target for local content of 60%. A mixed-methods research approach was used, including qualitative interviews, quantitative analysis, system dynamics modelling, secondary industry data, questionnaires and an automotive wiring harness case study to triangulate the results and confirm the influence on localisation dynamics. By conducting the wiring harness part-by-part, the key factors influencing localisation were identified: labour skills, tooling issues, capital investment requirements, and limited access to technology and design authority. These findings suggest that isolated interventions only result in small improvements, whereas more integrated solutions such as supplier capital investment, structured technology transfer, targeted skills development and logistics enhancement together show the greatest and most durable increases in localisation rates. This work recommends that long-term, stable policy interventions in the areas of finance, technology transfer, supplier development and workforce capability should be directed at improving South Africa's automotive manufacturing sector's competitiveness and localisation performance.

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DEFINITION OF KEY TERMS

Automotive components:

Individual parts and systems that make up a vehicle and allow it to operate safely, efficiently, and comfortably. They range from major mechanical systems to electronic modules and interior features.

Automotive industry:

Global sector involved in the design, development, manufacturing, marketing, sale, maintenance, and repair of motor vehicles and their components.

Component manufacturers: Companies that produce individual parts or systems used in larger products, machines, or equipment.

Local content: The portion of a product, service, or project that is produced, manufactured, sourced, or supplied within a particular country or region rather than imported.

Localisation: The process of increasing the amount of products, components, materials, and services that are sourced or manufactured locally instead of being imported.

Original equipment Manufacturers (OEMs): Companies that design, manufacture, and assemble complete vehicles, often using components supplied by other manufacturers.

Policy: set of laws, regulations, strategies, and government guidelines that control, support, and shape how the automotive sector operates and develops.

System dynamics: way of understanding and analyzing how complex systems change over time by focusing on the relationships between their parts, especially using feedback loops, delays, and cause-and-effect relationships.

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SCOPE

This research is focused specifically on evaluating low levels of localisation in the South African automotive manufacturing sector. It examines the structural, operational and institutional aspects impacting on the local content creation process for automotive component production. These include supplier financing constraints, skills shortages, limited technology transfer, tooling and capital investment requirements, policy-related challenges, and logistics inefficiencies. In terms of geography, the study is restricted to the South African automotive manufacturing environment, encompassing selected OEMs and tier-1 and tier-2 suppliers within the country. Global benchmarking is added only for local context such as in comparisons with India, Thailand and Mexico to demonstrate relative level of localisation performance and not serve as the unit of analysis.

In terms of product and analytical scope, the study focuses on automotive wiring harness manufacturing as a case study. Yin (2018) notes that case study research is appropriate for examining complex industrial systems characterised by multiple interacting variables. Accordingly, the wiring harness is treated as a bounded system for analysing localisation dynamics at component level, where labour availability, tooling complexity, and technology accessibility are key influencing factors. Methodologically, the study is restricted to a mixed-methods research design incorporating qualitative semi-structured interviews, structured questionnaires, secondary data analysis, quantitative analysis, and system dynamics modelling. Creswell and Plano Clark (2017) support mixed methods approaches where integration of qualitative and quantitative data is required to explain complex system behaviour and relationships.

The study does not conduct a comprehensive macroeconomic assessment of the South African industrial or manufacturing sector, nor does it cover all global automotive market structures and national trade policy frameworks that can be directly implicated in localisation outcomes. It also does not formulate comprehensive policy implementation frameworks but rather evaluates the feasibility and potential effectiveness of integrated intervention efforts. Within these defined boundaries, the study aims to develop an in-depth understanding of the

key drivers of automotive component localisation in South Africa and to evaluate whether coordinated interventions in supplier development, skills enhancement, technology transfer, finance, and logistics can contribute meaningfully towards achieving the localisation targets set by the South African Automotive Masterplan 2035.

CHAPTER 1: INTRODUCTION

1.1 Overview

The purpose of this chapter is to provide the background and context for the local content challenge in the South African automotive industry. The chapter starts with the industry context of the research problem, research objectives, aim, key research questions, and the hypotheses. These are followed by a presentation of several theories, including the Human Capital Theory, Technology-Transfer Theory, and the Resource-Based View. It wraps up with a discussion of the study's importance and a summary of the chapter.

The automotive sector is a catalyst for economic growth in many countries, including developing economies. (Tshwane Development Agent, 2023). It plays a pivotal role in driving industrialisation, generating employment and modernisation (Freser, 2024). The automotive industry in South Africa directly contributes about 6.5% of the national Gross Domestic Product (GDP). It also employs about 110,000 people, underscoring its strategic importance to the country's economy (National Association of Automobile Manufacturers of South Africa, 2023). Its local-content ratio averages around 40%, much behind peer economies such as India with about 75%, Brazil (65%) and Thailand (70%) (South African Government, 2024); (Ministry of Heavy Industries, 2023); (Intarakumnerd & Techakanont, 2014); (ASEAN Briefing, 2023).

By organising the chapter this way, the reader is given a clear, well-organised basis for understanding the study's flow. This chapter serves as an introduction to the following chapters, in which we will review the literature, discuss the methodology, present current empirical findings, and make recommendations to increase local content development in the South African automotive industry.

1.2 The Overview of the South African Automotive Industry

The automotive industry is an essential sector of the South African economy. It actively contributes to GDP and has generated an earned export revenue of approximately R200 billion in 2022 (National Association of Automobile Manufacturers of South Africa, 2022). It is one of the country's most advanced manufacturing sectors, supported by state intervention. It comprises global Original Equipment Manufacturers (OEMs) such as Toyota, BMW, Volkswagen, Ford, Nissan, Isuzu, and Mercedes-Benz (InvestSA, 2020). Industrial policy frameworks such as the Motor Industry Development Programme (MIDP) and its successor, the Automotive Production and Development Programme (APDP), have expanded vehicle production and exports but have failed to increase the low level of local component manufacturing (Monaco & Wuttke, 2023).

Despite the recovery in production after the COVID-19 pandemic, the share of locally produced components has remained at 37-42%. This is well below peer markets (Department of Trade, Industry and Competition, 2024). Relying on imports weakens the multiplier effects of local spending, such as the development of small and medium sized enterprises (SMEs), skills transfer, and employment generation, and puts additional pressure on the trade balance (Trade & Industrial Policy Strategies, 2024). The structural barriers include an ineffective local supplier system, insufficient technology transfer from multinational corporations, and a lack of engineering skills in advanced manufacturing (Megan, et al., 2025). The extent of this stagnation is illustrated in Figure 1.1, which shows the relationship between vehicle production volumes and estimated local content in South Africa from 2019 to 2023. The figures show that while production volumes have gradually recovered, the localisation ratio has remained static, highlighting the sector's structural weakness.

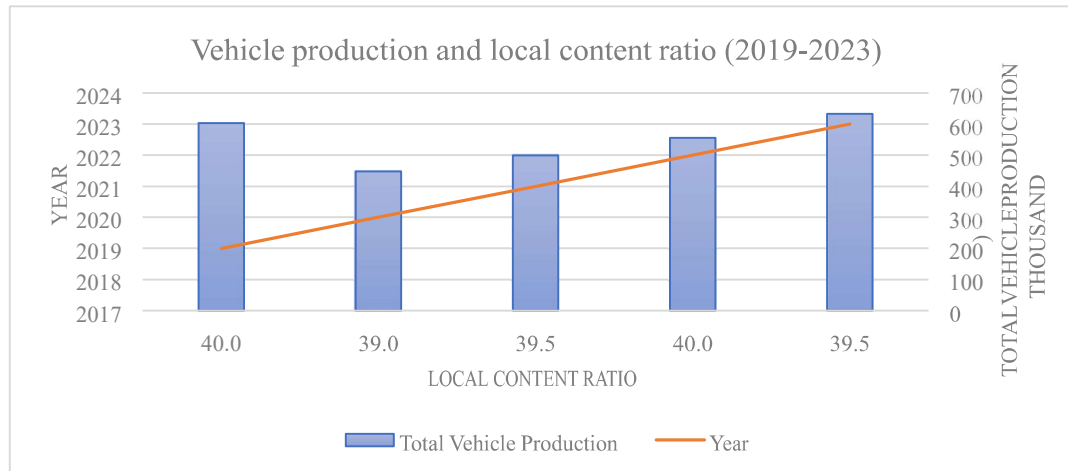


Figure 1.1: Annual Vehicle Production and Estimated Local-Content Ratio in South Africa (2019-2023).

Sources: (Statistics SA, 2024); (Australian International Education Conference, 2023); (National Association of Automobile Manufacturers of South Africa, 2023).

The automotive industry is complex. It integrates the design, manufacturing, assembly of components, distribution system, and post-sale services (Islam, et al., 2019). The production processes include stamping, welding, and painting, with final assembly as the final stage. This is supported by a tiered supply network of suppliers, with raw materials manufactured to complete assembly (Xiang, et al., 2025). This supply system model is represented in a pyramid form (Figure 1.2). It illustrates the hierarchical relationships between OEMs, Tier 1 suppliers, and lower-tier suppliers.

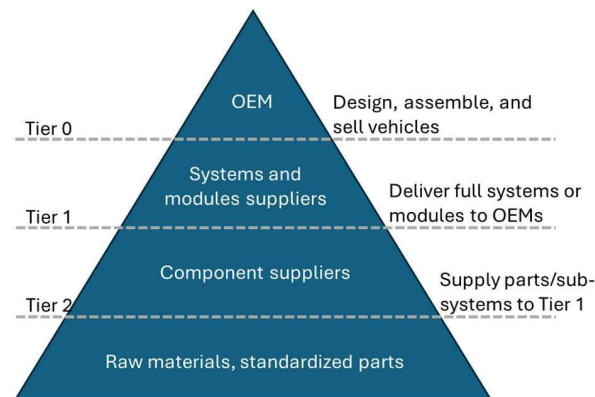


Figure 1.2: Automotive Supply Chain Pyramid.

Source: (Puii, et al., 2021).

Beyond vehicle manufacturing, the industry's output includes parts replacement, with software and electronic systems becoming increasingly important (Sonko, et al., 2024). Aftermarket services, such as maintenance and parts replacement, are essential to gain revenue and customer loyalty (McKinsey & Company, 2023). Other outputs include the role of government in policy guidance, where organisations such as the National Association of Automobile Manufacturers of South Africa (NAAMSA) support manufacturers. Skills development is facilitated by the Manufacturing, Engineering and Related Services Sector Education and Training Authority (MERSETA), while dealerships influence demand patterns and vehicle distribution. At the regional level, the African Continental Free Trade Area (AFCFTA) offers new opportunities for market consolidation and investment (World Economic Forum, 2023).

Apart from production, the automotive sector is a strategic force for industrialisation. It integrates into industries such as mining, steel, plastics and electronics (United Nations Industrial Development Organization, 2020). The industry also drives technological progress, with manufacturers adopting global best practices and advancing production innovation that can filter through to other sectors. However, employment in the South African automotive industry is small in scale compared to peer countries that are benefiting from more robust local supply chains (National Association of Automobile Manufacturers of South Africa, 2023); (Society of Indian Automobile Manufacturers, 2022); (ASEAN Briefing, 2023). Such disparities highlight the structural deficiencies of South Africa's industry, particularly its reliance on imported inputs and its small local supplier networks, which may not support wider industrial expansion and economic resilience.

These disparities are also evident in Table 1.1, which summarises metrics for South Africa, India, and Thailand. The Table includes localisation percentage, output mass produced to meet the local market's needs, number of jobs created, and export value. The comparison illustrates how South Africa's low local content limits employment and industrial multiplier effects. In contrast, India and Thailand have stronger local supplier networks and are more integrated into global value chains. These differences indicate policy options that might

improve the performance of South Africa's automotive sector. For example, local supplier incentives, skills development, and investment in advanced manufacturing technology.

Table 1.1: Comparison of Automotive Industry Performance and Local-Content in South Africa, India, and Thailand (2024).

Source: (National Association of Automobile Manufacturers of South Africa, 2023; Society of Indian Automobile Manufacturers, 2022; (ASEAN Briefing, 2023).

Indicator	South Africa (2024)	India (2024)	Thailand (2024)
Total Vehicle Export Value	R16.88 billion	USD 20 billion	USD 12.2 billion
Local-Content	Approximately 40% of components are sourced locally	Approximately 80% of components are sourced locally	Over 70% of components are sourced locally
Imported Components	60% of components imported, valued at approximately R12.66 billion	20% of components imported, with a large local supplier base	Less reliance on imports, with the majority of components sourced locally
Total Vehicle Production	~600,000 units (2024)	~5 million units (2024)	~2 million units (2024)
Economic Impact	Low local content reduces local economic benefits	High local content boosts local economic impact	High local content boosts local economic impact

1.3 Research Problem

The South African automotive industry faces a considerable challenge in increasing the amount of locally produced content (Monaco, et al., 2020). Localisation is widely recognised as a key driver of industrial development because it strengthens supplier capabilities, creates jobs, and reduces reliance on imported components (Centre for Development and Enterprise, 2021). To support this, the South African government policies such as the APDP, the MIDP, the Supplier Development Programme (SDP), and the broader Industrial Policy Action Plan (IPAP) have been implemented to incentivise local production, enhance supplier capabilities, and promote technology transfer (Barnes & Black, 2013). Recognising these policies'

importance can help policymakers feel their efforts are valued, even as localisation remains below desired levels due to structural constraints.

While literature on localisation and supplier development has expanded in recent years, limited research has examined the systemic interaction of structural barriers that keep local content levels low. For example, Myres et al. (2024) note that supplier development programmes often address isolated challenges, without considering how these issues combine in slowing down growth. In addition, Ebrahim & Berg (2024) observe that the influence of financial constraints and technological deficits on localisation is evident, and a closer examination of these dynamics is needed in developing countries such as South Africa. On the other hand, existing research is primarily based on developed economies, where structural conditions are significantly different from those in emerging markets, therefore providing little relevant guidance. Furthermore, Pooe (2016) concludes that understanding how multiple barriers interact is critical for designing interventions that effectively support supplier growth and increase local content. Monaco, et al., (2020) also emphasise that, despite existing policies, industry leaders lack evidence and a unified strategy to guide sustainable localisation efforts. This study addresses this gap by developing an evidence-based diagnostic framework that identifies key constraints and proposes practical interventions to increase local content sustainably.

1.4 Aim of the Study

This study aim is to investigate the impact of localization strategies and best practices that could enhance automotive component manufacturing in South Africa.

1.5 Objectives of the Study

The following are the objectives of the study:

- I. To quantify the percentage of locally manufactured components used in the South African automotive production and conduct a comparative analysis study with other automotive industries in emerging economies.
- II. To examine the factors contributing to low local component manufacturing in the South African automotive industry and assess their impact on industry performance and sustainability using data obtained during the study period
- III. To develop a conceptual framework to optimise the localisation of component manufacturing in the context of the South African automotive industry.
- IV. To validate the framework for the localisation process and its other key success factors.

1.6 Research Questions

In view of the research objectives, the following research questions guided the study:

- I. What percentage of local content is currently achieved in the South African automotive production, and how does it compare with other emerging economies?
- II. What are the key factors influencing locally manufactured components in the South African automotive industry, and how do these factors impact the sector's performance and long-term sustainability?
- III. What kind of conceptual framework can be developed to optimise the localisation process in the South African automotive industry, and how can it address the challenges identified in the study?
- IV. How can the proposed framework for localisation be validated, and what are the critical success factors necessary for its effective implementation within the South African context?

1.7 Hypotheses

This study analyses the linkages between workforce skills, technology-transfer investments, and local-content development in the South African automotive industry.

The following hypotheses are tested:

1.7.1 Inadequate Workforce Skills

Null Hypothesis (H_0):

There is no statistically significant relationship between workforce skills and the degree of local content in South Africa's automotive manufacturing industry.

Alternative Hypothesis (H_1):

The level of workforce skills is significantly positively correlated with the local-content rate in the South African automotive sector.

1.7.2 Technology-Transfer Issues

Null Hypothesis (H_0):

Technology transfer from global automotive companies to local companies has little influence on the rate of localisation.

Alternative Hypothesis (H_1):

Technology transfer between global automotive companies and local manufacturers significantly increases localisation rates.

1.7.3 Investment Constraints

Null Hypothesis (H_0):

Investment has no significant impact on the localisation rates of the South African automotive industry.

Alternative Hypothesis (H_1):

Increased investment levels correlate with greater localisation in the South African automotive industry.

1.7.4 Logistics Efficiency and Local-Content

Null Hypothesis (H_0):

Logistics performance dimensions, including port congestion, inland transport costs and lead-time variability, do not have a significant effect on the localisation rates in the South African automotive industry.

Alternative Hypothesis (H_1):

Improved logistics performance (decreased port congestion, reduced inland transport costs, and shorter lead times) plays a significant role in driving higher localisation rates within the South African auto industry.

1.8 Rationale of the Study

This research is important as it is a response to the challenge of poor component localisation in the South African automotive sector which remains a hindrance to industrial competitiveness and leads the industry to rely on imported parts, which in turn exposes it to global supply chain disruptions. The study will provide complimentary insights into the economic, technological, and structural factors limiting localisation in the automotive value chain. The outcome of the study may aid policymakers, industry stakeholders, and manufacturers to implement strategies to support local component manufacturing, improve supply chain resilience, and enhance competitiveness and sustainability within the South African automotive sector. The study will add to knowledge on automotive localisation and industrial development in developing economies through developing research-based findings applicable to the South African situation.

1.9 Limitations of the Study

Given existing research limitations, the current study also faced challenges accessing comprehensive, up-to-date industry data (specifically proprietary information from OEMs and suppliers), which affected the analysis's accuracy. Such reliance on self-reported data (including surveys and interviews) poses risks of respondent bias and incomplete portrayals of the entire automotive value chain, especially of lower-tier and informal suppliers. Given the limited extent to which the South African automotive industry is studied in a specific policy and institutional framework, the broader applicability of the findings to comparable countries and processes is limited. The long-term relevance of the results might be reduced by the structural and technological evolution of the automotive industry, including the electrification shift and changing trade structures. Lastly, diagnostic and modelling analytical approaches impose simplifying assumptions required by the diagnostic studies, which may mask company-level diversity and may add uncertainty to the implications of the conclusions.

1.10 Summary

This chapter provided the background to the study by framing the importance of the South African automotive industry and highlighting the on-going challenge of low local content. While the sector accounts for about 6.5% of GDP and employs around 110,000 people, the local content is significantly below 40%, and manufacturers continue to depend heavily on imported components. Based on the report presented in the chapter, most importantly the significant systemic and structural issues were identified around limited technology transfer from international OEMs, insufficient investment, scarcity of advanced manufacturing skills, and inefficient logistics and supply chains to localise. As a result, high-value and complex elements such as wiring harnesses, hydraulic systems, and electronic control units are predominantly imported because local suppliers lack the capacity and capability, exposing the industry to global supply chain disruptions, extended lead times, and increased

production risks. In general, this chapter set the basis for the study by defining the localisation problem and stressing its importance to counter these constraints.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter attempts to establish the extent of the challenges that make it difficult to manufacture most automotive components locally. It discusses how such challenges affect local content by reviewing existing literature and industry reports. It also makes comparisons with other developing countries, such as Brazil, Thailand, and India, to explain why those countries have achieved high local-content levels and how some of the lessons from these countries might be relevant to South Africa. The discussion concludes with recommendations to overcome these challenges, foster the development of local content, and advance sustained model development in the South African automotive industry.

2.2 Overview of the Automotive Industry

The global automotive industry is among the most complex and technologically advanced manufacturing sectors (Ambe & Badenhorst-Wess, 2013). It includes a wide range of suppliers, assemblers, logistics providers and multinational value chains (Naude, 2013). Its competitiveness relies heavily on production efficiency, innovation, and the range of local component industries that support vehicle manufacturing (Priyana, et al., 2024). Localisation and supplier development have emerged as critical means for countries to gain a competitive edge as they seek to industrialise through the automotive industry (Monaco, et al., 2020).

South Africa holds a distinctive position, being Africa's largest vehicle manufacturer and exporter to the international market, in this global environment (International Trade Administration, 2024). It produced 633,332 vehicles and exported 399,594 units in 2023, demonstrating its significant role in global supply chains and the export market (Department of Trade, Industry and Competition, 2024). However, the country's capabilities and ability to

harness the automotive sector for deeper industrial development have been hindered by persistently low levels of local content (Naude & Badenhorst-Weiss, 2012). Understanding what the industry looks like; How it works and how South Africa fits into the global process of value addition are necessarily key to putting into perspective the difficulties of further localisation. The sections that follow provide a detailed background for setting South Africa's automotive industry in the global context.

The automotive industry is a foundation of industrialisation and economic progress in many countries (Formex, 2023). Its wide value chain drives employment, exports, and advancement technology (Bojan Shimbov, 2024). It has changed a lot since the beginning of the first vehicle that ran on gasoline, created by Karl Benz, back in 1885 (Wuttke, 2021). Mass production eventually came into play, introduced by Henry Ford at the beginning of the 20th century. It changed the way vehicles are produced and the price at which they are sold. It continued to quickly grow throughout the 20th century, giving rise to large OEMs such as General Motors, Ford, Volkswagen and Toyota (National Association of Automobile Manufacturers of South Africa, 2022). In recent years, annual vehicle production at the global level was at approximately 80 million units, while individual countries such as China, the United States and Japan have been continually dominating the manufacturing output of the identical vehicles (International Organisation of Motor Vehicle Manufacturers (United Nations Conference on Trade and Development, 2024).

The literature indicates that, despite industry growth, OEMs prefer imported components to locally manufactured ones (Komarasamy & Hoque, 2015). The reason is that global supplier clusters are more competitive, better equipped with advanced manufacturing technologies, and more assured of quality and support for innovation (Kaziboni & Stern, 2020). Another reason for importing components is structural challenges in the local value chain, such as supply constraints on specialised skills in advanced electronics, robotics programming, and precision machining (Invisu, 2025). Another constraint is low levels of investment in capital-intensive tooling and production equipment (Meegle, 2024) and the absence of local manufacturing capability that meets global standards (Barnes, et al., 2018). Added to these

are supply chain inefficiencies, including port congestion, high inland transport costs, and extended lead times, which further weaken localisation efforts (Transnet, 2023).

2.2.1 Market Dynamics of the Automotive Industry

The automotive industry is divided into several categories (Day & Fand, 2019). These include vehicle types, business activities, geography, and the respective roles of different industry players. A vehicle could be a car, bus, truck, motorcycle, or scooter (European Commission, 2016). From a business standpoint, there are two leading actors: the OEMs who develop, manufacture and sell vehicles. This also includes companies that supply automotive components to OEMs for vehicle production, from raw materials through assembled modules and systems. These companies also supply aftermarket parts to support the vehicle after its sale, such as repair parts, maintenance services, and accessory components (Mashilo & Moothilal, 2021).

The automotive sector is also characterised by vehicles powered by diesel, petrol, electric, and biofuel. Petrol cars have been favoured for their smooth acceleration and responsive driving dynamics (Prime Team, 2024). Still, their popularity has been decreasing across multiple markets due to environmental and emissions concerns (Wang & Miao, 2021). On the other hand, diesel vehicles are still the most popular worldwide due to their fuel efficiency and high performance, especially on personal vehicles (Ahjum, et al., 2018). Recently, interest in electric vehicles (EVs) has grown as the world increasingly seeks a more sustainable, eco-friendlier alternative to traditional internal combustion engine (ICE) vehicles (Malik, et al., 2025). As an alternative to fossil-derived fuels, biofuel-powered vehicles that use renewable fuels such as ethanol or biodiesel have attracted researchers' attention. However, their current use is not widespread because they require a large amount of land for production, competing with land for food production (Renewable Energy Policy Network for the 21st Century) (El-Araby, 2024).

Design and fabrication of automotive vehicles are found in advanced countries such as the United States of America (USA), the United Kingdom (UK), Germany, etc. (Saber, 2018). The design and manufacturing of vehicles have always been a primary activity of the automotive industry. Customising and modifying vehicles are increasingly important, even in the high-performance and luxury body segments, where customers insist on a unique combination of features and technological advancements. These changes can occur both to the OEM flow during vehicle manufacturing and the aftermarket after consumers have had the vehicles. The world trend of modifying vehicles also stimulated the development of the aftermarket industry (CLEPA, 2017).

Analysing the global vehicle production trend over the past ten years, the automotive industry has experienced fluctuations driven by various emerging factors, including the global economy, supply chain disruptions (especially during the COVID-19 pandemic), and changes in consumer preferences towards greener options (Han, 2024). Production fell in 2020 due to the pandemic, but the industry is bouncing back, scaling up production of electric and hybrid vehicles. The transition from the conventional internal combustion engine to a more sustainable mode of transport is set to progress, particularly as global governments, especially in Europe, North America and parts of Asia, enforce stronger emissions controls (Han, 2024).

2.2.2 Technological Trends

The automotive industry is experiencing a significant shift in existing standards, driven by technological advancements, evolving consumer demand, and economic growth (Bharadwaj, 2015). Despite supply chain disruptions, regulatory pressures, and the increasing demand for sustainability, the industry is finding ways to innovate and adapt to the new normal. The most representative factors that reflect the world of the automotive industrial structure at the present stage are described below:

2.2.2.1 Electric Vehicle (EV) Growth

The most significant development in the world's automotive industry is the growing trend towards EVs. Pressured by environmental issues and regulation, a considerable number of automotive manufacturers are rushing to bring EVs to the market. Conventional internal combustion engines (ICE) vehicles are being phased out and replaced by EVs. This supports governments with strict emissions standards worldwide and provides EV adoption grants (Qadir, et al., 2024).

Technological developments to make batteries cheaper while lasting longer and charging faster have been essential to making EVs more affordable and accessible for consumers (International Energy agency, 2023). At the same time, the sale of EVs has been rapidly increasing worldwide. Major EV markets, such as China, Europe and North America, maintained their market shares and even expanded them, with China being the largest EV market, followed by European countries, including Norway, the Netherlands and Germany (International Energy Agency, 2024). Leading automotive manufacturers have made strategic commitments to electrification, including targeting a substantial share of electric vehicles in their production portfolios over the coming decades. (Mikael Hanicke, et al., 2024).

2.2.2.2 Autonomous Driving and Advanced Driver Assistance Systems (ADAS)

Autonomous driving technology is another key field in the global automotive industry. Full automation is still in testing, but many OEMs are working on ADAS to enhance vehicle safety and ease of driving. Safety and driver convenience features such as lane keeping assist, adaptive cruise control, automatic emergency braking, parking assistance are increasingly becoming standard in most modern vehicles (National Highway Traffic Safety Administration (National Highway Traffic Safety Administration, 2023). At the same time, companies including Tesla, Waymo and Cruise are driving advances and opportunities in autonomous vehicles. However, numerous legal, safety, and ethical issues act as barriers to the widespread adoption of autonomy (Redavid, 2023).

2.2.2.3 Sustainability and Environmental Concerns

Automotive manufacturers are under increasing pressure to be more sustainable as governments pass green laws and also consumers demand environmentally friendly products (Mondal & Goswami, 2024). Sustainability in the automotive industry does not mean simply making electric vehicles; it covers the whole life cycle of cars, from sourcing raw materials to emissions during manufacturing and end of-life recycling. Environmental factors now influence the automotive industry's strategies and innovations more than ever. Some countries have further tightened carbon controls, which will drive the transition to electric and hybrid models for reducing emissions (Tilly, et al., 2024). Some automotive companies are now focusing on sustainable manufacturing practices by tapping into renewable energy sources, recycled materials, and reducing industrial waste to help curb their CO₂ emissions (Giampier, et al., 2020). The recycling of end-of-life vehicles, including a limited number of EV batteries, which present their own technical and environmental challenges, has also become an increasing concern (Skeete, et al., 2020).

2.2.2.4 Digitalisation and Connectivity

The automotive industry is increasingly moving in a digital direction, and connectivity features are key to today's vehicles (Lopez-Vega & Moodysson, 2023). Mobility consumers want their vehicles to feature state-of-the-art infotainment technology, over-the-air (OTA) software updates, and seamless connectivity to their phones and other digital devices. Recent innovations in automotive technology have been focused on increasing relevance of connectivity, user experience, and data usage (Abdelkader, et al., 2021). 5G integration is anticipated to significantly improve vehicle connectivity and provide real-time communication links between vehicles, infrastructure, and cloud services that are conducive to safety, traffic management, and autonomous driving (Robustel Company, 2022). At the same time, automotive manufacturers are increasingly focused on updating in-vehicle experiences with more sophisticated infotainment systems, voice recognition technology, and personalised user conveniences to integrate navigation, entertainment, and e-commerce services (Katla, 2025). Vehicle manufacturers are using big investments to improve vehicle

performance, safety features, and offer predictive maintenance capabilities for increased reliability and customer satisfaction (Trade & Industrial Policy Strategies , 2024).

2.2.2.5 Global Trade

The global automotive industry is large and interconnected, with vehicles and parts moving across borders. Trade agreements, tariffs, and geopolitical tensions influence the flow of goods and the strategies of automotive manufacturers (Zhang, et al., 2025). China is experiencing rapid economic growth and, along with it, rapid growth in vehicle ownership (Chen, et al., 2020). It is also a significant hub of EV production (International Energy Agency, 2022). It represents an essential link in global automotive supply chains where several foreign companies operate and wish to expand their activities while facing stiff competition from fast-growing local EV companies (Salaberria & Xia, 2023). In North America, the US remains the centre of vehicle production with several local and foreign manufacturers. However, the United States-Mexico-Canada Agreement (USMCA) tariffs and trade policy have introduced new complexities into regional supply chains (Medina, 2021). Meanwhile, Europe remains a critical market for both traditional and electric vehicles, as stringent European Union emissions standards and increasing consumer demand for EVs are driving significant industry transformation (Qadir, et al., 2024).

2.3 Vehicle Manufacturing Value-Chain

The vehicle manufacturing value chain is a complex set of interrelated stages that include component production, vehicle assembly, distribution, and after-sales services (Kırbaç, 2020). Each stage influences the automotive industry's efficiency and innovation, as well as its local economic impact (Giampieri, et al., 2020). An in-depth understanding of this value chain is essential for identifying opportunities and barriers to enhancing local content, developing industrial capacity, and fostering global competitive advantage (Organisation for Economic Co-operation and Development, 2024).

2.3.1 Vehicle Manufacturing and Assembly

Having outlined the development, structure, and global dynamics of the automotive industry, it is essential to understand what makes vehicles come to life. The industrial activities that generate the most significant economic contribution and technological efforts of the sector are related to vehicle manufacturing and assembly (National Association of Automobile Manufacturers of South Africa, 2022). It is at these stages that the design concepts become products via complex production technology, advanced supply Chain Management and ever more sophisticated automation systems (Thomas, 2024). Figure 2.1 below shows the key processes in the manufacturing and assembly of vehicles, highlighting the steps that define vehicle production. Understanding these processes is crucial for assessing the capabilities of local industries and identifying opportunities to enhance competitiveness and localisation within the broader automotive value chain.

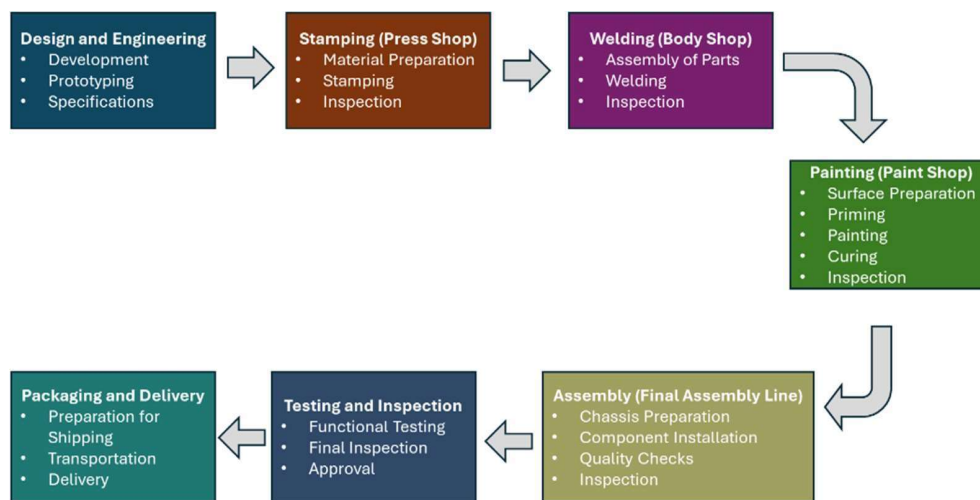


Figure 2.1: Typical Flow of Vehicle Manufacturing Processes, from Body Stamping to Final Assembly.

(Adapted from (Group1, 2021))

To understand the complexity of vehicle assembly, it is essential to go deeper and examine each part that goes into making a modern vehicle. An exploded view of a vehicle is

frequently used as a logical and descriptive representation of how multiple parts or sub-assemblies of the whole vehicle assembly are installed together (Elmaraghy, et al., 2012). The exploded view graphically disassociates key elements (engine, transmission, chassis and suspension systems, not to mention interior components and electronic control modules) to emphasise the complexity and level of design refinement that go into making vehicles today (Panchal & Wang, 2023). Such a view not only enables the explanation of each component's function but also highlights the high level of process integration across various manufacturing steps. Figure 2.2 further shows an exploded view of a conventional motor vehicle, illustrating the functional components used to assemble a complete vehicle.



Figure 2.2: Illustrative Example of Exploded View of a Typical Passenger Vehicle.

Source: (Superlink logistics, n.d.)

2.3.2 Vehicle Component Manufacturing

The production of vehicle components is the backbone of the automotive value-chain. It includes few thousand parts that are assembled to build up a complete vehicle. This includes engine parts, electrical systems, transmission systems, interiors and body structures, and the list goes on (as shown in Figure 2.2). In South Africa, automotive components offer the potential to contribute not only to higher localisation rates but also to increasing competitiveness in international markets. This section reviews the main

manufacturing technology developments, materials, and automation considerations, including productivity enhancements.

2.3.2.1 Forming Processes

Forming is a primary manufacturing operation that makes metallic parts in desired shapes without the removal of material. These processes are particularly important in the automotive industry to manufacture body panels, suspension arms, and chassis frames. The core principle involves plastic deformation of materials under mechanical force, using tools such as dies, moulds, and rollers. Instead of machining the material away, forming allows for minimum waste of the material and fast production with excellent repeatability. Different forming processes are encountered in the automotive industry (Lihui, et al., 2014) and are explained in detail below:

- a) **Stamping or pressing** is a widely used process for manufacturing sheet metal components such as vehicle doors and hoods, subject to multi-stage operations including blanking, drawing, and bending.
- b) **Forging** is when metal is heated, and a die uses significantly more force to press the metal into shape (a crankshaft, or control arm). It produces parts with much higher tensile strength and fatigue characteristics.
- c) **Extrusion** is a process in which hot material is forced through a shaped die to produce long, uniform profiles, typically aluminium, for lightweight structural parts.
- d) **Roll Forming**, slowly wraps material fed by a continuous ongoing cross sectional profile through the use of different rollers (Frames/Chassis, Trunks, etc.).

- e) **Hydroforming** uses high-pressure hydraulic fluid, forms metallic blanks into complex shapes and lightweight parts suitable for vehicle platforms, emphasising performance and fuel efficiency.

These forming processes are of critical importance considering modern automotive industry needs, supporting low-cost manufacturing, high quality, and long-lasting parts. Additionally, they support vehicle lightweighting initiatives by facilitating advanced materials, such as aluminium and high strength steels that are important to enhance fuel efficiency and meet more stringent emission standards (Busarac, et al., 2022). In addition to initial part manufacturing, forming processes also have substantial impacts on downstream secondary processes that include assembly, joining operations and surface treatment, reflecting their critical role in the overall automotive manufacturing process (Govik, et al., 2014).

2.3.2.2 Foundry Processes

Foundry processes are also among the essential manufacturing procedures for automotive components, especially for parts that require complex shapes, high strength, and excellent thermal performance (Bradáč, et al., 2024). A foundry is a place where metal casting is carried out. Metal casting is a metalworking process to form metal into a desired shape by melting and pouring the liquid metal into a mould. In the automotive industry, foundries are essential in the production of engine blocks, cylinder heads, brake calipers, transmission housing, and suspension arms (Bradáč, et al., 2024). Typical casting processes in automotive production include sand, die, and investment casting. For large-scale production, sand casting is still used for most cast engines, such as those in trucks, tractors, and other machinery. High-pressure die casting is used to produce aluminium components, resulting in lightweight parts with high dimensional accuracy and significantly faster cycle times (Baş, et al., 2022). Where more expensive, investment casting is used for making intricate parts that have strict dimensional tolerance requirements such as aerospace turbine blades or gearbox components.

South Africa's low-level production of larger value-added components including precision cast engine blocks, aluminium suspension components and electronic control units has also restricted the ability to localise core vehicle systems. Therefore, a lot of these parts are imported, and this is actively costing the country a chronically low local-content build-up. Without purposeful investment in advanced manufacturing capabilities, South Africa will be unable to transition from base component assembly towards higher-value-added activities.

2.3.2.3 Plastics and Ceramics

Automotive component manufacturing in plastics and ceramics has gained high attention recently because of the growing need for lightweight materials offering corrosion and heat resistance. Plastics are commonly used for interior, exterior, and under the hood parts. Ceramics are used in specialised applications requiring heat resistance, wear resistance and electrical insulation. Both the materials are used in enhancing the performance of vehicles, fuel efficiency and sustainability (Pradeep, et al., 2017; Automotive Components Trade, 2024).

a) Plastics

Injection moulding is the main shaping process for plastics, in which thermoplastic polymers are melted and injected into metal cavities under high pressure. With this process, complex parts can be produced in large numbers with reliable quality and little scrap. Usual applications in the automotive industry are bumpers, dashboards, instrument panels, fluid tanks, HVAC systems, and interior panels (Li, 2024). Engineering plastics such as polypropylene (PP), polyamide (PA), ABS, and PC have good impact resistance, low weight, and design flexibility.

b) Ceramics

Ceramics are less widely used but particularly important for high-performance applications. High-performance ceramics such as SiC, Al₂O₃, and ZrO₂ are used in components that operate under extreme conditions of temperature and chemical attack. Typical applications are spark plugs, exhaust gas sensors/wires, brake discs, and pads. (Wilkes, 2013).

Plastics and ceramics have their own manufacturing drawbacks. Environmental concerns related to end-of-life recyclability and microplastic formation have spurred demand for bio-based polymers and circular-economy approaches to plastics. At the same time, ceramic materials are inherently more expensive to fabricate as a result of their brittle nature, precise machining needs and controlled sintering techniques (Dadkhah, et al., 2023).

The local ability to produce plastic parts for interior trim and underbody applications has increased in South Africa. However, there is only limited infrastructure for advanced polymer compounding and for commercial-scale ceramic manufacturing. To close these gaps, investment would be needed in materials engineering, R&D facilities, and personnel training aligned with global manufacturing standards or the country's green innovation goals.

2.3.3 Challenges in Automotive Component Manufacturing

Precision component manufacturing is essential across a wide variety of industries, including electronics, automotive, aerospace, and medical devices, where accuracy and production throughput are key. However, manufacturers face several challenges that hinder production processes, affect cost-effectiveness, and threaten the quality of end products. The challenges include shipping delays due to disrupted supply chains, leading to both late delivery of components and delayed schedules, problems maintaining

consistent quality control for complex product designs, and increased demand for customisation. (Grzybowska & Stachowiak, 2022). Additionally, rising production costs and competitive pressures make manufacturing layout more difficult, making it harder for manufacturers to stay profitable without compromising quality (Omar, et al., 2019). Ensuring consistent quality in complex, highly customised component designs remain a significant challenge (Maware & II, 2022). Manufacturers often struggle to find the right balance between precision and throughput while reducing waste, rework, and defect rates (Taher & Bashar, 2024).

There is also a shortage of skilled personnel in precision manufacturing and advanced technologies. The scarcity of qualified workers reduces productivity, limits innovation, and impacts overall production efficiency, highlighting the critical role of workforce development programmes (Kadugala, 2025). Equipment reliability also poses another challenge. Unexpected machinery failures or maintenance needs can result in significant downtime, reducing throughput and increasing operational costs (Mustafa & Lleshi, 2024). Also, the complexities in manufacturing complex parts increase concerns of intellectual property (IP) protection and counterfeiting, which can threaten competitiveness and brand reputation (Skowronski & Benton, 2017). The rapid evolution of technology, including the implementation of Industry 4.0 solutions, demands substantial investment and adaptation, posing barriers for smaller manufacturers that may lack the resources to keep up with innovation (Horváth & Szabó, 2019).

Environmental and regulatory compliance adds another layer of complexity. Meeting strict environmental and sustainability standards can increase production costs and operational complexity, particularly for companies that are not yet equipped with green manufacturing capabilities (Abdellatif, 2024). In addition, fluctuations in market demand and changing customer preferences require agile production processes, which can be difficult to implement within traditional manufacturing systems (Kumar, et al., 2022). Lastly, South African manufacturers face the dual pressures of competing with international suppliers while simultaneously meeting local-content requirements. This

creates a need for strategic investment in local sourcing, capacity building, and operational flexibility to remain competitive in both domestic and global markets (Mucheka, 2019).

Collectively, these have shown that automotive components' manufacturers need to be extremely flexible, creative, and strategic to operate in a complex and rapidly changing industry in order to maintain quality, cost control, and compliance.

2.4 Automation and Robotics in the Automotive Industry

Applications for automation and robotics in the automotive industry have transformed how vehicles are produced by improving operating efficiency, quality, and safety. These are the technologies which contribute significantly to facilitating manufacturing of devices, increasing accuracy, and reducing work costs. Robotics has been applied in the automotive industry, ranging from assembly lines to welding, painting, and material handling (Adebayo, et al., 2024).

Higher efficiency is another major advantage of automation in the automotive industry (Zondo, 2023). Robots do not get tired, and they certainly do not require breaks. They work at speeds and with a precision far beyond human capabilities. This allows manufacturers to produce large quantities of vehicles in a shorter period keeping it up with the growing demand and reducing lead times (Javaid, et al., 2021). For example, mechanically strong robots used on assembly lines can continue welding, parts fitting or screwing without getting tired and not easily making a mistake since they maintain a high level of accuracy, thereby a smaller number of errors and hence better vehicles produced (Javaid, et al., 2021).

Cost reduction is one significant advantage of automation. Although the initial investment in robotics and automation systems can be high, the potential return on investment is significant (Rajuroy, 2025). Automation diminishes reliance on manual work and thereby decreases labour costs while minimising human error that results in expensive mistakes (Nazareno &

Schiff, 2021). The use of materials is maximised, while the waste and cost are minimised. Automation also serves to optimise the recycling function as well (Țîțu, et al., 2024). The implementation of robotics also contributes to improved workplace safety and employee welfare. Robots are frequently utilised for tasks that are repetitive, dangerous, or physically demanding, such as lifting heavy objects or operating in challenging environments such as welding and painting (Delgado, et al., 2019). This application minimises the risk of workplace accidents and injuries, thus promoting a safer environment for human workers. Moreover, robots can operate effectively in extreme conditions and hazardous settings where humans might encounter severe injury or even fatality (Yang, et al., 2022).

The capacity to adjust manufacturing processes instantly is a significant advantage offered by automation and robotic technologies. With the increasing demand for personalised vehicles, automation is essential for improving manufacturing flexibility. Robots can be quickly reconfigured to meet various model specifications or component set-ups, allowing automotive manufacturers to efficiently respond to the rapidly evolving market needs (Javaid, et al., 2021). However, there are still challenges that hinder the progress of automated robotics. A significant barrier is the substantial cost of automation systems, which can be particularly difficult for smaller enterprises to manage. Additionally, deploying advanced robotics necessitates a workforce equipped with specialised expertise in programming, maintenance, and technical support. There are also apprehensions about potential job losses as machines replace positions once occupied by humans. This transition raises worries about possible job losses and underscores the importance of reskilling employees (Harris, 2020).

2.5 Global Automotive Supply Chain Dynamics

With the growing global networks of today's world, automotive companies depend on an extensive and complex worldwide supply chain to produce technology-compliant vehicles while meeting regulatory and consumer requirements (Dakić, et al., 2024). This chain of supply includes getting raw materials, manufacturing parts, assembling vehicles together and

shipping them out to world markets spread across the global level (MacCarthy, et al., 2022). However, the automotive supply chain is very vulnerable to external shocks such as geopolitical tensions, trade rules, and macroeconomic developments because of its international nature and complexity (Katsaliaki, et al., 2021). The next three sub-sections illustrate the basic components of automotive supply chains, the main drivers of change they encounter and then focus on manufacturers' strategic leverage to manage this changing business environment.

2.5.1 Supply Chain Activities in Automotive Manufacturing

The automobile value-chain consists of three main phases: supply, production and distribution, which are important for vehicle manufacturing as well as delivery to the world markets. Automotive manufacturers procure raw materials and components from local as well as foreign suppliers (Ramanajneyulu & Mohan, 2023). These components are then transported to manufacturing facilities, often across multiple borders, where final vehicle assembly takes place. Completed motor vehicles are then shipped to global markets after their assembly, and the effectiveness of logistics is critical for satisfying consumer demand and keeping inventories at appropriate levels (Boysen, et al., 2015).

2.5.2 Challenges in Global Automotive Supply Chains

The organised stream of procurement, production and distribution forms the basis for lean global automotive supply chains but is gradually open to a range of external factors. The deeply interconnected nature of the automotive manufacturing also leads to the possibility that interruptions, such as those caused by the COVID-19 crisis, in regions can result in numerous downstream pressures on transnational value chains (Eldem, et al., 2022). Factors such as rising trade barriers, economic volatility, and geopolitical uncertainty have made it more difficult for manufacturers to maintain stable, cost-effective operations (T.Karibasappa, 2016). As a result, automotive manufacturers are pressured to continuously reassess their strategies to ensure resilience and agility. The following

outlines the most significant challenges currently facing the global automotive supply chain.

2.5.2.1 Tariffs and Trade Policies

Tariffs disrupt the automotive supply chain. For example, the 25% U.S. administration tariff on imported vehicles and parts has raised production costs and changed supply chains. Vehicle manufacturers have had to review their supply chain strategies, including some looking at moving and or localising production to lower the tariff impact (INFINITI, 2025).

2.5.2.2 Economic Fluctuations

A slowdown in the economy depresses consumer demand, causing production volumes and supply chain dependability to be compromised. The International Monetary Fund (IMF) observes that tariffs cause global economic downturns to which the automotive industry is affected (Krajisnik, 2014).

2.5.2.3 Political Instability

Drastic policy changes lead to instability in the supply ecosystem. Trade conflicts between the world's largest economies have also impacted automotive parts and complete vehicle flow (Automotive World, 2025).

2.5.3 Strategies for Mitigating Supply Chain Challenges

Due to all the risks associated with tariffs, economic volatility and political instability, automotive OEMs are implementing proactive strategies to build better supply chain resilience. One such measure is the diversification of import origins, which would lead to reduced dependence on a single region for components and reduce vulnerabilities resulting from trade disruptions or geopolitical instability (L. Jeff Hong; Jinzhi Li; Xiaole Wu; Shuyue Yi, 2023). Concurrently, numerous companies are building local plants to bypass tariffs and reduce lead times while also making it easier for them to respond to market demands (Research FDI, 2020). Furthermore, adoption of state-of-the-art monitoring and digital supply chain tools has helped manufacturers increase visibility, predict disruptions, and respond better to unforeseen issues (Celestin & Singaram, 2024). Such adaptive specifications are necessary to secure operational continuity and competitiveness in an atmosphere of higher degrees of global turbulence.

2.5.4 Supplier Management

Supplier management is one of the most critical scopes of work in the global automotive industry. These scopes are for coordinating and evaluating a group of suppliers providing supplies and components. High selection criteria, such as an approved list of suppliers conforming to international quality standards (International Automotive Task Force (IATF) 16949 etc.), are used by global supplier management to ensure continuous supply. The permanent assessment is based on the delivery time, total costs, reject ratio, and reaction to engineering changes (Park & Hartley, 2006).

OEMs' strategic collaboration is critical when dealing with supplier management in emerging economies. In this system, OEMs often form strategic supplier relationships in which the two enterprises work together to create and share benefits of innovative technology. This includes investing jointly in additional capacity and capabilities, building up contingencies to support production difficulties while spreading investment costs

(Modungwa, et al., 2021). Advanced economies use digital technologies and predictive analytics to enhance supply chain visibility in a world that witnessed shocks such as the COVID-19 pandemic, global shortage of semiconductors and geopolitical instability. Also considering the shift towards electrification and digitalisation in the industry, OEMs are required to partner with non-traditional suppliers such as software companies and battery suppliers where intellectual property (IP), cyber security and more need closer scrutiny (Huang, et al., 2023).

2.5.5 Supply Chain in Emerging countries compared with Developed Countries

Key strategic programmes such as diversifying the supply chains across sectors, investing in local markets, and boosting visibility in sectors all contribute to stronger global automotive supply chains. However, significant challenges still remain in the functioning of these supply chains when a comparison is made between emerging and developed economies. The automotive manufacturing sector plays a big role globally, it necessitates that supply chains are diversified and structured to meet regional demands, capabilities, and challenges (Ambe, 2014).

Limitation of infrastructure, raw material quality, lack of consistency as well as workforce skills gaps are still constraining factors in emerging markets for supply chain efficiency and integration (Alshahrani, 2023). Developed countries, on the other hand, have established industrial networks, advanced manufacturing technologies, and ways of easy access to high quality components (CFAM, 2019). The next section compares these differences focusing on raw material sourcing and technological capacity of which are core pillars of supply chain performance in the automotive sector.

2.5.5.1 Raw Materials and Components Sourcing

Developing economies face a high number of challenges in securing high quality materials for automotive manufacturing due to underdeveloped local production capacities. Essential materials such as steel, plastics, aluminium, and precious metals are either produced in limited quantities or with inconsistent quality, forcing manufacturers to rely more heavily on imports (National Association of Automotive Component and Allied Manufacturers, 2020). This reliance on global suppliers exposes them to risks related to trade constraints, currency fluctuations, customs inefficiencies, and transportation delays, which in turn increase production costs and lead times (Organisation for Economic Co-operation and Development, 2025). Although regional supply chains have been established among neighbouring emerging economies, these regional components often suffer from inconsistent quality and limited availability, undermining supply chain reliability and adding complexity to the operational environment (United Nations Conference on Trade and Development, 2023).

In contrast, developed economies have continued access to a stable and high-quality supply of raw materials including long established local industries and efficient international trade linkages for a smooth movement of resources (International Monetary Fund, 2025). They also use proper recycling technologies to recollect and reuse metals, plastics and batteries, which reduces dependence on virgin feedstock material and is aligned with sustainable goals (Sa & Korinek, 2021). Furthermore, advanced electronic systems, such as alloys and semiconductors are needed for producing modern technologically advanced vehicles, and these higher-value-added parts are more easily obtained by manufacturers in developed economies (AZO Materials, 2023). This proximity provides for efficient production, investment as well as innovation and worldwide competitiveness in the automotive business.

2.5.5.2 Manufacturing Capabilities and Technology

In emerging countries, manufacturers tend to have limited investment in new technologies, therefore, depending on old machinery and less-efficient processes which lead them to lose the competitive edge and product quality (Quaye, et al., 2024). Automation, robotics and industrial 4.0 technologies have been slow to being implemented due to high costs cost of infrastructure, frequent supply chain disruptions, production delays, and increased costs in general (Kuma, et al., 2021). In many of these economies, there is a lack of skilled labour and capacity (Invisu, 2025) where vocational and technical education systems have not kept pace with technological requirements for manufacturing in emerging economies. Thus, manufacturers in these areas have difficulties scaling up and ensuring good quality components, leading to poor integration into global automotive supply chains.

In contrast, manufacturers in developed economies benefit from significant investments in advanced manufacturing facilities equipped with top automation and robotic systems that improve efficiency, precision, and scalability (Deepika, et al., 2024). High levels of automation reduce reliance on manual labour, enabling cost savings and consistent quality output. Developed countries are also leaders in Industry 4.0 technologies, using internet-connected machinery, AI, machine learning, and data analytics to optimise production processes (Ricadela, 2024). These technologies support predictive maintenance, real time quality control, and efficient inventory management, which highly reduce downtime and waste while increasing productivity. The adoption of smart manufacturing practices allows developed-economy manufacturers to quickly adapt to market demands and sustain competitiveness in the digital global economy (Nzama, et al., 2024).

2.6 Industry Synergy and Ecosystems in the Automotive Sector

The automotive sector is undergoing a significant shift, driven by advances in manufacturing processes and technological innovations. This results in the development of industry collaborations and interconnected systems. These interconnected networks bring together

manufacturers, suppliers, technological companies, and government entities to encourage innovation, lower costs, and enhance sustainability (Kukkamalla, et al., 2021). The sector is shifting towards a collaborative environment where various stakeholders join forces to meet evolving consumer demands, comply with stricter environmental regulations, and keep pace with rapid technological changes (Dwivedi, et al., 2023). This trend towards increased collaboration is reshaping the future of mobility as Original Equipment Manufacturers (OEMs) increasingly form partnerships with uncommon participants such as technology leaders, battery manufacturers, and renewable energy companies. This co-operation not only accelerates innovation but also strengthens circular economic efforts through joint initiatives in material recycling and sustainable manufacturing practices (Stone, et al., 2023).

In some areas, for example, in Europe, government partnerships with automotive companies have seen EV infrastructure developed and battery technology perfected, driving the industry's dedication to conservation (Madaram, et al., 2024). Moreover, the application of Industry 4.0 facilitators such as artificial intelligence (AI), internet of things (IoT) and big data have increased manufacturing efficiency and facilitated the growth of innovative mobility solutions. These developments are transforming how automotive companies operate and interact with their customers, focusing on value chain collaboration (Gupta, 2025).

The automotive industry in South Africa is starting to move towards these global trends by focusing on local strengths, the development of an electric vehicle (EV) market and the shift to sustainable production. Joint co-operation between OEMs and local suppliers can reinforce South Africa's position in a global automotive ecosystem as manufacturers will depend on local suppliers for critical parts (Tshwane Automotive Special Economic Zone, 2023). In an effort to meet the increasing demand for EVs globally, South Africa is investing in EV infrastructure and providing incentives to support a rapid growth, where key industry players such as BMW South Africa and Mercedes-Benz are incorporating EV production into their local manufacturing lines (Department of Trade, Industry and Competition, 2023). Such programmes help the country to compete in the global EV market.

Another focus is sustainability. Some local OEMs such as Volkswagen Group South Africa are developing solar and wind-based energy for manufacturing while working with local recycling companies to avoid the negative ecological footprint associated with automotive productions (Mutumi & Simatele, 2017). In response to the skills gap in advanced manufacturing, South Africa's automotive industry is investing in training courses related to robotics, automation and digital manufacturing to develop local workforces and to support an Industry 4.0 environment (Ngepah, et al., 2024). Smart mobility services, such as ride sharing and integrated public transport, are also leading to increased collaboration between vehicle manufacturers and technology companies as well as with mobility service providers in cities such as Cape Town and Johannesburg (Ho & Tirachini, 2024).

2.7 Global Value-Chain Integration

As the global automotive industry becomes increasingly interconnected, value chains develop complex networks across continents. Such global value-chain (GVC) integration enables manufacturers to reduce costs, improve efficiency, and ensure quality by procuring components from specialised suppliers across the globe (Habisch, et al., 2022). But this kind of international reliance also puts pressure on local industries to comply with global standards at competitive costs. Although participation in GVCs opens access to international markets and facilitates export growth, it often poses structural barriers for countries aiming to enhance local content, particularly in sectors dependent on advanced technological inputs and established international supplier relationships (Yu, 2025).

The South African automotive sector is characterised by a dual of opportunity and constraint. About 64% of the country's vehicle production in 2021 was for export, with the European Union and the United States receiving most of this production, according to one estimate in the Automotive Export Manual (2021). Such high level of export orientation has made South Africa a strong player on world markets but also requires observation by sources for international products. As a result, OEMs and Tier 1 suppliers tend to favour long-standing global supply chains that can obey stringent quality/cost/delivery criteria. Almost 70% of

components in export models' vehicles are imported (Ramanajneyulu & Mohan, 2023). This demonstrates the low involvement of local suppliers in high-value-added segments.

While GVCs contribute to South Africa's export competitiveness in automotive, it also highlights key constraints preventing local-content growth. Addressing these will require mutually delegated policy interventions that encourage supplier development, help to upgrade technology and that promote local sourcing. This can lead to a stronger, more resilient, and globally integrated local automotive industry. Understanding the conceptual foundation of localisation and local content will also provide a clear direction through which policy interventions and industry reforms can be designed to enhance local value creation and economic resilience within the South African automotive sector (Monaco, et al., 2020).

2.8 Localisation in the Automotive Industry

There is a strategic necessity for countries engaged in automotive production to focus on localisation. This approach aims to enhance local value creation, reduce reliance on imports, and foster industrial development (Nyamwena, et al., 2023). Localisation serves not only as an economic requirement but also as a policy aimed at boosting competitiveness, generating employment, and strengthening the resilience of the automotive supply chain (Cholo, 2023). A comprehensive understanding of the characteristics and scope of localisation is essential for evaluating its implications as well as the responses from both policy makers and industry stakeholders (Lee, et al., 2021).

2.8.1 Conceptualising Localisation and Local Content

Localisation is vital for the cost optimisation strategies utilised by global automotive suppliers. This approach allows these manufacturers to cater to specific customer needs, react quickly to shifts in the market, and comply with local trade regulations (PwC, 2024). By manufacturing vehicles and parts nearer to their target markets, companies can lower transportation costs, avoid tariffs, and improve delivery speed. Additionally, local production has a beneficial impact on regional economies by generating employment

opportunities and bolstering associated sectors such as logistics, maintenance, and parts supply. Prominent global firms such as Toyota, Ford, and Volkswagen have set up production sites in different regions including Asia, Africa, and South America to strengthen their foothold in local markets and achieve competitive advantages (Lee, et al., 2021).

Closely related to local manufacturing is the practice of localisation which focuses on increasing the proportion of locally sourced materials, components, and services used in vehicle production. Localisation strengthens supply chain resilience, stimulates local supplier growth, and supports the larger objectives of industrialisation (Monaco, et al., 2020). Different countries have employed different means of encouraging localisation. In the case of India, localisation levels are driven primarily by the Make in India and Phased Manufacturing Programme (PMP), with major players such as Maruti Suzuki and Hyundai achieving exceedingly high levels. Brazil uses import substitution and fiscal incentives to drive component manufacturing locally (Miglani, 2019). Thailand has established itself as an integrated manufacturing base through a local sourcing network and the assistance of trade relations. China's model of localisation features strong joint-venture requirements and aggressive supply chain support for electric vehicles, which makes China a global leader in both production and innovation (Seth, 2025).

2.8.2 Definition and Theoretical Frameworks

Localisation in the automotive industry involves the sourcing of parts, components, labour, and services from local suppliers instead of shipping them from foreign manufacturers (Ambe & Badenhorst-Weiss, 2010). This approach does not only serve to reduce costs, fiscal dependency, and bolster supply chain resilience, but it is also a way to foster local economic development through employment creation and the promotion of local companies.

Several theoretical frameworks provide insights into why companies pursue localisation. Transaction Cost Economics (TCE) highlights that local sourcing minimises contracting and monitoring costs because of geographic proximity and cultural closeness (Pinto, 2017). In the literature, there has been a resurgence of interest in the RBV focus on hard-to-imitate resources (concepts such as local market knowledge, specialised labour and relationships with suppliers), which support sustainable competitive advantage (Kero & Bogale, 2023). Human Capital Theory underscores the importance of workforce investment, with recent studies showing that localised skills development enhances productivity and innovation in manufacturing industries (Awu, et al., 2025). Technology-Transfer Theory continues to explain how companies transfer knowledge and advanced production technologies to local suppliers, enabling them to meet stringent quality standards and innovate (Wahab, et al., 2012). Finally, Institutional Theory stresses the role of regulatory frameworks and social norms in shaping localisation strategies, with recent work showing that alignment with institutional pressures is crucial for legitimacy and integration in global value chains (Pinto, 2017).

These theories collectively contribute to a deeper understanding of localisation strategies, which aim to lower costs, obtain vital resources, enhance workforce capabilities for technological transfer, and adapt to institutional frameworks that benefit both industries and local economies (Wahab, et al., 2022). In light of these theoretical models, it is crucial to analyse the difference in how nations customise their localisation strategies to align with their unique economic, technological, and political environments. Understanding the implementation of localisation is vital because of the significant differences in policies across nations, shaped by unique national goals such as enhancing industrial competitiveness, safeguarding supply chains, and promoting technological progress (Banda, et al., 2022).

2.8.3 Global Localisation Strategies

Localisation strategies differ significantly across the globe, influenced by the unique economic goals, political contexts, and technological ambitions of each country or region. These approaches are generally motivated by national priorities, which include enhancing industrial competitiveness, safeguarding supply chains against global disruptions, and advancing technological frontiers to maintain or achieve leadership in key sectors (Hitt, et al., 2015). For example, particular countries emphasize more advanced manufacturing to be able to better compete in high-tech industries while others are concentrated on creating self-reliance for essential goods which also reduces the degree of external vulnerability (Atkinson, 2024). Institutional pressures, such as regulatory and cultural ones also heavily contribute to the context-bound nature of localisation policies because companies are forced to conform their strategies to local contingencies (Yuning, et al., 2024).

These multiple motives and external pressures lead to a variety of localisation strategies that deal with distinct country-specific challenges and opportunities. This diversity becomes evident by looking at different strategies pursued in major global players such as Europe, Russia, China and the United States with their separate policies and strategies stemming from national industry targets and geopolitical context:

2.8.3.1 Europe: Strategic Localisation Through Industrial Policy

European localisation strategies focus on supporting industrial resilience and competitiveness by integrating advanced technologies and creating supportive policy frameworks. For example, the German Industry 4.0 initiative aims to transform manufacturing through digitalisation and automation; this initiative encourages other EU members to adopt state-of-the-art technologies in their local industries (Rojko, 2017). At the EU level, relevant policies for key sectors such as pharmaceuticals and renewable energy aim to foster production capacity in Europe, reduce reliance on non-EU

manufacturers and enhance the security of supply chains (European Commission, 2023). The initiatives also, together, represent a strategic commitment to promoting strong, technologically advanced, and autonomous industrial bases throughout the EU.

2.8.3.2 Russia: Import Substitution and Industrial Sovereignty

Since the early 2010s, Russia has increased its localisation efforts to achieve industrial self-sufficiency and reduce import dependence. A key tool of that strategy has been the Special Investment Contracts (SPICs), through which foreign investors are offered subsidies, tax breaks, and regulatory help to build locally. These contracts are designed to facilitate technology-transfer, open up employment opportunities at home, and help build the capacity of Russia's local industrial base (Aydinyan & Goulis, 2021). More recently, with an increasing focus on broader economic security goals (e.g to limit reliance on imported components and promote investment in advanced manufacturing technologies), localisation has been on the rise.

2.8.3.3 China: From Global Factory to Technological Powerhouse

China's localisation story has undergone a shift from being the world's factory to pursuing technological self-reliance. "Made in China 2025" which was introduced in 2015, aims to improve indigenous manufacturing by raising the local content of several key industries such as semiconductors, aerospace and electric vehicles as well stimulate innovation (Marcato, 2022). Special Economic Zones (SEZs) like Shenzhen and Dongguan have played a great role in bringing in foreign investment, technology diffusion, development into key nodes for high-tech manufacturing centres as well China's economic expansion resulting in a considerable increment of the industrial capacities (Yijie & Zeyu, 2023).

2.8.3.4 United States: Revitalising Local Manufacturing

The United States has renewed its emphasis on localisation, especially in the wake of disruptions to global supply chains made clear by recent world events. One such example of this trend is the CHIPS (Creating Helpful Incentives to Produce Semiconductors and 0

. Together, these strategies indicate that localisation is a critical approach and a crucial strategy that countries need to take to maintain industrial competitiveness, ensuring their supply chains and innovation are under greater complexity in a global and more unpredictable world (Department of Trade, Industry and Competition, 2021).

2.8.4 Localisation in Developed Economies

Evidence over the last five years shows that developed economies are consistently achieving high localisation rates, with Germany often noted by example as obtaining between 75-80% of local value addition in its automotive industry, facilitated by mature supplier and advanced manufacturing ecosystems (Reynolds & Uygun, 2018). This reflects the critical role localisation plays in maintaining vehicle manufacturers' advantage in advanced markets. Such localisation strategies are characterised by government industrial policy, substantial investment in Industry 4.0 technologies and strong supplier integration, which allow developed economies to react to the new global conditions and retain their role as innovators of the automotive industry (Organisation for Economic Co-operation and Development, 2024).

2.8.4.1 Labour Costs

With labour costs increasing in emerging markets, automotive manufacturers are considering shifting operations back to developed nations where labour costs are high but may be offset by advanced technological capabilities and stable economic environments.

Furthermore, technology-transfer is an important factor in localisation as companies leverage foreign markets' innovation ecosystems to improve efficiency and absorption of advanced manufacturing technologies (The Conversation, 2020). Localisation efforts are also increasingly associated with the adoption of industry 4.0 technologies, such as automation, digital twins or AI enabled quality inspection systems. They improve supply chain agility and production flexibility which are critical to remaining competitive in this evolving global marketplace (QIKTRUCK Logistics, 2022).

2.8.4.2 Market Access

Market access is another key reason for localisation strategy. With local production, vehicle manufacturers have direct access to regional markets and can respond quickly to changing market demands for products while eliminating shipping costs and tailoring products for local market conditions. This will not only make the response cycle of automotive companies shorter, but it will also help them to be better prepared for market trends and legal requirements in certain regions (PwC, 2024). Accordingly, localisation offers the possibility of greater flexibility and hence competitiveness in both local and international markets, providing automotive companies with the ability to be flexible and more competitive, strengthening their position in both local and international markets (Centre for Development and Enterprise, 2021).

Studies reviewed refer to the synergies and strategic advantages associated with localisation that increase competitiveness such as cost disadvantages, technology spillovers, and market potential (Ordorica, 2023). On the other hand, challenges such as regulatory barriers, combined with adjusting to a more complex and diversified supply base, need to be managed carefully (World Economic Forum, 2022). These insights set the stage for examining localisation in emerging economies, where localisation rates tend to be lower and distinct obstacles exist (World Economic Forum, 2022).

Applying theoretical frameworks such as Rew (RBV), TCE, and the institution-based view (IBV) offers valuable perspectives on how companies navigate the challenges of localisation in emerging economies (Onwuzulike, et al., 2024). These frameworks help explain how companies balance cost efficiency, resource development, and institutional alignment when making sourcing decisions. Furthermore, government policies, market forces, cultural fit and readiness along the supply chain are all crucial determinants of localisation experiences, and this highlights the complexity and multiple nature involved when promoting local automotive industries within developing economies (Nnaji, et al., 2024).

2.8.5 Localisation in Emerging Economies

Localisation levels in emerging countries are relatively lower when compared to those from developed countries, with South Africa reporting an average localisation rate of 40% (National Association of Automobile Manufacturers of South Africa, 2024). This difference highlights the difficulties of developing countries in achieving high local content levels in their automotive industries, due to a lack of skills, especially to absorb and produce technologies, technology infrastructure, and investment. These gaps indicate that targeted interventions are needed to build local supply chains and industrial capacities (Naude & Badenhorst-Weiss, 2012).

The process of localisation can be examined through several theoretical frameworks, including the Resource-Based View (RBV), transaction cost economics (TCE), and the IBV, each providing unique insights into how companies navigate the complexities of localising production (Patnaik, et al., 2022). The RBV underscores the competitive advantage that can be gained from effectively leveraging local resources and capabilities, such as skilled labour and raw materials. In contrast, TCE emphasises the importance of minimising transaction costs and enhancing operational efficiency when managing supplier relationships and production processes. At the same time, IBV theory places a significant emphasis on institutions including regulation, policy and culture, as

determinants of localisation strategy and success (Mahoney, 2020; Patnaik, et al., 2022). Combined, these theories offer a more complete understanding of the factors that influence localisation, with companies balancing resource utility, cost, and institutions adaptiveness under different conditions.

There are a number of critical elements that influence the success of automotive localisation. Policy initiatives take a leading role as they offer such incentives as tax holidays, reliefs, and subsidies that stimulate foreign direct investment (FDI) and cause manufacturers to source locally (Chipfupa, 2022). Local content requirements encourage vehicle manufacturers to source locally and promote economic integration, given that they have to engage with local suppliers. Market dynamics, including an understanding of local consumer preferences, pricing strategies, and distribution networks, are also important in tailoring products to meet regional demands (Monaco, et al., 2020). Additionally, cultural relevance in ensuring that vehicles align with local cultural values and preferences can foster consumer loyalty and improve market penetration. Last but not the least, a ready and resilient local supply chain is also key to the viability of localisation initiatives, as they also make it possible to efficiently source components and materials (Liu, 2023).

Localisation remains a critical challenging goal but important objective for emerging economies, particularly in the automotive sector. The problem is building capacity, both technological and skills based. To have this, there has to be the right combination of strategic policy support, institutional alignment, and the development of supply chain. Therefore, the following graph compares localisation rates across selected emerging economies, illustrating the diversity of local-content and the importance of customised measures to raise competitiveness.

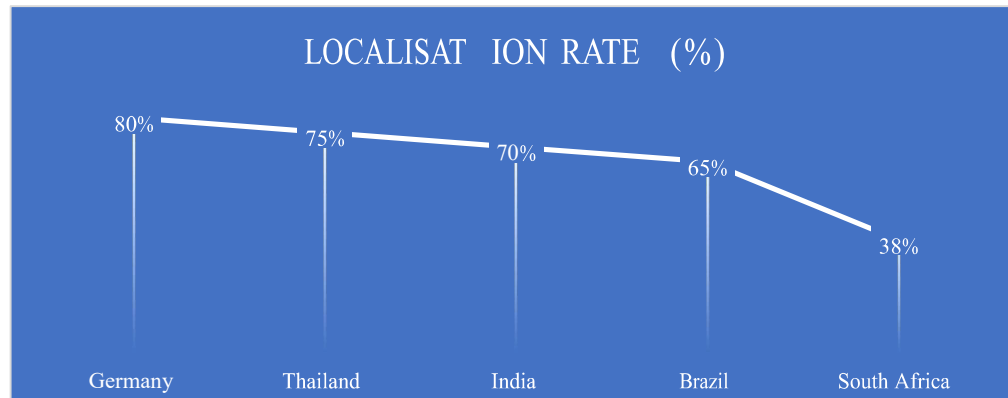


Figure 2.3: Comparative Localisation Percentages.

Source: NAAMSA, 2024 (shared after the interview)

The relatively good performance of India, Brazil, and Thailand with local content levels greater than or close to 70% show the importance of integrated policy, investment, and skills strategies. By contrast, South Africa's local content sits at 38%, with the fragmented nature of skills development and a still immature supply base, including access to local tool-making facilities, all these contribute to this low figure. These are obstacles to the potential upscaling of local production in high-value-added segments of the automotive supply chain.

2.8.6 Comparative Localisation Approaches in Emerging Economies

Some among emerging markets have gained much higher localisation through purposeful policy alignment, strong incentive structures, and focused skills development. Table 2.1 outlines some of the critical approaches utilised by India, Brazil, and Thailand, whose policies have resulted in a successful enhancement of local content, as well as local industrial ecosystems. These examples offer valuable lessons for South Africa's automotive localisation agenda.

To understand South Africa's difficulties and possibilities for localisation, a reference to developing countries, whose local content is high, should be done. India, Brazil and

Thailand have used industrial policies with effective incentives, skills development and regulatory conditions to promote local production. These examples provide constructive insights into the interventions that will help to develop local suppliers, enhance their competitiveness, and bring sustained investment. Table 2.1 summarises the localisation strategies that were employed by these countries and illustrates that a combination of policy instruments, selective incentives, and workforce development programmes contributed to their success (Department of Trade, Industry and Competition, 2021).

Table 2.1: Comparative Localisation Strategies in Emerging Automotive Economies.

Sources: (Ministry of Heavy Industries, 2025; Marx & Mello, 2014; Wonglimpiyarat, 2016)

Country	Policy Instruments	Localisation Incentives	Skills Development Initiatives	Outcomes
India	Phased Manufacturing Programme (PMP)	Tariff protection for local parts Production linked incentives	Automotive Skills Development Council Industry (academia certification programs)	(1) Localisation > 70%. (2) Strong Tier2 supplier base
Brazil	Inovar Auto Programme Tax reform for industrial growth	(1) Tax credits tied to local content Import substitution measures (2) R&D incentives	SENAI training Institutes OEM-led apprenticeships	(1) Expanded local content. (2) Diversified component manufacturing
Thailand	Automotive Master Plan "Detroit of Asia" strategy	Tax holidays for local production, Mandatory local sourcing in ecocar programmes	Automotive Human Resource Development Institute (AHRDI) OEM-coordinated vocational training	(1) Localisation > 80% (2) Regional export hub (3) Strong SME integration into the supply chain

2.8.6.1 Comparative Analysis of Local Content Development in Emerging Countries

Local content promotion is now seen as more than an economic policy; it is also a strategic instrument to foster self-sustenance, creativity, and broad-based industrial expansion. Countries including Brazil, India and Thailand have proven the power of long-range, industry-specific policies that support the development of local auto ecosystems. They provide valuable case comparisons of how indigenous capacity can be developed to support sustainable development and international competitiveness (Kaziboni & Stern, 2020).

The Brazilian government has implemented a measure, through which automotive manufacturing companies are required to include a certain proportion of local parts (ANFAVEA, n.d.). This has improved the local value-added chain and valorised national companies. In Brazil, local content reached around 65% in 2023, driven by incentive policies that foster national innovation and industrial development. Such measures have enabled Brazil to reinforce its industrial resilience while promoting homegrown engineering capacities (Rocha, 2018).

India presents another successful example, especially the implementation of Production-Linked Incentive (PLI), which has raised the local-content requirement to 75% by 2023. Such growth has been supported through investments in indigenous technology development, labour force training and inter-institutional collaborations (Government of India, 2024). Government initiatives, to narrow the academia-industry gap through R&D collaborations, have created a pool of talent that can feed into world integrated value chains. The Indian (and others) experience reconfirms that human capital development and policy confluence can fuel technology advancement and job generation (Society of Indian Automobile Manufacturers, 2022).

Validation from Thailand also supports the need for inclusive policy design. The country has prioritised focus, such as the development of SMEs, public-private sector collaboration through projects introduced by Thailand Automotive Institute and Board of Investment Thailand (Srisathan, et al., 2023). Thailand, with local content of over 70%, has effectively established itself as a regional automotive production hub. This process has also led to enrichment of communities and an improved national competitiveness with supplier development being driven by targeted government-led innovation strategies and coupled with strong stakeholder buy-in (Asada-Miyakawa, 2024).

These international examples are a model for South Africa on how to grow its automotive industry. South Africa has a strong policy platform, coupled with industrial strength and skilled labour that can enable higher local content. However, doing so will require

coherent policy direction, ongoing investment in regional suppliers and a deliberate effort to lower import dependence. There is more to local content than just promoting a few jobs. Poverty-reduction argument aside, it is a chance to create decent jobs and build up local value chains; potential opportunities that should make a strong enough case for an inclusive economy.

2.8.6.2 Barriers to Local-Content Development in South Africa's Automotive Sector

Several systemic challenges are holding South Africa back from fully optimising its potential to deepen its involvement in global automotive by focusing on promoting local content development. Limited technology transfer from multinational OEMs to local suppliers remains a key challenge, restricting access to state-of-the-art technologies that could enable local companies to innovate, expand production capacity, and compete on quality (RMB, 2021). This challenge is closely related to the small-scale production capacity of local suppliers, which usually operate in old plants with limited capabilities and a lack of knowledge to meet the levels demanded by OEMs (Tekere & Zondo, 2020).

At the root of these challenges lies stubborn investment constraints, as both local and foreign investors have shied away from significant commitments amid policy uncertainty, market risks and fears about competitiveness (Mirzaei & Pal, 2021). Furthermore, the sector faces a shortage of critical engineering and advanced manufacturing skills, exacerbating the challenges of localisation across the automotive value chain. Collectively, they create a challenging environment that constrains South Africa's ability to increase local content and maximise the economic impact of its automotive manufacturing industry (Ambe & Badenhorst-Weiss, 2010).

a) Technology Issues

Technology gaps are often cited as a significant hurdle, as the inability to manufacture advanced components locally results in a heightened reliance on imported parts. The

South African automotive industry is predominantly reliant on OEMs, which are frequently limited in their technology transfer to local suppliers, thereby stifling local innovation and the development of complex automotive components. (Komarasamy & Hoque, 2015). Recent studies highlight that this dependence impedes the localisation of higher-value components and restricts South Africa's opportunities to move up global value chains. In addition, local companies have low capacity to absorb low investment in R&D, and weak institutional linkages lower their ability to adopt new technologies and adapt them, which sustains the reliance on foreign producers (Avenyo & Nyamwena, 2023).

b) Supplier Capacity

Local supplier capacity constraints in South Africa pose a significant challenge to the growth of local content in the automotive industry. Due to limited funds, technical capability, and managerial skills, many enterprises face difficulties in expanding production. This results in further external deterrence dependence and thus locks out the growth of indigenous production (Monaco, et al., 2020). This is then complicated by the absence of well-structured technology-transfer platforms, as well as weak skills development programmes that limit local manufacturers' ability to upgrade their production capabilities to address demand growth. These controls inhibit the march towards higher local content and compromise any effort of economic empowerment in the region (Enemuo, et al., 2018).

c) Investment Constraints

Investment constraints are made due to a perception of risks involved in local manufacturing in South Africa's automotive sector. The inflow of FDI into the sector has remained erratic and is mainly driven by policy stability and economic outlook uncertainties (Inclusive Society Institute, 2021). Government policies that have traditionally favoured multinational corporations have not sufficiently incentivised local companies, limiting their growth and ability to compete both locally and globally (Liu, 2025). This failure to support local companies has created an uneven playing field,

hindering their ability to scale up and innovate amid increasing global competition (Nedbank, 2024).

d) Skills Shortage Issues

Apart from transfer of technology issues and lack of investment, the South African automotive industry is facing the challenge of limited skills development programmes. Skill shortages across the country have a large audience of talented individuals who have a passion for the automotive sector. Still, there are many skills mismatches with what the market wants (PMI Adcorp, 2022). Furthermore, up-skilling programmes on advanced manufacturing processes namely robotics, automation, and lean production are underfunded or ill-conceived (Rakhmasari, et al., 2025). This lack of a well-trained workforce reduces the industry's capacity to adopt advanced manufacturing processes, leading to a decline in local production capacity (Invisu, 2025).

Skills availability is a critical factor influencing the production capabilities of local manufacturers. The Automotive Industry Development Centre conducted research into the problem of skills shortage in the automotive component manufacturing sector and identified that a large number of engineers and technical specialists are kept in the South African industry, limiting scaling up production and increasing local content (Bowden, 2021). Addressing educational and workforce development needs is essential for fostering a competitive local supply chain capable of meeting the increasingly sophisticated requirements of Original Equipment Manufacturers (OEMs) (merSETA, 2020).

e) Infrastructure and Logistics Bottlenecks

Underdeveloped infrastructure, including frequent power shortages, inefficient port logistics, and a lack of advanced rail and road networks, makes operations costly and supply chains less reliable. A 2022 CSIR report estimated the cost to the automotive sector of load-shedding and inefficient port operations at R10 billion a year in lost productivity and delays.

f) Policy and Institutional Misalignment

Although the APDP2 includes provisions for local content requirements, many companies, particularly SMEs, are unable to comply with or take advantage of these regulations. Meanwhile, trade education and industrial policy are not well linked. This leads to poorly aligned training outputs, inadequate institutional support to suppliers and overlapping interventions (Nieuwenhuizen, 2019).

The South African automotive policy environment has been transformed to stimulate industrial growth, attract foreign direct investment (FDI), and drive local content development. The three primary policy tools are the MIDP (1995 - 2012), the APDP (2013 - 2020) and the current SAAM 2035. While having had a relatively positive influence in securing South Africa's position as a regional production hub with OEMs investing into the local economies of the country, local content production levels remain low, around the same percentage (Monaco, et al., 2020). The Motor Industry Development Programme (MIDP) utilised duty credits to support exports, but there was no mechanism to stimulate indigenous component manufacturing or the development of technical capabilities. That led to the underdevelopment of the South African supplier base. The Automotive Production and Development Programme (APDP), introduced in 2013, emphasised local production volumes through the Production Incentive (PI) and Automotive Investment Scheme (AIS) (Barnes & Black, 2013).

These policies continued to prioritise vehicle assembly over local parts production and lacked enforceable localisation targets. The South African Automotive Masterplan 2035 (SAAM) seeks to address these gaps through a target of 60% local content and advocates strategic plans such as transformation, value addition, and long-term manufacturing sustainability (South African Government, 2018). However, persistent implementation challenges, an inappropriate skills match, and marginal support for lower-tier suppliers raise concerns about the extent of SAAM's influence. Division within automotive stakeholders is another barrier to achieving increased localisation. Organisations such as the Automotive Industry Development Centre (AIDC), MERSETA and Sector Education

and Training Authority's (SETA) work in isolation, with no common purpose or set of goals. This poor collaboration also prevents attempts made to ensure that skills development, R&D funding, and supplier upgrading are aligned (Bowden, 2021). The recurring misalignment between policy intentions and actual localisation outcomes across successive programmes is summarised in Table 2.2 below.

Table 2.2: Summary of South African Automotive Policy Frameworks and Localisation Outcomes

Source: (National Association of Automobile Manufacturers of South Africa, 2022)

Policy	Goal	Achievements	Shortcomings
MIDP (1995-2012)	Promote exports and attract FDI	Boosted exports and OEM investment	No localisation incentives; shallow supplier development
APDP (2013-2020)	Encourage production volume and stability	Improved production consistency	Prioritised assembly over value-added local production
SAAM:2035 (2021 to date)	Achieve 60% content and sector transformation	Clear targets, transformation goals	Weak enforcement; poor alignment with skills and R&D funding

South Africa's automotive policies successfully attracted investment and stabilised production but failed to lift local content. Challenges include non-binding local content rules, fragmented policy implementation and weak commitment to supplier development. To achieve the 60% local content target in SAAM 2035, it is recommended that the upcoming reforms establish localisation content, link supplier development with incentives, and coordinate institutional efforts. The structure of such diagnostics provides the basis for the empirical analysis that follows, enabling a more specific and targeted search for the drivers and barriers of South African automotive localisation. Table 2.3 further presents a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis summarising South Africa's localisation position relative to higher-performing emerging market peers:

Table 2.3: SWOT Analysis of Localisation in South Africa's Automotive Industry.*Source: (Department of Trade, Industry and Competition, 2024)*

Strengths	Established OEM presence with export capacity.
	Government support via APDP2 and SA Automotive Masterplan.
	Existing supplier base and regional transport potential.
Weaknesses	Low local-content (<40%) and limited Tier-2/3 supplier capabilities.
	Weak tooling and technology transfer.
	Skills shortages, especially in digital manufacturing.
	Poor policy coordination between industry, education, and trade.
Opportunities	Global EV shift opens new localisation pathways (e.g., battery packs, electronics).
	Growing African market demand (AfCFTA potential).
	Possibility of replicating India/Thailand-style skills and tooling hubs.
Threats	OEM global sourcing policies limit local supplier participation.
	Infrastructure risks (load-shedding, port delays).
	Continued under-investment in R&D and automation.
	Risk of technological marginalisation in EV and digital ecosystems.

This SWOT analysis confirms the previous diagnostic results by clarifying South Africa's position. Policy intent and OEM participation are strengths, but long-standing weaknesses, especially in tooling, skills, and the supplier base, reduce localisation efforts. Strategic handling of these challenges could enable South Africa to take advantage of emerging opportunities and prevent further relegation, in a changing global automotive environment (Monaco, et al., 2020).

While several factors and related dynamics drive attempts at localisation (e.g., leveraging OEM presences and state-led interventions), the development of South Africa remains constrained by specific structures that hold back progress. Table 2.8 provides an overview of the relative effect of the main drivers and barriers on local content development.

To summarise the evidence from this literature review, Table 2.4 presents diagnostic insights into the key constraints inhibiting local-content development in South Africa's automotive industry. Each constraint is associated with a strategic effect on the localisation performance:

Table 2.4: Summary of Diagnostic Insights by Constraint in South Africa's Automotive Localisation.*Source: (Department of Trade, Industry and Competition, 2024)*

Constraint	Diagnostic Insight	Strategic Impact on Localisation
Skills Gap	Technical and managerial skills are misaligned with evolving production technologies.	Restricts technological upgrading and supplier readiness.
Tooling & Technology-Transfer	Tooling capabilities are weak due to a lack of capital, skills, and exposure to technology.	Increases cost, reduces flexibility, and deters local supplier participation.
Investment & Capital Access	SMEs face limited access to financing for scaling or tech upgrades.	Constrains capacity development and supply chain integration.
Supplier Fragmentation	Tier-2 and Tier-3 suppliers lack scale, quality systems, and OEM linkages.	Weakens local value-chain depth and limits backward linkages.
Infrastructure & Logistics	Energy instability and port inefficiencies increase cost and risk.	Reduces the reliability and competitiveness of local sourcing.
Policy & Institutional Misalignment	A disconnect between industrial, skills, and trade policy creates support fragmentation.	Hinders co-ordinated development of local content capabilities.
R&D and Innovation Deficit	Low investment in applied research, testing, and product development.	Prevents localisation of high-value and next-gen components.
Export-Oriented OEM Models	Centralised sourcing decisions limit local supplier autonomy.	Limits local sourcing opportunities and local innovation.

The existing literature consistently identifies a number of key barriers to the development of local content in the automotive sector in South Africa, as described above. However, these discussions remain primarily descriptive and fragmented, offering little explanation of the underlying causes or of how these barriers interact across the value chain. Most studies do not investigate the institutional or governance mechanisms underlying limited technology transfer, nor do they critically assess the effectiveness of localisation policies in addressing supplier-upgrading constraints. There is also a lack of comparative evidence showing how South Africa's policy environment differs from those of more successful automotive economies, and minimal integration of theoretical perspectives such as GVC governance and supplier upgrading frameworks.

Empirical evidence on supplier upgrading pathways, Tier 2 and Tier 3 supplier dynamics, and the role of OEM procurement strategies is also notably scarce. Additionally, the literature does not adequately analyse how skills shortages interact with technology adoption, supplier development, or investment patterns, resulting in a narrow and siloed understanding of

capability constraints. These gaps collectively demonstrate the need for a more comprehensive, system-based, and diagnostic examination of the root causes of low local content in South Africa's automotive sector. This is an analytical gap that this study seeks to address.

2.8.6.3 Strategies for Enhancing Local Content in the Automotive Industry: Case Studies from India, Brazil, and Thailand

To address the identified obstacles and add value locally, some key recommendations can be made. One is that South Africa could benefit from implementing a clear policy framework to facilitate technology transfer. This may involve giving incentives to multinational enterprises participating in knowledge exchange programmes with local suppliers. Such policies also promote innovation in a way that helps local businesses to implement modern manufacturing processes that maximise their international competitiveness as well as their local competitiveness (South African Reserve Bank, 2025).

Secondly, there is a need for education and training institutions to focus on the automotive industry. Building strong partnerships between industry and schools/colleges to develop relevant curricula can inspire policymakers to prioritize collaboration, fostering a shared commitment to skills development in automotive manufacturing (Esqueda, et al., 2019). South Africa will be able to grow its local manufacturing capabilities and stop the reliance on imported components by developing an experienced skills base in advanced technologies. Implementing supplier development programmes, backed by mentorship, financial, and technology support, would also strengthen the local automotive supply chain. Government-linked research and development (R&D) and innovation clusters can also boost local production (Roberts, et al., 2021). Success stories in countries such as India, Brazil and Thailand indicate that integrated strategies can play a significant role in increasing local content and global competition, and South Africa thus has the potential to follow such a path. (Bazilian, et al., 2020).

Studies carried out in other countries emphasize the need to increase the local automotive content through collaboration by relevant stakeholders such as the government, Industry stakeholders and employees (Husain, 2014). For instance,

a) India

The PLI scheme promotes local manufacturing and transfer of technology, in the auto industry, PLI is quite strong. Launched in 2020, the policy mechanism incentivises companies to increase local value-added manufacturing, especially in advanced automotive technologies like electric vehicles and batteries (Pandit, 2022). A comparative study indicates that the programme has raised local value-added for India, enhanced its automotive industry's competitive standing (Ramachandran & Chandramohan, 2025).

In this direction, the Indian government has also highlighted investment in manufacturing infrastructure and incorporation of high-end technologies and stronger thrust on supply chain for strategic components like automotive electronics (Government of India, 2025). Academic-industry collaborations, as well as focused R&D and skills programmes, were regarded necessary to developing a workforce that could meet OEM quality and technology standards. The objectives of these efforts are to assist India in raising its levels of localisation, decreasing dependence on imports and improving global competitiveness in the country's automotive industry (Esangbedo, et al., 2023).

b) Brazil

The Brazilian case includes the use of regulatory tools such as Inovar-Auto (2012-2017) and its follow-up programme, Route 2030 (from 2018 to date), requiring vehicle manufacturers to reach a fixed share value for their local integrations and offering tax benefits for those companies that undertake R&D or foster the development of local suppliers (Filho, et al., 2022). Studies on Inovar-Auto show that these policies promoted the further integration of the local supply chain, technology development and a decrease in imports (Sturgeon, et al., 2017). In addition to this, more general research on Brazilian industrial policy highlights that tax cuts and incentive systems were meant to strengthen

the capacity of local supplying industries, thus demanding the knowledge transfer and technology-transfer from multinational companies (Bazilian, et al., 2020). The local content ratio of Brazil by early 2020s in the auto industry therefore stands at about 65%, prompting attention on how government intervention and collaborative arrangements are used to sustain industrial resilience (Sturgeon, et al., 2017).

c) Thailand

Thailand offers an instructive case in how localisation policies and clustering can be used to develop a strong local automotive industry. Historically, Thailand deployed local content requirements (LCRs) mandating that automakers procure a share of parts locally, which supported supplier development and enabled backward linkages within its automotive value-chain (Hassler, 2010).

Industrial clustering has also played a strategic role: the formation of supplier networks around major production hubs in Thailand has been studied in detail, showing how governments, OEMs, and local companies collaborated to build cluster capability (Kuroiwa & Techakanont, 2017). While the original LCR mandate was later relaxed or abolished (to comply with World Trade Organization (WTO) obligations), the legacy of those policies still influences Thailand's automotive strategy today.

Thailand provides selective incentives and tax support for joint ventures in component manufacturing as well as EV-related localisation (United Nations Conference on Trade and Development, 2024). Industry estimates indicate that many vehicles built in Thailand have approximately 60-80% of their parts sourced from Thailand, with some segments (e.g., eco-cars, pickups) reaching even higher localisation levels (WUXI Aotian Steel Wire Products Co. LTD, 2024). And international lessons from that situation prove that firm policy, cluster development, supplier upgrading and institutional alignment all count when a country intends to increase local content into its automotive value chains (Monaco, et al., 2020).

2.8.7 Comparative Challenges Between Emerging and Developed Economies

Despite successful localisation initiatives in emerging economies, the road to sustainable global automotive competitiveness has been unclear. Global structural and developmental imbalances between developing and developed countries contribute to the challenges faced by countries. These distinctions have important implications for countries' ability to meet global benchmarks, access frontier technologies, and support high-value-added production in their own economies (Monye, et al., 2023).

This chapter examines three critical dimensions: quality assurance and standards, workforce and labour force, and financial resources and capital access, and thus focuses on the role that institutional capacity, human capital and economic infrastructure play in differentiating localisation outcomes. Such differences should be considered when creating functional, situation-specific policy strategies to upgrade South Africa's automotive GVC.

2.8.7.1 Quality Assurance and Standards

Developing countries face significant challenges in meeting international quality standards in the automotive industry. Limited financial investment, insufficiency of infrastructure and lack of trained workforce led to increased defect rates, re-work and product recalls, which affect the consumer confidence (Monye, et al., 2023). Unclear regulative regimes and breaches of regulative conditions in many instances make matters worse, which makes it hard to meet global standards for safety concerns about products, environmental sustainability and labour rights (Organisation for Economic Co-operation and Development, 2022). Some governments have attempted to provide incentives and impose stricter compliance regulations for improvements, but with little success (Collison, 2024).

On the other hand, in developed economies, companies have strong institutional frameworks, heavy R&D investments and compliance with internationally accepted quality systems such as ISO 9001, ISO 14001 and IATF 16949 (Castellacci, et al., 2022). Systems consistently support the production of excellence, fewer errors, and enhanced confidence. Furthermore, regulatory compliance with stringent environmental and labour standards enhances both local competitiveness and global market access (Dechezleprêtre & Sato, 2017). The advanced capabilities of developed economies suggest that strategic investment, institutional capacity, and policy are crucial for high-quality automotive production.

2.8.7.2 Manpower and Labour Force

Emerging economies have a significant labour-cost advantage, attracting automotive manufacturers seeking cost-efficient production. However, this benefit is often offset by persistent skills shortages in key technical areas such as robotics, software, and engineering (Chigbu & Nekhwevha, 2020). The lack of alignment between training programmes and current automotive technological requirements presents a further impediment to the renting or adoption of Industry 4.0 technologies (Macpherson, et al., 2022). In addition, labour unrest, driven by poor working conditions, low wages, and fragile industrial relations, poses operational risks that can disrupt production and reduce supply chain reliability. Overcoming these human capital challenges is crucial for emerging economies to achieve sustainable competitiveness in global automotive manufacturing (Macpherson, et al., 2022).

In comparison, developed countries are more privileged, with highly skilled and educated workers, which should reassure the audience about the sector's strength and the proximity of advanced vocational training systems (Dixit-Bajpa & Ravichandran, 2023). Despite higher labour costs, manufacturers in these regions enjoy enhanced productivity, innovation, and operational efficiency, which offset wage disadvantages. The integration of innovative technologies is supported by stable labour relations and robust institutional

frameworks, leading to fewer disruptions than in emerging markets (Leogrande, 2024). While wage negotiations and adaptation to rapid technological changes remain ongoing challenges, the overall environment in developed economies supports high-value, innovation-driven automotive manufacturing (Dakić, et al., 2024).

2.8.7.3 Financial Resources and Capital Access

Dynamics of capital availability often hinder the ability of promising emerging markets to invest in contemporary technology and infrastructure to sustain competitive automotive production. The high cost of credit and developed financial markets, as well as the low investor confidence, create an unfriendly condition for seeking funds, which hampers investment in automation, robotics and Industry 4.0 systems (KPMG, 2015). Such monetary limitations constrain the manufacturer's ability to ramp up, innovate, or meet standards demanded along the global automotive value chain, thereby limiting their long-term growth and competitiveness (Duong, et al., 2024).

In contrast, developed economies benefit from developed financial systems that provide easier access to diverse sources of capital, including loans, public markets, and venture investments. This financial backbone gives the automotive companies an advantage in modern technology, modernisation, and plant expansion (Organisation for Economic Co-operation and Development, 2024). We also find that borrowing is less expensive and the economy is less volatile, both of which reinforce the industry's innovative capacity and government-backed efforts to enhance digital capabilities and support sustainability, thereby sustaining ongoing investments. These benefits place producers in advanced economies to continue leading the world through ongoing development and efficiency improvements (Doyle & O'Connor, 2014).

Both developed and emerging market economies face unique challenges in automobile production, particularly in quality control, labour skills, and access to capital. In many developing economies, limited financial resources, inadequate regulatory frameworks,

and insufficient skills pose constraints on quality and the uptake of technology (Lee, et al., 2021). Developed economies are typically characterised by strong institutional frameworks, highly skilled labour, and ready access to capital for investment in the latest technology, resulting in high standards and global competitiveness (Hooks, et al., 2022).

2.8.8 Vertical vs Horizontal Integration in Localisation

A successful localisation strategy in the automotive sector mostly depends on the structural approach taken by manufacturers and suppliers to organise production and sourcing. Two dominant paradigms, vertical integration and horizontal integration, significantly shape the depth and effectiveness of localisation. Understanding their implications is essential to diagnosing the barriers to increasing the localisation rate in South Africa.

2.8.8.1 Vertical Integration

Vertical integration occurs when a company takes control over multiple stages of the value chain, from raw material extraction to component manufacturing to final vehicle assembly. This model allows companies to exercise greater control over quality, logistics, intellectual property, and technology transfer, while retaining more value within local operations (Nogueira, et al., 2023). Globally, vertically integrated manufacturers such as Tesla and BYD make use of this approach by localising in-house production of EV batteries, drivetrain systems, and proprietary software within gigafactory ecosystems. Such strategies reduce dependence on foreign suppliers, enhance resilience to external shocks, and strengthen competitive positioning in global markets (Naor, et al., 2021).

In contrast, South Africa's automotive industry exhibits limited vertical integration, as locally operating Original Equipment Manufacturers (OEMs) remain heavily dependent on globally managed supplier networks for high-value, complex components such as

electronic control units (ECUs), battery systems, and infotainment modules. This reliance on imported advanced technologies prevents local value addition and it also restricts opportunities for industrial upgrading (Monaco, et al., 2020). Additionally, (Morris, et al., 2021) highlights that South Africa's integration into global value chains has often been peripheral, characterised by assembly and low-complexity component production rather than higher localisation. More recent studies confirm that this lack of vertical integration in the industry has contributed to stagnant localisation rates, and limited participation in higher-value levels of the global automotive industry (Sakuramoto, et al., 2019).

2.8.8.2 Horizontal Integration

Horizontal integration refers to expanding operations at the same stage of the value chain, often through clustering, partnerships, or consolidation among similar companies. In the automotive sector, horizontal integration supports production scaling, enhances standardisation, and enables cost competitiveness, particularly among local suppliers. Successful examples are seen in Thailand and India, where strong industry clusters have created competitive ecosystems that allow knowledge transfer and economies of scale (Yang, et al., 2023). In contrast, South Africa's supplier base remains weak. It is dominated by small and medium-sized enterprises (SMEs), which usually face persistent challenges in accessing capital, technology, and Original Equipment Manufacturer (OEM) contracts. According to (Mhlongo & Daya, 2023), the lack of integration as well as cluster development prevents the ability of local suppliers to meet global standards in terms of cost, quality, and volume, limiting deeper localisation outcomes.

To foster localisation, there is a strong push to encourage horizontal integration among local component suppliers, particularly for non-complex parts such as plastic mouldings, wiring harnesses, and seats, where technological barriers are lower, and production can be consolidated to achieve greater efficiency (Monaco & Wuttke, 2023).

Table 2.5: Comparison of Vertical vs Horizontal Integration in Localisation.*Source: Adapted from (Inbound Logistics, 2024)*

Type	Definition	Impact on Localisation
Vertical Integration	The company controls multiple stages of the value chain (e.g., raw materials to assembly).	Increases local content through value retention, quality control, and in-house capability.
Horizontal Integration	Expansion across companies within the same production tier (e.g., supplier clustering).	Enables economies of scale, improves competitiveness, and fosters supplier development.

Vertical integration increases local content by absorbing functions within the hierarchy to reduce imported content, while horizontal integration builds capacity at the supply end. South Africa's current localisation strategy should employ a hybrid approach that has OEMs localise high-value costs and policies and endorse clustering and consolidation among local SMEs. This dual approach could accelerate the development of a more self-sufficient, competitive, and resilient automotive supply ecosystem. To understand how such a hybrid integration strategy might succeed, one needs to unpack the existing organisational and economic functions of South Africa's motor industry. This perspective offers essential guidance on capacity, constraints and opportunities for increased localisation of the industry.

2.9 The South African Automotive Industry Context

Analysis of South Africa's automotive industry is crucial for assessing its prospects for enhanced localisation, including competitiveness and sustainability. As a regional manufacturing base, this industry has transformed in the context of distinctive socioeconomic and policy-specificities, imbued by global integration and industrial nationalisation.

2.9.1 Industry Structure and Economic Role

The automotive industry is one of the most critical sectors in the world, not only for its contribution to GDP but also for technological advancement, job creation, and economic growth. As an essential part of the global supply chain, it has strong interconnections with related industries, including steel, electronics, plastics, and chemicals (International Labour Office, 2020).

The automotive industry in South Africa is a key sector of the economy, ranking 20th globally in production. It is the largest manufacturing sector in the country in value terms and one of the most established automotive clusters in the capital continent, contributing to 4.9% of % GDP of South Africa and around 27.6% of its manufacturing production during 2022 (National Association of Automobile Manufacturers of South Africa , 2022). The industry is also a leading exporter, accounting for R227.3 billion in vehicle and component exports in 2022, which accounted for 12.4% of South Africa's total exports (Trade & Industrial Policy Strategies, 2023).

South Africa's competitive position has been nuanced through both trade agreements and industrial policy. Relevantly, the AGOA (African Growth and Opportunity Act) has granted access to the U.S. market on a preferential basis, and the APDP has encouraged investment and localisation through global OEMs and component producers, including suppliers (Department of Trade, Industry and Competition, 2023). These incentives have contributed to the influx of foreign direct investment (FDI), entrenching South Africa's status as an automotive hub on the continent and strengthening supply chains.

The South African automotive industry revolves around vehicle assembly and has established companies producing vehicles such as Toyota, BMW, Volkswagen, and Ford. These global companies have a significant footprint in South Africa, manufacturing vehicles primarily for the local market and exporting to other regions, particularly Europe, Asia, and other parts of Africa. South Africa is also a manufacturing and export base of

vehicle components, with several local companies that supply assembly plants (Trade & Industrial Policy Strategies, 2023).

However, the automotive sector in South Africa has to confront challenges common to many developing countries, including fluctuations in global market demand, emerging trade realities, and a skills deficit. Following international trends, such as the introduction of electric vehicles (EVs) and other more sustainable forms of mobility, could play a greater role in South Africa's vehicle manufacturing sector. The integration of Industry 4.0 technologies, such as robotics, automation, and AI, has also become essential for maintaining a competitive edge globally (PwC, 2025).

Despite the industry's size and importance, South Africa still faces challenges in achieving higher local content levels in automotive production. Even though it is home to multinational vehicle manufacturers which build plants across the country, locally sourced components in vehicles are relatively low (Monaco, et al., 2020). This reliance on imported components prevents the growth of local supply chains and economic development. There is also the growing influence of electric vehicles and increased attention to sustainable transport, which have transformed the automotive manufacturing landscape in South Africa and around the world. These trends still impose complexities that continuously bring attention to the low local content issue (Bowden, 2021).

2.9.2 Role of OEMs and Tier Suppliers

The automotive supply chain is layered, and component suppliers operate at different levels of the structure according to the functions of components, ranging from simpler to more complex. Tier 1 suppliers are those that supply OEMs with components and complete systems. They engage with OEMs in design engineering and integration to achieve the required performance and specifications (Tolmay & Badenhorst-Weiss, 2015). Tier 2 and Tier 3 suppliers, on the other hand, provide subcomponents, raw materials or

small parts that Tier 1 suppliers combine and supply to OEMs as complete assemblies. Although these second group suppliers are more like secondary to OEMs because they may not be as directly linked, their work is essential in maintaining the effectiveness and continuity of the production system (Bam, et al., 2021).

South Africa's supply chain depends on high-value, imported parts. Its Tier-2 and 3 suppliers often find it challenging to up-scale their technology or resources to compete on an international level (Department of Trade, Industry and Competition, 2021).

Recent research has also revealed that although localisation is one of the policies of the APDP aiming to promote local content, it has been challenging to upgrade suppliers to be compliant due to limited R&D skills and inadequate supplier upgrading programmes (Haroon & Whitehead, 2021).

Tier suppliers are taking a stronger position in promoting local content and export competitiveness in the South African automotive industry. Some of them have invested in local manufacturing to serve international OEMs. Their growing participation in the regional and global value market indicates an increasing industrial potential (Department of Employment and Labour, 2019), but the barriers to entry, including skills scarcity, technology access and disruption of the global value-chain, are still preventing them from achieving their growth potential. As they continue to penetrate both local and international automotive value chains, access to technology and production facilities enables these suppliers to engage more in localisation initiatives. This means that technology development in South Africa's automotive industry is a key factor underlying its prospects for future competitiveness and value addition (Barnes, et al., 2021).

2.9.3 Product Lifecycle

The product lifecycle in the South African automotive sector aligns with global standards. R&D takes place alongside design (mainly performed abroad), followed by assembly, distribution and after-sales services (Raja, et al., 2021). Local involvement in the initial

product lifecycles, such as concept generation, designing, prototyping and engineering of such products, is negligible and is not usually done locally. IP and key strategic product decisions reside with OEM head offices abroad. The operations here in South Africa are merely for assembly and market adaptation (Council for Scientific and Industrial Research, 2022).

Complementary investment is required for local R&D, supplier upgrading, and advanced manufacturing. Among these recommendations, more public-private collaborations, skill-building programmes for the local workforce, and financial incentives for SMEs to invest in state-of-the-art machines are suggested (Monaco & Wuttke, 2023). This commitment to greater participation not only strengthens resilience and competitiveness but also fosters a longer-term strategy for maintaining active engagement in global value chains.

2.9.4 Supplier Management

In the South African automotive industry, the effectiveness of localisation and deeper integration with global value chains depends on suppliers' management. Despite being one of Africa's most advanced automotive industries, South Africa faces persistent supplier-related challenges. These include the lack of advanced tooling and technology, limitations in the skilled workforce, and a lack of quality control systems within local companies (South African Government, 2018). There is evidence suggesting that only a minority of component manufacturers meet higher requirements for participation in higher-value-added manufacturing segments such as software integrated electronic systems and advanced technologies (Simpson & Padayachee, 2018). Limited R&D capacity and a lack of investment prevent the ability of local suppliers to innovate and expand (Trade & Industrial Policy Strategies, 2024).

In line with this, government-led South African Automotive Masterplan (SAAM 2035) and the Automotive Production and Development Programme (APDP) initiatives have encouraged supplier development. The intent behind these policies is to enhance localisation through encouraging local procurement, supporting skills training, and

strengthening OEM-supplier relationships (South African Government, 2018). Most of the leading OEMs in South Africa, such as Toyota, Ford, and BMW, have adopted these policies, complementing them with formal supplier development initiatives. Such programmes normally consist of mentorship schemes, joint access to infrastructure, quality audits, and collective improvement projects with the goal to improve the technical and operational standards of local partners (National Association of Automotive Component and Allied Manufacturers, 2021).

Internationally, supplier management is shifting from being transactional to being strategic and focuses on partnerships. In South Africa, the same shift is required to ensure that suppliers are globally compliant and innovative, especially as the industry moves towards electric mobility, digital manufacturing and a circular economy. This aligns with the fact that the improvement of supplier capabilities is important for industrial deepening and increased competitiveness (Drotskiel & Okanga, 2016).

Compared with developing country peers that have adopted comprehensive localisation programmes incorporating elements such as supplier development, cluster formation, and reform of vocational training (as in Thailand, India, and Brazil), the South African approach has remained fragmented. The lack of vertical integration and industrial clusters reduces economies of scale, technological transfer and cooperative innovation. In effect, South Africa's localisation requirements are both the byproduct and the cause of low levels of local content. Without structural countermeasures aimed at skills development, industrial finance, supply chain resilience and R&D investment, the automotive sector could remain insignificant in global value chains (BDO South Africa, 2024).

The persistence of these interlinked barriers, ranging from technological gaps and fragmented supplier networks to weak tooling capacity and limited R&D, reveals a systemic failure to align South Africa's industrial ecosystem with the demands of modern automotive manufacturing. These same challenges not only prevent local companies from participating in higher-value segments of the value chain but also reduce the country's

competitiveness in a rapidly changing global industry. To address these challenges, a coordinated approach that combines incentive reform with purposive investment in skills, tooling, and supplier upgrading will be required. This needs to be underpinned by greater institutional coherence across the trade, education and industrial policy that allows local suppliers to build their technological capabilities progressively. India and Thailand show that with the proper policy framework and continued public-private partnership, emerging economies can experience significant localisation growth. Without such a strategic aim, South Africa's place in the global automotive value chain remains at risk. To move beyond the reforms into implementation, these reforms need to be underpinned by an institutional infrastructure that encourages longer-term thinking across government, industry, and education bodies.

2.10 Capital Investment and Cost Implications

Capital investment in the automotive industry is essential to remain competitive. There are many technological changes in this sector worldwide. This section reviews South Africa's investment landscape compared to global peers, highlighting key challenges and opportunities. It also considers the cost factors affecting localisation efforts, crucial to the sector's growth (Monye, et al., 2023).

2.10.1 Capital Investment

The development of automotive capital investment is essential to maintaining the country's competitiveness, particularly at this time, as the industry is entering a major technological shift worldwide. The leading vehicle manufacturers have invested heavily in what is seen as the technology of the future. These investments are often supported by government subsidies, favourable loan programmes, and policy incentives that promote sustainability and modernise manufacturing practices (Ramos & Ruiz-Gálvez, 2024). Advanced economies are also spending heavily on digitalisation and automation, with

high-tech machinery such as AI-based quality control, digital twins, and robotics, to increase production efficiency, lower defects, and enable flexible, scalable manufacturing. Such capital investment is necessary to stimulate innovation and meet ever-increasing environmental and safety standards (Javaid, et al., 2022).

By contrast, South Africa's automotive industry, while necessary to its economy and export profile, is struggling to sustain continued capital inflows. Foreign direct investment (FDI) in the industry has decreased (Komarasamy & Hoque, 2015). This contrast has been explained by factors including international economic instability, inconsistent local policies, and gaps in energy and logistics infrastructure. While South Africa is home to some of the world's largest Original Equipment Manufacturers (OEMs), it continues to struggle to attract investment levels comparable to those in markets such as Mexico and India. In these countries, there is more conducive regulation, a higher degree of supply chain integration, and more active use of industrial policy to make the automotive industry an attractive destination for sustained investment (International Trade Administration, 2024).

One of the key barriers to attracting investment in South Africa's automotive sector is the supplier base that is not developed enough. Most suppliers are not able to produce at the required level of technology, quality and volume that OEMs demand for high value components such as electronics, batteries and drivetrains (Monaco & Wuttke, 2023). This constraint prevents South Africa's capacity to develop local content and integrate itself further into global value chains. In reaction, the South African government has concrete initiatives such as the South African Automotive Masterplan 2035 (SAAM 2035) that aims to incentivise investment through tax reductions, supplier development programmes and localisation targets (Miao, 2023). While these initiatives are promising, substantial progress will be determined by improvement in the areas such as energy security, transport logistics, policy predictability and skills development. Additionally, the worldwide acceleration towards green mobility and digital manufacturing acts as a catalyst, signaling to South Africa the need to align its industrial landscape with global

trends and be competitive in order to encourage capital investment (National Association of Automobile Manufacturers of South Africa , 2023).

While localisation presents a strategic opportunity for South Africa to enhance industrial depth and global competitiveness, realising its full benefits requires substantial and sustained capital investment. Upgrading supplier capabilities, expanding technological infrastructure, and closing skills gaps are all capital-intensive undertakings that cannot be achieved without strong policy support and private sector commitment. However, alongside investment needs, the cost dynamics of localisation also pose significant challenges that influence decision-making at both OEM and supplier levels.

2.10.2 Cost Implications on Localisation

The cost impact on localisation is another crucial aspect affecting the South African automotive sector. Local manufacturing is more expensive than importing components from existing global suppliers. A KPMG report in 2021 revealed that the price of locally produced car parts in South Africa was up to 15-20% more than imported equivalents, which was largely due to higher cost of energy, materials and labour (Ambe & Badenhorst-Wess, 2013).

Smaller local suppliers often have difficulties achieving economies of scale, which makes their products less competitive on price. In its 2020 report, the Automotive Industry Development Centre (AIDC) said that getting costs down to the level of imported parts requires a lot of money to be spent on process optimisation, automation, and training the workforce (Naude, 2013). The high capital costs of complying with global quality and certification standards are also a factor. South African suppliers wanting to supply OEMs must invest in specially-purpose equipment, testing facilities and continuous improvement programmes just to keep pace, which raises their cost base (National Association of Automobile Manufacturers of South Africa, 2024).

To reduce those cost barriers and to incentivise greater localisation, a mix of public-private partnerships, targeted government incentives, and financing mechanisms could be employed. These could range from tax incentives for investments in local production capacity, to grants for suppliers' development programmes and intervention programmes focused on enhancing operational efficiency in the local automotive industry (Monaco, et al., 2020). South Africa's effectiveness in localisation is not only about the performance of its manufacturers, but it also depends on access to inputs and their affordability and quality across the value-chain.

2.11 Raw Materials in the Automotive Industry

The automotive industry is one of the most material-intensive sectors in the world, with metals, polymers, and rubber materials used. These materials are key to the performance of vehicles, to fuel cost metrics, and to press shop emissions more broadly. Amid the global transition to sustainability, raw material supply is playing a critical role. South Africa is both a producer and a consumer of essential raw materials. Its place within the global value-chain structure and environmental infrastructure on the ground limitations emphasise the necessity of aligning the national raw material strategy with the international one (Ambe, 2014).

One of these is the global effort for reducing energy usage by reducing the environmental impact of steel and aluminium, which are still crucial materials for vehicle components. Foreign steel producers now use recycled materials and utilise low-carbon steel processes worldwide. Coal-based energy input practices dominate the local production of South Africa (Rumsa, et al., 2025). This results in extremely high carbon content in local vehicle production. South Africa is also a major producer of chrome and manganese, which are essential for stainless steel and alloys. Yet the environmental costs of mining, such as water and land pollution, indicate that more robust regulation and promotion of cleaner mining technologies are necessary (Ntuli, et al., 2024).

Global demand for rare earths and battery metals such as lithium, cobalt, and nickel, as well as graphite, has been fuelled by the shift to electric vehicles (EVs). Although South Africa is not yet a major producer of these resources, it offers prospective reserves and is strategically located. Most significantly, South Africa produces the highest levels of PGMs (platinum group metals), which are vital for manufacturing catalytic converters. As environmental, social, and governance (ESG) demand grows, so too does pressure for South Africa's mining sector to adopt low-emission operations that are more transparent (Khan, et al., 2025).

Outside the world of metals, global interest is also shifting to polymers and rubber materials used in interiors, body panels and tyres. The developed world is headed towards bioplastics and circular recycle models. But South Africa has some challenges with its recycling sector being underdeveloped. Although some OEMs have initiated projects on waste management and recycling initiatives, the majority of automotive plastic and rubber products still end up in landfills, undermining sustainability objectives (Muzenda, 2013).

South Africa's overwhelming reliance on coal-fired power adds another layer of challenge, enlarging the carbon footprint even further from raw material processing. This reliance operates to the disadvantage of local manufacturers relative to competitors in the world, moving away from fossil fuel energy. Without major investment in solar, wind, and other clean energy sources, South Africa risks falling behind in competitiveness and compliance with global automotive value-chain standards (PwC, 2024). These problems are not only a challenge but also an opportunity. South Africa can capitalise on its previous wealth on minerals and industrial infrastructure to become a champion in sustainable raw materials. This would not only lower environmental impact but also enhance the role of the country in global supply chains. Enforced strict regulations, incentives to adopt clean technologies and public-private partnerships are necessary in order for South Africa's raw materials' strategies to align with global future sustainability needs (South African Government, 2025).

2.12 Environmental and Sustainability Challenges

The automotive industry worldwide is changing hugely at the very pressing demand to lessen its effect on the environment. Internal Combustion Engine (ICE) vehicles are among the leading sources of greenhouse gas (GHG) emissions. Policies, for example, the EU's Green Deal has an objective of reducing emissions by 55% in 2030 and Norway, which aims at 100% zero-emission in vehicle sales produced from 2025 onwards, are changing the global automotive value-chain landscape (Schnurrer & Braun, 2023) These policy shifts inform the procurement, production, and investment decisions of international OEMs and countries such as South Africa, which are under mounting pressure to adjust.

The environmental requirements of the global automotive industry impose both obstacles and limitations on South Africa regarding local content. While the country is heavily involved in global value chains, particularly for vehicle exports and component production, the use of coal for electricity generation (which accounts for > 80% of generation) increases the carbon intensity of local output (National Association of Automobile Manufacturers of South Africa, 2023). This limits the competitiveness of South African-made parts as OEMs globally begin to introduce carbon-related sourcing requirements. The likes of BMW and Volkswagen have introduced renewable energy projects at their South African plants. Still, such moves are not yet common among lower-tier suppliers because they lack the means to switch to clean energy (Komarasamy & Hoque, 2015).

In line with global trends around circular economy models and sustainable material sourcing, leading OEMs are seeing new opportunities to improve their environmental footprint through increased recycling, reduced waste, and a more sustainable and responsible use of raw materials such as aluminium, rubber, and rare earth elements. But in this regard, South Africa faces significant structural limitations. The country is home to key raw materials such as platinum, chrome and manganese, which are exported on a large scale, often extracted at the expense of water pollution and habitat loss (Ohiomah & Sukdeo, 2022). Additionally, the absence of local battery production, advanced recycling capabilities and a viable end-of-life

vehicle (ELV) dismantling process, impedes local suppliers' ability to participate in closed-loop output at the level increasingly sought internationally (Holly, et al., 2023).

At the global level, zero-waste approaches to processing vehicle-related waste are becoming common. Vast amounts of production waste, ranging from scrap metal, paint sludge, and plastic offcuts, are still being discarded by many South African manufacturers because of infrastructure constraints, training deficiencies, and weak regulatory enforcement. In turn, this reduces their environmental compliance and prevents their capacity to meet the emphasised sustainability criteria in OEM procurement strategies (Council for Scientific and Industrial Research, 2021). Without systemic improvements, local companies will find it challenging to derive greater value from component localisation and supply chain upgrades.

The lack of local demand for green vehicles makes matters worse. Despite measures put in place by the South African government to promote the purchase of EVs, Sales are declining due to high prices, the absence of local production of EVs or related components, and inadequate infrastructure for EV charging (Scholtz, et al., 2023). In contrast, countries that have aligned industrial, energy, and transport policies to support green mobility are becoming hubs for EV-related manufacturing, leaving South Africa at risk of being bypassed in the next generation of automotive investment (Tongwane & Moeletsi, 2021).

Meeting environmental and sustainability challenges is key to South Africa's automotive industry, but so too are the applications of technology, innovation, and resilient quality systems. These elements serve as key drivers for localisation by enhancing supplier capabilities, improving process efficiencies, and enabling the production of globally competitive components.

2.13 Quality System in Automotive Manufacturing

Worldwide, the automotive industry performs at higher levels due to strong quality systems that maintain compliance with the latest standards and remain competitive across the entire production chain. Standards such as ISO 9001 and IATF 16949 are not just preconditions for

accessing international supply chains, they also play a key role in terms of promoting effectiveness, minimising faults and meeting the requirements of OEMs (Laskurain-Iturbe, et al., 2020). Advanced manufacturing uses improvement concepts, including Six Sigma, Lean Manufacturing, and Total Quality Management (TQM), to help achieve continuous improvements and process optimisation (Ghelani, 2021). Techniques such as Statistical Process Control (SPC) and Failure Mode and Effects Analysis (FMEA) are also utilised to minimise production variation. AI-powered predictive analytics are also used to maintain quality and reduce production variation. These quality frameworks enable OEMs and Tier 1 to localise manufacturing without sacrificing product quality or the business operations (Uçar, et al., 2024).

South Africa, on the other hand, still struggles to align local suppliers, particularly at the Tier 2 and Tier 3 levels, to the international standards as above. Although many of the larger OEMs in South Africa meet global standards, local content growth is hampered by quality system implementation gaps that remain widespread within SMEs operating on lower tiers, as well as a skills gap in these same small sectors (Bowden, 2021). These enterprises face financial constraints that prevent them from engaging in certification and adopting sophisticated quality practices (Sfakianaki, 2018). As a result, the OEMs are forced to use imported items or established global suppliers with minimal risk, avoiding local procurement.

Adding to these challenges is the skills gap in quality control and industrial engineering. Most South African suppliers lack adequately trained personnel to drive and enforce systems such as Six Sigma or TQM, as these are commonly used in international plants (Abd-Elwahed & El-Baz, 2018). Without targeted interventions, these deficiencies contribute to higher defect rates, production slowdowns, and operational inefficiencies, reducing the economic viability of localising supply chains. Inadequate infrastructure, such as power outages, congested ports, and logistics weaknesses, exacerbates quality compliance by forcing manufacturing to operate on a just-in-case rather than a just in time basis and delaying component supply (Karanam, et al., 2024).

2.14 Industry Structure and Competition

The nature of industry and competition significantly impacts localisation rates in the South African automotive sector. A few large Original Equipment Manufacturers (OEMs) have substantial market power in addition to a fragmented supplier base which restricts the scope for smaller local suppliers to grow (Monaco, et al., 2020). The dominance of high multinational corporations (MNCs) often leads to reliance on established global supply chains, with over 60% of automotive components being imported in 2020 (National Association of Automobile Manufacturers of South Africa , 2022).

To address these barriers, developing an inclusive supplier base through financial grants and support for SMEs, and OEM-local partnerships, including incentives for local value addition, is essential. These two measures would also be facilitated by the creation of industry clusters or free zones, which can foster co-operation and help to cut supply costs. With the right interventions, the sector can move away from reliance on imported components and towards a more resilient, locally anchored value chain (Naude, 2013).

2.15 Recommendations and Strategic Interventions

Given the diagnostic review of barriers to localisation in the South African automotive sector and insights from international best-practice studies, several strategic interventions and policy suggestions are essential to optimise local content and foster sustainable industrial development. In this section, key recommendations arising from the challenges identified in previous sections, along with practical solutions applicable to improve South Africa's automotive sector, are outlined.

2.15.1 Establish Long-Term Policy Stability and Clear Localisation Targets

The local automotive industry could do with a long-term, predictable policy environment that includes well-defined, clear, and enforceable local-content targets. The government

can have an investment plan with a roadmap for, say, a phased localisation process, which would let manufacturers know there are guaranteed prospects and capacity-building. This is consistent with successful approaches in countries such as India and Thailand, where incremental, binding localisation norms have resulted in significant local value creation (RMB, 2021).

2.15.2 Strengthen Supplier Development Programmes

One main pillar of South Africa's industrial policy should be the development of a competitive local supply base. Drawing on India's PMP and Thailand's EcoCar Programme, South Africa could incentivise localisation targets for Tier 2 and 3 suppliers to bolster their capabilities, improve quality standards, and align with OEM specification requirements. This could be facilitated by skills development programmes and technology-transfer programmes (Department of Trade, Industry and Competition, 2024).

2.15.3 Enhance Coordination Between Government and Industry

Cooperation mechanisms between policymakers, industry associations, and OEMs should be improved. Sectoral forums or public-private partnerships can work towards a common goal by aligning on shared objectives, such as increasing local content. The Moroccan experience of combining infrastructure, training and policy support within automotive clusters might act as a point of reference for encouraging co-operation among different players (Ramolobe & Khandanisa, 2024).

2.15.4 Expand Financial Support for Innovation and R&D

With today's high-tech automotive manufacturing, local R&D is essential. Policy encouragement, such as R&D tax incentives or subsidies for EVs (Electric Vehicles), batteries, and advanced electronics, could stimulate local innovation (Qadir, et al., 2024). There is evidence for how selective state intervention could be well designed to enhance R&D and technical capabilities in the automobile business, demonstrated by Brazil's initiative Rota 2030 (Santos & Nunes, 2025). In South Africa, enabling relationships among universities, research councils, and OEMs would be instrumental in developing sustainable technological capabilities (Kruss & Gastrow, 2016).

2.15.5 Improve Infrastructure and Logistics

To lower the cost of doing business and make local suppliers more competitive, South Africa should work to enhance infrastructure, particularly in logistics, transport, and energy reliability. Expanding and upgrading industrial zones, ports, and roads serve not to reduce production costs, but to enhance the efficiency of the automotive value chain as a whole. Thailand's automotive clusters and Morocco's industrial zones are good examples showing the role of strategic infrastructure investments in boosting the industry (BDO South Africa, 2024).

2.15.6 Focus on Environmental Sustainability and Green Technologies

As the automotive sector heads towards being environmentally friendly, South Africa would do well to localise green technologies, including electric vehicle (EV) parts and components, batteries, and renewable energy in their automotive production, working towards new global sustainable production trends can open new growth prospects for local-content, whether embracing the direction the rest of the world is heading in or

utilising green technology incentives. (Department of Trade, Industry and Competition, 2023).

The proposed steps outline key strategic interventions to help overcome barriers to localisation in the South African automotive sector, inspiring confidence in policymakers and stakeholders to develop effective solutions. Integrating knowledge from international case studies, South Africa can develop a complementary and multidimensional policy regime that could help build a more competitive, sustainable and locally integrated automotive industry.

2.16 Summary

This chapter reviewed the South African automotive industry and examined why local content remains low despite decades of industrial policy. Although programmes such as the APDP and SAAM 2035 provide strategic direction, they have not resolved the core barriers limiting localisation. The industry continues to depend on imported, highvalue components because global suppliers retain advantages in cost efficiency, manufacturing capability, quality assurance and technological innovation. Four interconnected constraints have been identified as driving this dependency: persistent shortages of specialised technical skills; limited access to investment and modern production technologies; shortages of tooling and advanced manufacturing infrastructure; and supply chain inefficiencies, including high logistics costs and long lead times. International examples such as Brazil, Thailand, and India show that coordinated policy support and focused supplier development can enable localisation; however, South Africa lacks a component-level diagnostic framework to address these systemic constraints. Consequently, a broader, evidence-based analysis is needed to determine operational and strategic impacts of imported components. The subsequent chapter describes the mixed-methods research approach used to investigate these issues, and the study further develops

recommendations to strengthen local supplier competitiveness and reduce reliance on imports.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The preceding chapter reviewed the structural barriers to higher levels of local content, notably in high-value components such as wiring harnesses, hydraulic systems, precision castings and electronic control units. These continue to be significant hurdles, with low localisation rates due to skills gaps, investment restrictions, tooling and infrastructure requirements, and supply chain inefficiencies. A comparative examination with emerging economies, including Brazil, Thailand, and India, reveals that higher localisation is attainable by targeting systemic issues through policy coordination and specific industry support. Utilising these insights, the current chapter describes the methodological approach employed to explore these barriers and to develop a framework to enhance localisation in the South African context.

Research is an organised and systematic way of finding answers to questions. Saunders et al. (2019) highlight that good research adheres to logical processes that add strength and credibility to data and facilitate replication. While Cresswell & Cresswell (2018) point out the fact that the choice of research methodology should suit the problem being studied. In complex industries such as the automotive industry, where economic behaviour results from interactions among multiple economic, institutional, and technical factors, it is increasingly suggested that methodological triangulation can capture both measurable momentum and context dynamics (BansAkutey & Tiimub, 2021).

To address these challenges, this research used a mixed-methods approach that combined qualitative and quantitative methods, as well as a simulation technique. Exploratory interviews with key stakeholders informed the development of a structured questionnaire to ensure that the survey items were grounded in industry realities. The survey was then distributed more broadly to collect quantifiable evidence on the drivers and barriers of

localisation. Lastly, a system dynamics model was constructed to project the long-run effects of policy, investment, skills, and supply chain interventions on local content performance. Systems dynamics has recently emerged as a powerful tool to test feedback loops and dynamic relationships in industrial systems (Schwaninger & Groesser, 2020). It is, therefore, necessary that the research approaches are sound and value-adding to the body of knowledge.

The remainder of this chapter, therefore, presents the research design, the population and sampling design, the methods for collecting data, the analysis of the data, and the ethical considerations guiding the study.

3.2 Research Design

The general research approach, design and process adopted in this study are shown in Figure 3.1. It emphasises the steps in the order of operation in which the research was carried out, from exploratory interviews to the survey instrument. It concludes with a system dynamics simulation model. Each stage was intended to lead systematically into the next, so that the methods would be coherent and consistent with the aim and objectives of the study. This structured approach aims to build confidence in the research process and its findings.

Table 3.1: Mapping of Research Questions to Methodological Approach

Source: Adapted from (Cresswell & Cresswell, 2018)

1.	How does the South African automotive industry compare with other emerging economy countries in terms of local content in components, and what percentage of local content is currently achieved in the South African automotive production?	Qualitative
2.	What are the key factors influencing local-content levels in the South African automotive industry, and how do these factors impact the sector's performance and long-term sustainability?	Quantitative
3.	What kind of conceptual framework can be developed to optimise the localisation process in the South African automotive industry, and how can it address the challenges identified in the study?	Qualitative
4.	How can the proposed framework for localisation be validated, and what are the critical success factors necessary for its effective implementation within the South African context?	Qualitative

Further details of each stage, including sampling, data collection, data analysis, and ethical considerations, are presented in the figure that follows.

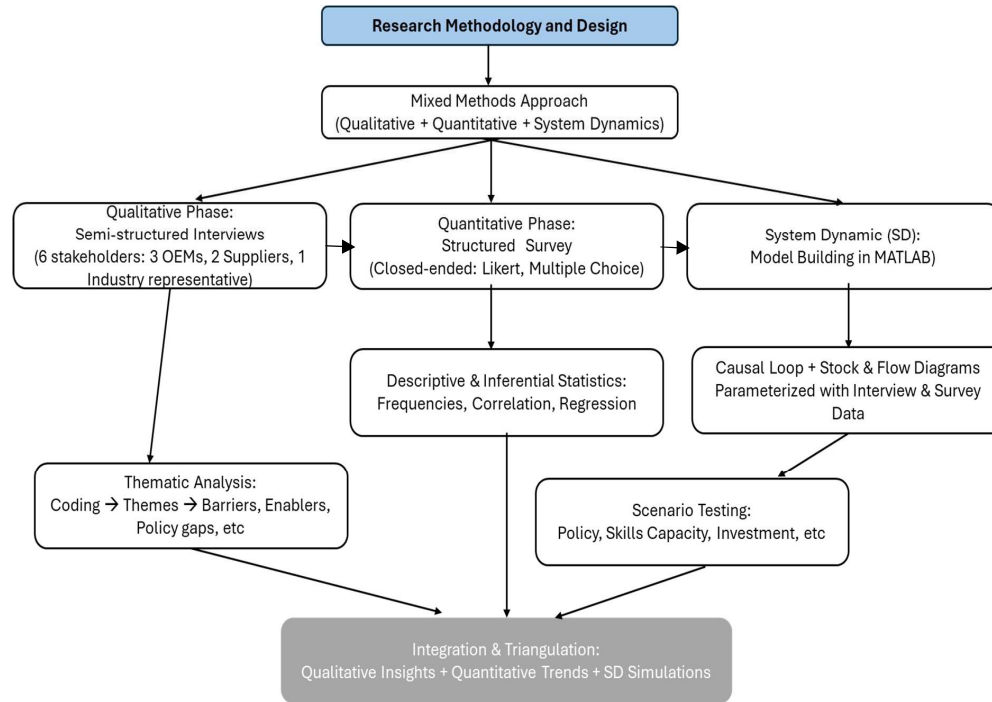


Figure 3.1: Outline of Research Methodology

Source: Adapted from (Kajamaa, et al., 2020)

To guide the reader through the methodological choices made in this research, it is essential to define the key statistical techniques presented in the figure above for a clear understanding of the context. These definitions explain the purpose and relevance of each method, highlighting how they contribute to ensuring a balanced, representative, and analytically sound research design.

I. Descriptive Statistics

Descriptive statistics is used to summarise, organise, and present data in a meaningful way, using measures of central tendency (mean, median, mode), measures of dispersion (range, variance, standard deviation), and visualisations (graphs, tables). They do not allow generalisation beyond the observed data (Yellapu, 2018).

II. Inferential Statistics

Inferential statistics enable researchers to infer conclusions about a population from sample data using probability, hypothesis testing, and estimation methods. They help in generalisation and decision-making under uncertainty (Makwana, et al., 2023).

III. Causal-Loop Diagram

A causal-loop diagram is a system-thinking tool that maps variables and their interrelationships to show feedback loops (reinforcing or balancing) that influence system behaviour. CLDs are widely applied in health, education, and sustainability research to make dynamic complexity visible (Littlejohns, et al., 2018).

IV. Stock and Flow Diagram

Stock and flow diagrams extend causal mapping by explicitly modelling accumulations (stocks) and rates of change (flows). They provide a quantitative structure for system dynamics simulations and highlight how delays and feedback drive long-term system behaviour (Lin, et al., 2020).

V. Thematic Analysis

Thematic analysis is a standard method in qualitative research for breaking down data to identify, analyse, and report patterns (themes) within the data. The data are coded into themes of the clusters, from which interpretations emerge. It is a flexible approach that can be applied with multiple qualitative research designs (Jnanathapaswi, 2021).

VI. Scenario Testing

In scenario testing (also called scenario analysis or stress testing), various strategies, systems, or institutions are examined across multiple plausible futures to assess their resilience. It is commonly used in policy, finance and environmental research, which frequently interconnects narrative scenarios with quantitative modelling (Majka, 2024).

VII. Triangulation

Triangulation improves the validity of studies by using multiple data sources, methods, investigators, or theories in relation to a single object of inquiry. It helps to mitigate bias and ensures credibility in both qualitative and mixed-methods research (Bans-Akutey & Tiimub, 2021).

3.3 Research Approach

A research methodology guides how a study will be designed, carried out and tested by connecting philosophical assumptions to methodological decisions (Aburaya & Gomaa, 2020). Methods are typically categorised into qualitative, quantitative, and mixed-methods research, with all approaches offering distinct ways of viewing things.

Building on this foundation, the chapter presents the general approach used to identify factors affecting local content and their implications for the expansion and resilience of South Africa's automotive industry. To achieve the research goals, comparative analysis, impact studies, and the development and validation of a localisation framework have been conducted using a mixed-methods approach. They include qualitative, quantitative, and system dynamics (SD) methods, allowing for the descriptive representation of current dynamic behaviour and the prospective exploration of future behaviour over time. Mixed-methods research designs have a particular application for complex phenomena that demand both inductive and deductive understanding (Ahmed, et al., 2024).

The qualitative component comprised six semi-structured interviews with stakeholders (OEMs, component suppliers, and an industry association), providing rich data on localisation barriers, enablers, and policy impacts. These findings were then used to inform the questionnaire design, thereby supporting construct validity (Banha, et al., 2022). The quantitative phase involved a structured, cross-sectional survey with closed-ended questions (Likert and multiple-choice scales). This enabled local content percentages, skills gaps, and

investment requirements to be measured, as well as supply chain considerations (Young, 2015). The numerical trends from the empirical data were used to parameterise system dynamics, which was supported by structured evidence. Lastly, system dynamics (SD) modelling was used to investigate how variables, including supplier capacity, skills, policy levers and the presence of testing infrastructure, interact over time (Guzzo, et al., 2022). Recent studies highlight how the SD approach enables exploration of long-term policy and operational outcomes in industrial systems (Anderson, et al., 2023), as well as in transport systems (Zhu, et al., 2023).

By combining the strengths of these three methodologies, the study implements methodological triangulation. It is, therefore, capable of establishing both empirical validity and predictive understanding, necessary for guiding localisation policy in a complex sector.

3.3.1 Qualitative Research

Qualitative research is distinguished by its emphasis on meaning, context, and lived experience rather than statistical measurement. It is rooted in an interpretivist paradigm that assumes reality is socially constructed and best understood through rich narrative inquiry (Pervin & Mokhtar, 2022). Among standard methods are interviews, focus groups, and document analysis, which can be used to examine how perspectives play out in institutional settings closely (Busetto, et al., 2020).

For this study, the qualitative phase was intended as an exploratory point. Six semi structured interviews were conducted with key stakeholders: two suppliers, three OEM representatives, and one industry body. This approach gave a window into the perceived barriers, enablers, and policy influences affecting localisation. Importantly, these results helped to shape the questionnaire and ensure survey questions were based on actual industry needs and connected quantitative investigation to contextual evidence. Qualitative research in this study, therefore, did not seek to produce generalisable results

but rather to inform and validate future quantitative and simulation analysis that would also reflect the lived experience of the sector.

3.3.2 Quantitative Research

Quantitative research involves collecting numerical data and analysing it to identify measurable patterns or test relationships between variables. It sits within the positivist paradigm, which emphasises objectivity, replicability, and empirical testing (Cresswell & Cresswell, 2018). This approach allows broad generalisation and the use of statistical tests to make overall judgements from samples. This technique enables population-level generalisation and statistical inference from representative samples.

In this research, the quantitative phase consisted of a structured cross-sectional survey administered to participants in the South African automotive industry. The questionnaire, composed of closed-ended questions (Likert scale and multiple choice), covered qualitative data such as localisation rates, human resource skills, investment levels, and technology transfer. This enabled descriptive and inferential statistical analysis (Yellapu, 2018) to take place, which generated quantifiable evidence corroborating the qualitative findings and parameterising the system dynamics model. This meant that we could find and statistically validate correlations in the trends within companies' marketing practices (Naugle, et al., 2024).

3.3.3 System Dynamics (SD) Simulation

In this study, system dynamics (SD) extends the mixed-methods approach by simulating the dynamic interactions among key localisation drivers, including supplier capacity, skills development, policy incentives, financing, and testing infrastructure. The model was parameterised using both qualitative interviews with industry representatives and quantitative survey responses from fifty participants. This was done to ensure that the model structure mirrored the reality of the South African automotive market and that

coefficients and weights were based on quantifiable facts obtained through a structured survey. The modelling environment chosen for implementation was MATLAB, which provides a robust platform for stock-and-flow modelling, parameter testing, and scenario analysis.

The development of the SD model followed a standard sequence. First, causal relationships were identified and expressed in feedback form. Second, these relationships were translated into a stock-and-flow structure, which formalises the accumulation of resources and their rates of change. Finally, the system of equations was simulated in MATLAB under different policy and investment scenarios. Figure 3.2 presents the causal-loop diagram, which shows how policy incentives stimulate investments, skills development, and testing capacity. These, in turn, strengthen supplier capacity and increase local content. At the same time, external pressures such as rising imports act as balancing constraints, reducing potential localisation gains.

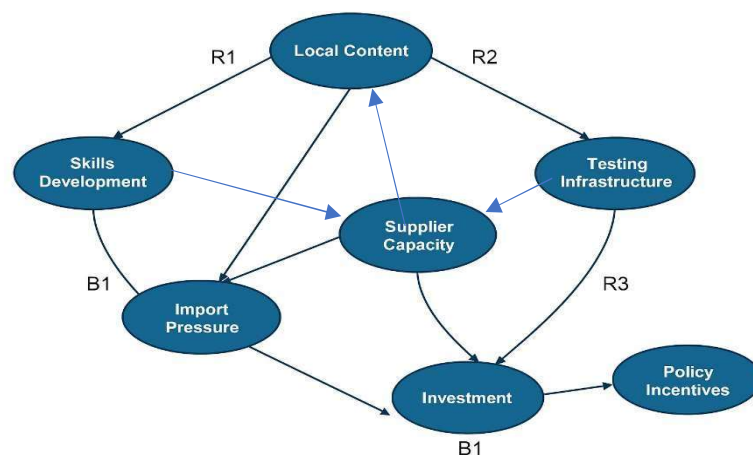


Figure 3.2: Causal-Loop Diagram of Localisation Dynamics

Source: Adapted from (Wopereis, et al., 2024)

This system shows interconnected positive feedback loops that strengthen local industrial development through skills, infrastructure, and investment, but also includes balancing pressures from imports that can dampen the effect. Positive loops (R1–R3) reinforce local

content growth. The import pressure loop (B1) acts as a counterbalance. It pushes things back towards stability when they start to go too far in one direction.

I. Loop 1 - Skills development (Reinforcing Loop R1)

- a) Enhanced skills → stronger supplier capacity
- b) With better suppliers → higher local content
- c) More local content → further skills training

This is a virtuous circle that strengthens local industries.

II. Loop 2 - Infrastructure Support (Reinforcing Loop R2)

- a) Better test infrastructure → higher component supplier capacity
- b) Stronger suppliers → more local content
- c) Increased local content → provides justification for construction of even larger test facilities.

This is a virtuous cycle that gains quality and credibility.

III. Loop 3 - Investment & Policy (Reinforcing Loop R3)

- a) Good policy incentives → pull in more investments.
- b) More investment → develops supplier capability → increases local content.
- c) Greater local content → boosts confidence → more investment

This is the virtuous cycle that smart government policies and funding can drive when it comes to innovation.

IV. Loop 4 - Import Pressure (Balancing Loop B1)

- a) High import pressure → decrease in local content
- b) Low local content → loses supplier capability.
- c) Weaker capacity → can only slightly ease pressure on imports when demand adjusts.

This is a stabilising loop that ensures local production does not expand too rapidly or get too inefficient.

Building on this causal representation, Figure 3.3 further presents the stock-and-flow diagram, which translates these dynamics into formal model components. In this framework, Supplier Capacity (S), Skills (K), and Local Content (L) are treated as stock variables. Flows such as investment, training throughput, and localisation adoption determine their rates of change. Import pressure, included as a balancing feedback loop, negatively influences the level of localisation. Together, Figures 3.2 and 3.3 form the structural backbone of the system dynamics model. The causal-loop diagram depicts the relationships and feedback loops, whereas the stock-and-flow diagram formalises these in terms of equations.

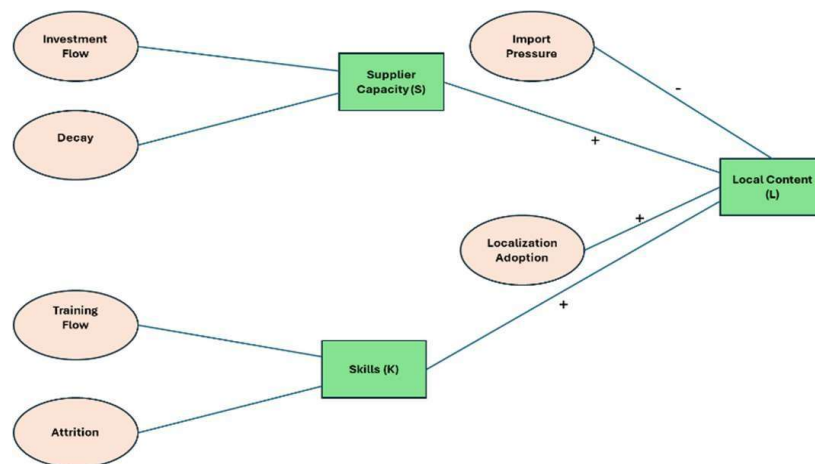


Figure 3.3: Stock and Flow Diagram of Localisation Dynamics

Source: Adapted from (Freeman, et al., 2017)

Figure 3.3 indicates that:

- I. Investment and Training are growth drivers, they build capacity and skills.
- II. Decay and Attrition are loss factors; they erode what has been built.

- III. Localisation Adoption is a policy lever; it pushes the system towards more local participation.
- IV. Import Pressure acts as a balancing force, it limits local content expansion if imports dominate the market.

The diagram shows that Local Content (L) depends on two major foundations:

1. Supplier Capacity (S) - created by investment but eroded through decay, and
2. Skills (K) - raised by training, depleted by attrition.

Both S and K feed into L, which is finally influenced by import pressure (negative) and localisation adoption (positive).

The relationships represented in Figures 3.2 and 3.3 were formalised into a system of differential equations to capture the dynamic interactions between investment, skills development, and local content performance. Shown in Equations (1) - (3), supplier capacity, skills, and local content were each modelled as continuously evolving variables influenced by key driving and constraining factors.

$$\frac{dS}{dt} = I(t) - \delta S, \quad (1)$$

$$\frac{dK}{dt} = T(t) - \theta K, \quad (2)$$

$$\frac{dL}{dt} = \alpha S + \beta K - \gamma L \quad (3)$$

Where $I(t)$ represents investment flows, $T(t)$ training throughput, δ and θ natural decay/attrition rates, and α, β, γ are parameters that have been calibrated using interviews, survey information and other sources.

- I. **Equation (1)** models supplier capacity (S) as the balance between investment inflows and the natural decay of company capability. Continuous investment strengthens supplier performance, while decay represents the gradual loss of efficiency or technological relevance over time.
- II. **Equation (2)** describes skills accumulation (K) as a function of training throughput, which increases workforce ability, and attrition, which decreases the pool of skilled labour through turnover, retirement or skill obsolescence.
- III. **Equation (3)** defines local content (L) as a weighted sum of supplier capacity and skills, reduced by import pressure (M) that limits local sourcing opportunities. Together, these equations describe how investments and training drive long-term localisation outcomes, while decay, attrition, and import competition constrain them.

This set of equations explains both how investments and training lead to the development of the workforce over time. For instance, 67.4% of survey respondents identified limited financing as a critical barrier, which was reflected in the weighting of α . Likewise, skills shortage were mentioned as a blocker (30.2%) increasing the magnitude of β , and low production volumes (86.0%) was identified as a disincentive for localisation, which we have captured through import pressure M . NAAMSA's report of 38% average local content in 2024 served as the baseline initial condition for L_0 .

To illustrate the usefulness of the model at a component-level, the wiring harness subsystem was examined. Harnesses are labour-intensive and often localised through assembly in South Africa, but with many inputs still imported. A simplified harness-specific equation 4 was introduced:

$$\frac{dL_h}{dt} = \beta_h K - \gamma_h M \quad (4)$$

Where L is the localisation share of harnesses, β depicts sensitivity to skill composition of labour and γ is vulnerability to import competition. Interview evidence confirmed that

harness localisation increases when training pipelines are strengthened but declines rapidly when global sourcing pressures rise. This example shows how the model can zoom into specific subsystems while maintaining a systemic perspective.

The model was implemented in MATLAB using the standard ordinary differential equation solver ode45. State variables (S, K, L) were specified inputs, while flows were parametrised from survey and interview results. Investment flows were modelled as functions of policy incentives and finance, while training flows reflected government and institutional capacity building. The full MATLAB code, including the ode45 implementation, parameter files, and plotting routines, are provided in the Appendix E.

3.3.3.1 Linking the System Dynamics Equations to MATLAB Implementation and Scenario Design

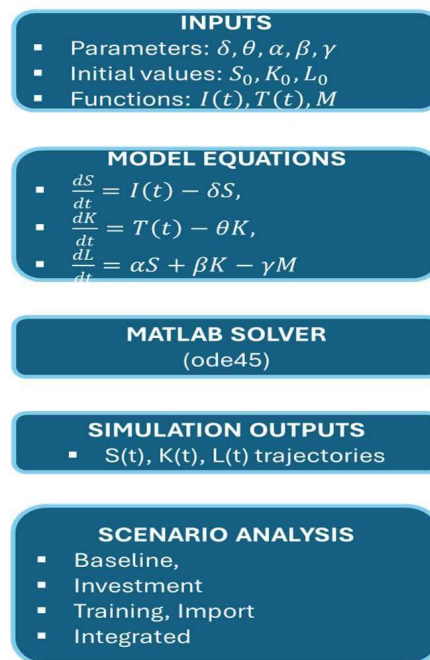
To operationalise the causal and stock-flow structures presented in Figures 3.2 and 3.3, the relationships were formalised through a system of ordinary differential equations (Equations 1-3) and implemented in MATLAB. Each equation corresponds directly to a key stock within the system, Supplier Capacity (S), Skills (K), and Local Content (L) and expresses how these evolve over, time in response to inflows and outflows.

In MATLAB, these equations were coded as a system of first-order differential equations using the ode45 solver, which integrates the rates of change over time to produce continuous trajectories for S, K and L. Initial values (S , K , L) were defined based on baseline industry data, with $L = 0,38$ (reflecting NAAMSA's 2024 average local-content). Parameter values for δ , θ , α , β , γ were calibrated using survey and interview results: 67.4% of respondents identified limited financing as a critical constraint (weighing α), 30.2% highlighted skills shortages (weighing β), and 86.0% cited import dominance (weighing γ). Table 3.2 summarises the key parameters used in the simulation.

Table 3.2: Parameters Used in the System Dynamics Model of South African Automotive Localisation

Parameter	Description	Source/Justification
δ	Supplier capacity decay-rate	Derived from interview averages ($\approx 5\%$ per annum)
θ	Workforce attrition rate	Survey data: 8% turnover rate
α	Supplier capacity weight	Calibrated from 67.4% citing financing constraints
β	Skills weight	Calibrated from 30.2% citing skills shortages
γ	Import pressure coefficient	Calibrated from 86.0% citing low production volumes

The model formulation in MATLAB replicates the logic of causal diagrams: stocks (S, K, L) evolve over time as functions of flows (investment and training), that stabilise or limit growth according to feedback (import pressure and decay). Figure 3.4 illustrates the logical flow of the MATLAB simulation, from parameter input to model output.

**Figure 3.4:** Flow of MATLAB Implementation

Source: Author-created image

Scenario testing was then used to explore how different policy or investment strategies affect localisation outcomes. Each scenario corresponds to a realistic policy question derived from stakeholder consultations:

Table 3.3: Scenario Definitions for System Dynamics Model of Automotive Localisation

Source: Author-created table

Scenario	Model Change	Policy Interpretation
Baseline	Current $I(t)$, $T(t)$, M	Business as usual – continuation of 38% localisation
High investment	Increase $I(t)$ by 30%	Strong supplier development funding
Enhanced Training	Increase $T(t)$ by 25%	Expansion of technical training and apprenticeships
Integrated Strategy	Combine all above	Coordinated industrial policy and localisation support

The resultant curves $L(t)$ illustrate how various interventions affect the time evolution of local content. The modelled patterns speak directly to the principal issue posed by the study: why has local content been flat, and what is an achievable combination of interventions that can lift it.

3.4 Population and Sampling

Sampling is an important methodological choice as it determines the degree to which findings may be generalised back to the population of interest. Crucial and appropriate sampling procedures optimise the representativeness as well as reliability of study results in basic on industry-based data collection dealing with a diverse clientele (Makwana, et al., 2023). Stratified sampling allows the researchers to classify the population into relevant strata in order to ensure proper representation of certain influential categories; thus, enhancing accuracy and generalizability (Makwana, et al., 2023). Consistent with this, purposive sampling permits one to choose the purposive information-rich cases and individuals as such who are more applicable to meet the aim of the study (Campbell, et al., 2020).

The population for this study comprised sixty-three key role-players within the South African automotive value-chain. This comprised Original Equipment Manufacturers (OEMs), suppliers and industry representatives such as the Automotive Industry Development Centre (AIDC) and the National Association of Automobile Manufacturers of South Africa (NAAMSA). These groups were chosen because of their central influence in shaping localisation outcomes through production decisions, Supply Chain Management, and regulatory frameworks.

3.4.1 Sampling Frame and Participants

A mixed sampling strategy was employed to capture both depth and breadth of insights. For the qualitative phase, a purposive sampling strategy was adopted to ensure that information-rich participants with specialist knowledge of localisation were included. Six semi-structured interviews were conducted, three with OEMs and two with suppliers, one industry representative (NAAMSA). In a qualitative study, sample size adequacy was determined by the principle of theoretical saturation/informational power and not by predefined numbers. Due to the expertise of the participating participants and the focused objective of this study, six interviews were considered adequate to yield common topics used as a guide for questionnaire elaboration (Hennink & Kaiser, 2021). The researcher's choice of 6 respondents was justified because the respondents all kept on giving the researcher the same information and thus the researcher quickly reached data saturation and was thus satisfied that even if the researcher had obtained more participants, they would not have yielded any new information that the researcher had not yet obtained from the previous 6 participants.

With respect to the quantitative survey, a stratified random sampling approach was applied. The population was stratified (OEMs, suppliers, and industry representatives), and a simple random sample of respondents was drawn in each stratum. This guaranteed equitable distribution throughout the value-chain (Hossan, et al., 2023).

The sample size required for the survey was estimated using finite population correction (Saunders, et al., 2019) which is applicable to small overall populations:

$$n = \frac{N}{1 + N\varepsilon^2} \quad (5)$$

Where:

n = required sample size

N = population size (57)

ε = margin of error (0.05, or 5%)

Substituting values:

$$n = \frac{57}{1 + 57 \times (0.05)^2} = \frac{57}{1.14} \approx 50$$

The minimum number of responses required for the survey was fifty, at 95% confidence level and with a margin for error of 5%. It stands to reason that although the population may be small, a sample survey large enough to ensure well representation is still feasible and does not overestimate the target size required for a study (Taherdoost, 2017).

Unlike interviews and surveys, the System Dynamics (SD) model did not require direct sampling of participants. Instead, it was parameterised using insights from the qualitative interviews, measurable data from the quantitative survey, and secondary sources (industry reports). This integration ensured that the SD model was grounded in both stakeholder perspectives and empirical evidence. By combining these inputs, the model was able to simulate dynamic relationships between localisation drivers (Martinez-Moyano, 2023).

3.4.2 Rationale of the Sampling Strategy

Purposive sampling for interviews combined with stratified random sampling for consulting surveys enhanced expert-driven depth, plus statistical representativeness. The interviews elicited rich descriptions of localisation barriers, enablers and policy

challenges, while the survey provided quantitative evidence of these dynamics throughout the broader stakeholder community. This complementarity enhances methodological rigour, and it is consistent with best practice in mixed-method research for complex industrial contexts (Creswell & Clark, 2018).

By tailoring the sampling strategy to the finite population of sixty-three stakeholders, this study was able to strike a balance between statistical validity and practical feasibility, which produces findings that are both robust as well as of direct policy interest concerning South Africa's automotive localisation agenda.

3.4.3 Reasons for Selecting Participants

Participants for the study were selected based on the requirement to represent a broad spectrum of views which sufficiently reflect the intricate relationships in the South African automotive industry. The inclusion of key players at various levels of the value chain offered an overall vision about what is at stake and gains in the automotive industry.

The participation of OEMs, suppliers and government officials contributed to an extensive and holistic representation of the localisation environment. Each had a unique and distinctive impact upon their localisation results; the OEMs through sourcing and composition decisions, suppliers via component production methods and sub-assembly processes, and either policymakers or industry players that set regulations to provide strategic guidance. Both views taken together reflect standard methodological approaches for mixed-method research in complex industries (Monaco, et al., 2020).

3.4.4 Location of the Study

The study was conducted across three automotive major hubs in South Africa:

- I. Rosslyn:** a significant hub of vehicle production and supply chain operations.

- II. Silvertown:** Another automotive corridor with critical mass of OEM activity and supplier chain.
- III. Port Elizabeth (Gqeberha):** an industrial hub with a growing automotives' sector, it provides geographical diversity.

3.4.5 Rationale for Location Selection

The choice of study locations was strategically guided by industry concentration and geographical coverage:

- I. Geographical coverage: Reporting for various provinces helped to capture regional variation in localisation practice.
- II. Industrial concentration: Each location has a strong automotive base, making it ideal for accessing relevant participants.
- III. Accessibility to stakeholders: The hubs enabled to engage more easily with the focal people, which improved information gathering (both qualitative and quantitative).

This aligns with recent methodological recommendations that advocate for geographically diverse sampling to capture context-specific industrial dynamics (Flick, 2018).

3.4.6 Population Sample Responses

The desired number of survey respondents was fifty, calculated using the finite population correction formula for a total population of fifty-seven stakeholders (see Section 3.4). This target represented approximately 87.7% of the defined population and was selected to ensure statistical validity while remaining manageable within the study's scope.

Response rate percentages were calculated using arithmetic proportions using the formula:

- a) $\text{Response rate} = \text{Response proportion} / \text{Non-response proportion} * 100\%$

b) Response rate = $50/57 * 100\%$

c) Response rate = 87.7%

It is important to note that the study obtained fifty respondents, which was necessary to reach the targeted sample, which meant that the study attained the precision level needed to yield 95% confidence interval.

This survey covered two major South African automotive manufacturing clusters; Pretoria (Rosslyn and Silverton) and Port Elizabeth (Gqeberha). These regions are the backbone of automotive assembly and component production in South Africa.

A total of fifty questionnaires were returned from which 100% achievement of the calculated minimum required sample size was attained. A high response rate means high engagement among targeted stakeholders and enhances the reliability of the findings. In fact, only 7 (12.3%) of the total population were non-respondents because they did not complete the survey, but their absence did not compromise representativeness, since the minimum sample size was fully attained. In surveybased research, attaining the calculated minimum sample is considered robust and assures the findings can be generalised for all parties (Sharma, 2021).

Table 3.4: Population Sample Responses

Response Outcome	Frequency	Outcome
Completed Questionnaires	50	87.7% of population
Non-Responses	7	12.3% of population
Total Population	57	100%

This outcome indicates that the study successfully attained its sample size in both selected hubs in Pretoria and Port Elizabeth. The resulting dataset constitutes a solid foundation for the quantitative analysis developed in the following chapter.

3.5 Data Collection Methods

The process of data collection constitutes the most critical step in research due to the fact that the validity of the study results is related to how efficiently data are collected and organised. As (Cresswell & Cresswell, 2018) explain, qualitative data collection can be carried out employing various methods such as interviews, surveys, observations and secondary sources, all of which should be adapted to the research setting. In industry-case-based research, such as automotive localisation, triangulation between several sources is particularly relevant to provide as holistic a view on the various stakeholders' perspectives and still guarantee real objective evidence (Clark & Ivankova, 2016).

This outcome indicates that the study has successfully attained its sample size in both selected hubs in Pretoria and Port Elizabeth. The resulting dataset constitutes a solid foundation for the quantitative analysis developed in the following chapter.

3.5.1 Primary Data Collection

Three main approaches were utilised in this present study: (i) primary data were gathered in interviews and surveys, (ii) secondary sources were obtained from industry authoritative reports and global databases, and (iii) these inputs especially survey results were fed into a System Dynamics (SD) model for simulating localisation effects.

The primary data collection process comprised two key phases: semi-structured interviews and a structured survey. Six key stakeholders were purposively sampled: three from OEMs, two suppliers and one trade association. These semi-structured interviews gave useful insights into barriers as well as enablers for localisation. The fluid nature of the

interview structure enabled stakeholders to provide in-depth industry commentary, while making sure that conversations unfolded in response to research aims (Creswell & Poth, 2018).

The interview protocol followed the five-phase approach from Kallio et al. (2016) and included modern testing methods such as expert reviews and cognitive interviews.

The researcher began by identifying key discussion areas from existing studies. These included skills, finance, technology, and policy. Each topic was linked to the main goals of the study to make sure the questions were relevant and meaningful (Boateng, et al., 2018). The researcher then created a semi-structured guide with open-ended questions grouped into main themes such as supplier capacity, skills development, financial support, technology readiness, and policy coordination. For example, participants were asked to explain the main challenges that stop local suppliers from producing advanced components. Follow-up questions encouraged them to share real examples and timeframes. Before starting the main interviews, the guide was tested with two industry experts to remove unclear or biased wording. Each interview lasted between 45 and 70 minutes. Participants received an information sheet and consent form before the session. The researcher recorded the interviews with permission and wrote detailed notes to capture key details and body language. The same trained interviewer or pair conducted all sessions to ensure consistency. After each interview, the researcher wrote short notes to record first impressions, patterns, and themes for later analysis (Braun & Clarke, 2019).

Insights gained from the interviews were subsequently used to inform the development of a structured survey questionnaire, ensuring strong construct validity. The survey utilised close-ended question structures (e.g., Likert-type scales and multiple-choice) to capture more quantifiable evidence of localisation percentages, investment levels, skills gaps, and supply chain bottlenecks. The number of valid responses was fifty, accounting for 87.7% of the sample population, and meeting the minimum required sample size described in Section 3.4. This high rate of response improved the representativeness of the sample and was utilised as a basis for further statistical analyses.

3.5.2 Secondary Data Collection

Secondary data were equally essential to triangulate and validate information obtained from primary sources. Information was also gained from industry reports on localisation patterns and supplier development interventions, as well as on policy guidance. To enhance the comparative nature of the study, international trade repositories (namely UN Comtrade ITC Trade Map and OECD/World Bank datasets) were used to benchmark South Africa's localisation performance against other emerging automotive nations including India, Brazil, and Thailand. Multiple sources also made it possible to triangulate findings and minimise biases that may be introduced from using a single type of data (Saunders, et al., 2019).

The researcher paid close attention to the quality of these sources and recognised several limitations. Some datasets were not up to date since they were released annually. When more recent company data became available through interviews, the researcher used it to update key parameters and recorded when these updates were made. Different organisations defined "local content" in diverse ways. To deal with this, the researcher used NAAMSA's definition as the baseline and adjusted other data to match it. Any uncertainty caused by these differences was noted and tested in the sensitivity analysis. Another challenge was the limited detail available for high-value components such as precision castings and electronic control units. In these cases, the researcher combined trade data with company-level information from interviews to create the most accurate estimates possible. These combined estimates and their limitations are reported in Chapter 4 and the Appendix. The researcher also recognised that industry reports can reflect advocacy positions rather than neutral analysis. To reduce bias, each claim from such sources was verified against at least one independent dataset, such as government reports or peer-reviewed studies (Vogl, et al., 2019). Secondary data played a vital role in setting benchmarks, building baselines, and confirming findings. However, the researcher treated these data with caution, clearly identifying uncertainties and testing their effect in the model's sensitivity analysis (Saltelli, et al., 2019).

3.5.3 System Dynamics Inputs

In this study, the system-dynamics (SD) component builds on descriptive and mixed method approaches by modelling the feedback loops and time dependent interactions that drive localisation outcomes in South Africa's automotive sector. Data collection process behind the SD model was formulated to do more than simply capture parameter values, but also to comprehend the causal mechanisms and estimate coefficients as well validate system behaviour against data on observed industry trends (Malbon & Parkhurst, 2022).

3.5.3.1 Data Collection for Model Variables

Three complementary sources informed the SD model:

a) Qualitative Interviews:

Six semi-structured interviews with key industry actors (OEMs, Tier-1 suppliers, and associations) supplied qualitative insights into causal linkages among localisation drivers such as investment inflows, skills development, technology transfer and policy incentives. These interviews formed the framework for a casual loop diagram (CLD) that is represented by reinforcing loops (skills growth, infrastructure support, investment & policy incentives), and a balancing loop (import pressure).

b) Quantitative Survey Data:

A quantitative survey of fifty participants provided numerical estimates for model coefficient. For example, 67.4 % of respondents cited inadequate financing as a major barrier; 30.2 % reported skills shortages; and 86.0 % highlighted import and production volume constraints as critical. These proportions were normalised and used to calibrate weights and coefficients so that mathematical relationships mirror stakeholder perceptions.

c) Secondary Data:

Secondary datasets from industry-wide sources (such as the NAAMSA Trade Manual, industry output data, and localisation trends) generated baseline conditions and time-series inputs. For example, the industry local-content level was reported at around 38 % in 2023 (NAAMSA 2024), while vehicle production volumes reached 633 332 units in 2023 (NAAMSA, 2024) and exports rose markedly (National Association of Automobile Manufacturers of South Africa, 2023). These anchor the initial condition for the localisation stock and support calibration of rate parameters.

Using these data, the SD model's structure was formalised through differential equations consistent with stocks, flows and feedback loops. Supplier capacity (S) and workforce skills (K) are treated as stocks accumulating through inflows and decaying through attrition. The model was implemented in MATLAB, using Simulink to visualise and connect stock-flow relationships, the Symbolic Math Toolbox to define and manipulate the differential system, the ODE solver ode45 to integrate stocks over time) and the Optimisation Toolbox to fit simulation outputs to empirical series). Input datasets (survey results, formatted industry statistics) were imported and mapped to model parameters, and the output trajectories under each scenario were exported for comparative analysis.

Model validation followed multiple levels. Behavioural validation compared baseline simulation outputs with historical NAAMSA localisation data (2013-2024), reproducing trends within $\pm 5\%$. Extreme-condition testing exposed the model to boundary scenarios, such as zero investment inflow or unlimited training capacity, confirming stable and realistic behaviour. One-at-a-time sensitivity analysis ($\pm 25\%$ variation in key parameters) showed that localisation is most sensitive to investment inflows (~ 0.47 elasticity), moderately sensitive to training throughput (~ 0.31), and least sensitive to import pressure (~ 0.12). The results of these parameter perturbations were visualised using a tornado chart (presented later as Figure 4.18 in Chapter 4), where the horizontal bar length represents the percentage deviation of the final local content value from the baseline. Longer bars

indicate higher model sensitivity and thus greater leverage potential for policy intervention.

Scenario testing over a ten-year horizon evaluated four “what-if” interventions: a baseline scenario maintaining steady localisation (~38-40%), a skills overhaul scenario based on improved throughput into training (~8% growth in over time), a finance scenario with a 25-30% increase in investment while holding training constant, and an integrated policy package combining investment, skills development and policy reforms to deliver above target levels of grey side activity (>55%) by year ten. Such validation, sensitivity, and scenario analyses have demonstrated that the model repeats historical patterns thus reacts to policy changes, evidencing its value as a diagnostic and forecasting tool (Razavi, et al., 2020).

3.6 Data Analysis

In line with research design of mixed and multi-methods strategies, collection of data had three phases. The integration of qualitative insights, quantitative measures, and simulation modelling enabled both descriptive and predictive understanding of localisation in South Africa’s automotive industry. This methodological triangulation gave full accounts that were both accurate and meaningful (Creswell & Clark, 2018).

3.6.1 Qualitative Data Analysis

The six semi-structured interviews were analysed for qualitative data using thematic analysis following the method of (Nowell, et al., 2017). This approach involves a sequence of steps of coding, categorising and themes being generated in order to identify commonalities throughout the data. Interview transcripts were first transcribed verbatim and coded manually to extract recurring ideas related to localisation barriers, enablers, and policy gaps. The resulting codes were organised into higher level categories such as skills development, investment barriers, policy translation and supplier readiness, which in turn evolved into the key themes that served to structure both the development of the

questionnaire as well as the interpretation of survey results. Thematic analysis was particularly suited to this study as it captured nuanced perspectives and contextual insights that could not be obtained from numerical data alone. The steps of the thematic analysis are highlighted below:

Step 1: Getting Familiar with the Data

The researcher started by spending time with the data. They listened to the interview recordings, read the transcripts several times, and wrote short notes about first thoughts and ideas. This helped them understand what participants were really saying and how they felt about the issues discussed (Braun & Clarke, 2019).

Step 2: Coding the Data

The next step was to break the data into smaller pieces. The researcher went through each line and gave short labels or “codes” to key ideas. This helped capture both what was said and the meaning behind it. The coding was done by hand, and another person checked about 20% of the work to make sure the ideas made sense. The researcher then created a codebook that explained what each code meant and gave simple examples.

Step 3: Finding Themes

After coding, the researcher grouped similar codes together to form bigger ideas called “themes.” These themes showed patterns across the interviews. Some of the first themes were about finance and credit problems, testing and certification, tooling and lead-time issues, and unclear procurement rules.

Step 4: Checking and Improving Themes

The researcher went back over the data and checked each theme to make sure it was clear and accurate. They removed overlaps, joined related themes, and made sure each one captured a single main idea. This step made the themes stronger and easier to understand.

Step 5: Naming and Explaining Themes

Once the themes were final, the researcher gave each one a simple name and clear meaning. They also showed how these themes linked to the system dynamics model, explaining how they affected each other within the bigger picture of the study.

Step 6: Making Sure the Work Was Trustworthy

To make sure the analysis was solid, the researcher kept clear notes of all decisions, wrote reflections after each step, and checked some facts with participants. They also compared the interview results with data from surveys and reports to make sure everything matched (Braun & Clarke, 2019).

3.6.2 Quantitative Data Analysis

Quantitative data collected through the structured survey was subjected to both descriptive and inferential statistical analysis. Descriptive statistics, including frequency distributions, means, and percentages, were used to summarise key characteristics of the sample and responses. This provided an overview of current localisation levels, investment trends, and workforce skills distribution.

Relationships among variables were then examined using inferential statistics. Correlation analysis was applied to correlate factors such as investment, localisation percentage and supplier capacity. The causal links and effects in the direction of policy incentives versus levels of investment to local content adoption, formed part of a regression analysis. All statistical analyses were performed with SPSS Software, ensuring accuracy and reproducibility of results. This two-level approach ensured both an understanding of general patterns and rigorous testing of hypotheses derived from the qualitative phase (Pallant, 2020).

Inferential statistics were then applied to test relationships between variables. Correlation analysis was used to identify associations among factors such as investment levels,

localisation percentages, and supplier capacity. Pearson's R was the correlation used for continuous, normally distributed constructs. When the distribution of data was found to not be normal, Spearman's rho was used for ordinal or non-normal data. Normality assessed by Shapiro-Wilk and visual Q-Q plots; where assumptions failed, nonparametric tests were used. Regression analysis was conducted to determine the strength and direction of causal relationships, particularly in relation to how policy incentives and investment levels influence local content adoption. Multiple linear regression models tested hypotheses about predictors of measured local content percentage (dependent variable). Assumptions checked: multicollinearity (VIF), linearity, independence (Durbin-Watson), homoscedasticity (Breusch-Pagan), and normality of residuals. All statistical analyses were carried out using SPSS Software, ensuring accuracy and reproducibility of results. This two-level approach ensured both an understanding of general patterns and rigorous testing of hypotheses derived from the qualitative phase.

3.6.3 System Dynamics Modelling Analysis

To study the long-term feedback relationship between localisation determinants, an SD modelling framework was used. This approach facilitated a systematic representation of how investment, skills accumulation, supplier capabilities and import competition interact dynamically through time.

Qualitative and quantitative information from interviews, questionnaires, and secondary data sources informed the formulation of model parameters. These inputs were parametrised in MATLAB to maintain consistency and traceability of data flow through the system. The model conceptual foundations were laid down by means of CLDs depicting reinforcing and balancing feedback loops between localisation drivers.

After the concept mapping stage, the CLDs were operationalised into stock-and-flow configurations, testing accumulation and depletion processes over time. Stock variables were defined, each subject to inflows such as investment and training throughput, and

outflows representing decay and attrition. Local Content (L) was modelled as a dependent stock influenced by the dynamic interactions of S, K, and import pressure (M).

The model was implemented using MATLAB's built-in functions for dynamic simulation. Behavioural validation was put in place for methodological rigour by benchmarking simulated trajectories against historical trajectories, while extreme condition testing assessed the stability and logic of the model including under boundary conditions (e.g., no investment or unconstrained training input scenarios). Such validation procedures were essential in verifying the structural validity of the model, and its ability to simulate feasible system behaviour.

3.6.3.1 Scenario Analysis

A scenario analysis was used to visualise the dynamic relationships between investment, up-skilling, and localisation impacts over a ten-year future projection horizon. It allowed for the examination of alternative policy and industry developments under controlled 'what-if' scenarios. Four alternative scenarios were developed to cover the spectrum of plausible outcomes:

I. Baseline Scenario: This scenario assumed the continuation of established investment and skills development trajectories, with localisation performance remaining similar to historical behaviour. This was the base case for comparison.

II. Skills Development Scenario: Modelled the effects of a 20% increase in training throughput to assess the isolated effect that skills growth has on localisation. In this way the purpose of the exercise was to explore how far quality rather than quantity of human capital by itself could change localisation, when no corresponding shifts in investment behaviour were assumed.

III. Finance Scenario: In this scenario the effect of 25–30% increased investment inflow was considered, while keeping training throughput constant, to understand

how direct financial support affected localisation outcomes. The findings revealed that enhanced access to finance enabled the supplier base and technological improvement, thus propelling localisation rates upward to a level of some 50% over the ten-year horizon. However, in the absence of simultaneous skills development, gains eventually became stuck on a plateau assuring that investment is not enough without concurrent human capital enhancement for unlocking localisation potential.

IV. Integrated Reform Scenario: Combined reform scenario: the combined effects of increased investment flows, targeted policy incentives and increased training throughput – to estimate the dynamic interaction between coordinated reforms on localisation dynamics.

Sensitivity analysis was used in addition to the scenario simulations to explain influencing dynamics of localisation responsiveness. Parameter elasticities were also simulated to measure the degree of change in localisation performance due to changes in investment inflows, skills throughput and import pressures. This process was intended to identify which factors had the strongest influence, so that high-impact leverage points for policy and industry intervention could be identified.

3.6.3.2 Implications of Analysis

The interpretation of the system dynamics (SD) modelling outputs focused on identifying the structural characteristics of the South African localisation system and the policy levers with the greatest potential influence. Rather than presenting outcomes, this analytical phase aimed to translate model behaviour into actionable insights for policy and strategy formulation.

The analytical process involved synthesising simulated relationships among investment, supplier capacity, skills development, and import dependence to infer systemic dependencies. Particular attention was given to determining the dominant feedback

mechanisms that shape localisation performance over time. Based on this interpretive approach, a number of central analytic themes were developed:

- I. Investment as the Primary Lever:** The elasticity of localisation outcomes with respect to inflows' penetration was examined in this exercise and it proved that investment is the most elastic policy variable, which makes sense to consider it as a critical variable.
- II. Complementarity of Skills and Capital:** Model interrogation focused on the interrelation between skills development, financial and technological inputs, highlighting the need for interventions to occur jointly rather than in isolated skill programmes.
- III. Systemic Coordination:** The analysis assessed cross institutional connections contained within the model and emphasised high coordination between government, OEMs, and industry bodies as a factor to determining global efficiency.
- IV. Temporal Dynamics:** Sensitivity analyses were performed using lags to study the delayed effects of investment commitments, capacity expansions and observed patterns of localisation.
- V. Evidence-Based Policy Application:** The methodological framework was used to demonstrate how SD modelling can serve as a decision-support tool, allowing policymakers to pre-test intervention scenarios under controlled, simulated conditions.

By embedding these analytical levels in the SD model helped to provide a structured basis for interpreting localisation as a systemic and path-dependent process. This enabled

diagnostic understanding of contemporary limits and prescriptive guidance for crafting coordinated, evidence-informed strategies to hit national localisation targets.

The system dynamics (SD) modelling approach was used to interpret the structural nature of localisation challenges within the South African automotive sector. The analysis focused on understanding the interdependencies between investment, supplier capacity, skills development, and technology-transfer. Rather than presenting results, the methodological emphasis was on examining system behaviour and identifying the key leverage points that influence localisation trajectories. Scenario simulations were applied to test how coordinated interventions could alter these dynamics over time. This interpretive framework provided a structured, evidence based foundation for developing targeted policy and industry strategies aimed at sustainable localisation growth.

3.7 Ethical Considerations

3.7.1 Permissions and clearances

This study adhered to strict ethical standards to protect the rights and dignity of all participants. Prior to commencing data collection, ethical clearance was obtained from the relevant institutional review board (Training And Resources in Research Ethics Evaluation (TRREE) (reference number: 5209), see Appendix A.

3.7.2 Informed consent

Informed consent was sought from all interview and survey participants, please see Appendix B. They were provided with a clear explanation of the study's objectives, the voluntary nature of participation, and their right to withdraw at any stage without any repercussions.

3.7.3 Confidentiality and anonymity

Confidentiality and anonymity were maintained throughout the research process. Interviews were recorded only with the permission of participants, and responses were anonymised during transcription and analysis. Survey data were treated with the same level of confidentiality, with results aggregated to prevent the identification of individual respondents or companies. Participants were given a clear outline of their rights, and special attention was paid to potential power dynamics during interviews. All data were used solely for academic research, and results will be published in aggregate form to protect individual identities.

3.7.4 Data storage and retention

The data generated in this study are stored in encrypted hard drives. The audio files will be deleted once the transcripts have been verified to be accurate to avoid any victimisation of participants who gave their data. The researcher conformed to all the university's prescripts on data handling.

3.8 Limitations and Delimitations

Like all empirical research, this study has certain limitations which must be acknowledged.

3.8.1 Limitations

I. Data Availability: Although the survey achieved the minimum required sample size, some stakeholders declined participation, limiting the breadth of perspectives. In addition, secondary data on localisation rates in specific high-value components was fragmented, which constrained comparative benchmarking with global automotive hubs. The implications related to data availability include that some

trends or insights could be underrepresented, potentially affecting the accuracy and comprehensiveness of the findings. Future studies should aim to improve data access and coverage to enhance reliability and comparability across contexts (Saunders, et al., 2019).

II. Generalizability: Findings are context-specific to South Africa's automotive industry, particularly Pretoria (Rosslyn and Silverton) and Port Elizabeth (Gqeberha). While comparisons with emerging economies such as Brazil, Thailand, and India provide broader context, results may not be entirely transferable due to different regulatory, institutional, and industrial settings. The limited generalizability implies that the findings should be applied with caution outside the South African context. Future research could expand to other geographic and industrial settings to improve external validity and allow for more robust cross-country comparisons (Creswell, 2014).

III. Interview Bias: The qualitative phase relied on a small number of purposively selected participants. Although this approach ensured expertise and conceptual saturation, responses may still reflect individual biases or strategic positioning by stakeholders. Triangulating these insights with survey data helped mitigate this risk. Potential interview bias implies that findings based on participants' perspectives may not represent the full range of stakeholder experiences. Future research should consider using mixed-method approaches with larger and more diverse samples to minimise bias and improve the robustness of interpretations (Flick, 2018).

IV. Model Simplifications: The System Dynamics (SD) is an attempt to keep a manageable prominent level of complexity by abstracting from some complex phenomena. Although it does a good job in capturing feedback and dynamical relationships, this formulation is not comprehensive to discount all external shocks (such as global supply shortages or abrupt policy changes).

3.8.2 Delimitations

The study was deliberately bounded in scope to ensure focus and feasibility:

I. Geographically, it was limited to South Africa's primary automotive hubs, Pretoria and Port Elizabeth. The justification for this is that these areas are the highest concentration of production and supplier networks and thus results from these areas best inform provincial and national policy for major automotive clusters.

II. The population frame was defined as fifty-seven key stakeholders, including OEMs, Tier 1 and Tier 2 suppliers, and policymakers/industry bodies, ensuring representativeness across the value-chain. The researcher justified this population by realising this was the most suitable group to yield the desired results for the study. The researcher also viewed that other stakeholders were outside the scope of where the study needed to go, especially in view of time as well.

III. Thematic content was to be limited to the barriers, enablers and strategic measures from a localisation perspective and not wider macro-economic or trade policy considerations.

IV. System dynamics modelling concentrated on skills, investment, supplier capacity, and policy levers as core variables, leaving aside secondary dimensions such as consumer behaviour or export demand.

These delimitations helped the study to keep course and deliver discoveries that are valid as well as useful, for the South Africa localisation agenda.

3.9 Summary

This chapter discussed the research methodology used to study localisation in the South African automotive industry. It described the research plan, which uses a mixed methods (qualitative interviews, structured survey and a system dynamics simulation model). This triangulated strategy combined conceptual depth and empirical soundness. The chapter also outlined the population and sampling approach that balanced purposive with stratified random sampling to secure expert-driven insights as well as statistical representativeness.

The approach to gathering information included semi-structured interviews, a structured questionnaire in the major automotive clusters of Pretoria and Port Elizabeth, as well as triangulation among data sources using secondary data. Data analysis was performed in three steps: qualitative thematic analysis, descriptive and inferential statistics of survey responses, system-level modelling to project long-term localisation results.

Ethical considerations were addressed by obtaining institutional approval, acquiring participant consent, securing confidentiality and maintaining integrity of the data. Finally, the chapter recognised limitations of the study such as data availability, generalisation and model reduction and also established delimitations guiding its boundaries.

In overall, the methodological framework developed throughout this chapter constitutes a solid ground on which Chapter 4 is later based for analysing and interpreting the empirical findings with respect to the research questions.

CHAPTER 4: RESULTS AND ANALYSIS

4.1 Introduction

This chapter shares the findings from both the qualitative and quantitative parts of the study, which followed an exploratory mixed-methods approach. The design was based on a few important assumptions. First, it assumed that the views of a small group of six industry experts would provide sufficient insight to guide the development of the larger survey. Second, it assumed that the opinions of managers and specialists working in the main automotive hubs of Pretoria and Port Elizabeth could reflect the broader situation across South Africa's automotive sector. Third, the high survey response rate of 87.7% was expected to reduce the risk of bias from those who did not respond. Recognising these assumptions is important when considering how broadly the results can be applied and what limitations they may carry. Data collection commenced with six semi-structured interviews conducted with key stakeholders in the South African automotive value-chain, including OEM representatives, suppliers, and an industry body. Insights from these interviews informed the design of the survey questionnaire, ensuring that items reflected the practical realities of localisation barriers, enablers, and policy challenges.

The refined questionnaire was administered in two automotive clusters, Pretoria (Rosslyn and Silverton) and Port Elizabeth (Gqeberha). In summary, 57 stakeholders were found in the total population and 50 of them accepted to participate ($\approx 87.7\%$ response rate), which is what allows the conclusion to say that the minimum sample size needed was surpassed. This high response rate increased the validity of the results and the possibility to generalize findings in the specific population area.

Recent research highlights that effective analysis in mixed-methods studies requires a combination of qualitative narratives and quantitative evidence, going from mere description to interpretation with policy and practice implications. This chapter initially provides descriptive discussion of the demographic information of respondents and then presents the

findings for each research question; both interviews and surveys' data are utilized to allow methodological triangulation.

4.2 Biographical Data of Respondents

The demographic details of respondents are shown to give an idea about the overview of participants who contributed to this study. Such information is important for contextualizing the findings, as demographic and professional characteristics often shape perceptions, decision-making, and industry experiences. In automotive industry research, reporting respondent profiles also enhances the credibility and representativeness of the results (Denzin & Lincoln, 2018).

Respondents' profiles are shown in Table 4.1. For ease of analysis, and to emphasise strategic functions, all job roles were grouped into two broad categories: management and specialists/other. This grouping is based on the fact that, regardless of job title, all respondents possessed knowledge of and were directly involved in localisation initiatives or projects within the South African automotive industry. The distribution shows that 72.0% of respondents were specialists, while 28.0% occupied management positions. This balance highlights the study's attempt to capture views of decision-makers and technical experts who are directly involved in the localisation process.

Table 4.1: Frequency Distribution of the Biographical Variables

Variable	Category	Frequency	Percentage
Position	Specialist/Other	36	72.0%
	Management	14	28.0%
Organization Type	OEM Representative	28	56.0%
	Component Supplier Representative	10	20.0%
	Industry Association Representative	12	24.0%
Years of Experience	More than 10 years	30	60.0%
	6-10 years	13	26.0%
	3-5 years	2	4.0%
	Less than 3 years	5	10.0%

In terms of organisational type, the majority of respondents (56.0%) were representatives from Original Equipment Manufacturers (OEMs), followed by component supplier representatives (20.0%). A small number of participants came from industry associations (24.0%). This means that the study indeed gathered inputs across the value-chain, which also corresponds with the stratified sampling approached outlined in Chapter 3.

With respect to work experience level, more than half of the respondents (60.0%) had over 10 years of experience in the automotive industry, while 26.0% reported 6-10 years of experience. Only minority groups with 3-5 years (4.0%) and less than 3 years (10%) of experience among respondents participated in the research. This distribution suggests that the dataset is weighed towards highly experienced professionals, which strengthens the reliability of the findings, as these individuals are well-positioned to provide informed insights on localisation barriers, enablers, and policy impacts.

4.2.1 Organisation Type and Local-Content Bracket

This subsection tests whether reported localisation levels differ systematically by respondent type. Specifically, it asks whether organisation type (supplier, industry association, OEM) is associated with local content bracket (<20%, 20-40%, 41-60%, $\geq 61\%$). A Pearson χ^2 test of independence is applied to the 3 $\times$ 4 contingency table.

Table 4.2: Organization Type $\times$ Local-Content Bracket

Organization type	Less than 20%	20-40%	41-60%	61% or more	No response	Total
Supplier Representative	2	5	2	1	-	10
Industry Association Representative	1	7	2	0	2	10
OEM Representative	8	16	3	1	-	28
Total	11	28	7	2	0	50

Descriptives: Responses cluster in the 20-40% bracket across groups. Among OEMs, 57.1% fall in 20-40%, with smaller shares at <20% (28.6%), 41-60% (10.7%), and ≥61% (3.6%). Suppliers likewise centre on 20-40% (50.0%), followed by <20% (20.0%) and 41-60% (20.0%) and ≥61% (10.0%). Associations (n=10) report 20-40% (70.0%), with some at <20% (10.0%) and 41-60% (20.0%). At face value, this pattern suggests a mid-range plateau rather than stark differences by organisation type.

Let $r = 3$ rows (organisation types) and $c = 4$ columns (local content brackets); total $N=48$ (two respondents did not specify a local content bracket and were excluded from the test).

Expected counts under independence is given by

$$E_{ij} = \frac{(\text{row total}_i) \times (\text{column total}_j)}{N} \quad (6)$$

$$\text{i. e Supplier} < 20\%: E = \frac{(10) \times (11)}{48} = 2.29$$

$$\chi^2 = \sum_{i,j} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} = 3.46 \quad (7)$$

$$\text{Degrees of freedom(df) are } (r - 1)(c - 1) = (3 - 1)(4 - 1) = 6 \quad (8)$$

$$\text{The right-tail probability from } \chi^2_{(6)} \text{ is } p = 0.749 \quad (9)$$

$$\text{Effect size Effect size Cramér's } V = \sqrt{\chi^2 / (N \times \min(r - 1, c - 1))} \quad (10)$$

$$V = \sqrt{3.46 / (48 \times 2)} = 0.19$$

Table 4.3: Pearson χ^2 Test Summary (based on Table 4.2)

Test	χ^2 (df)	p- value	N	Effect Size
Pearson χ^2	3.46 (6)	0.749	48	0.190

The χ^2 test indicates no statistically significant association between organisation type and local content bracket at conventional levels ($p=0.749$). The effect size (Cramér's $V=0.190$) is small-to-moderate but imprecisely estimated given the sample size and does not reject the null of independence.

The distribution of responses suggests that most stakeholders' report localisation in the 20-40% range, with only limited representation in the higher brackets. The absence of statistically detectable differences by organisation type (χ^2 , $p = 0.749$) implies that system-wide constraints such as limited production scale, access to supplier finance, and restrictions around design authority/intellectual property likely shape localisation outcomes across the value-chain rather than being specific to OEMs or suppliers. This interpretation aligns with the interview evidence and the study's broader baseline that localisation performance tends to stabilise in the mid-range.

If constraints are structural rather than actor-specific, policy and programme responses should prioritise cross-cutting enablers such as demand aggregation to increase scale, supplier development finance, and technology-transfer frameworks rather than interventions narrowly targeted at a single respondent group (Humphrey & Memedovic, 2019).

4.3 Local Content Trends in the South African Automotive Industry

Figure 4.1 shows trends in local content of the South African automotive industry over the period 2013-2024 from data obtained through interviews with NAAMSA (2024). The graph illustrates this situation with local content, showing a degree of variability around 38%-43% over the past decades and no sustained trend moving upwards. Spikes were recorded in 2013 and 2021 (43%), while in 2024, they had dropped back to 38%.

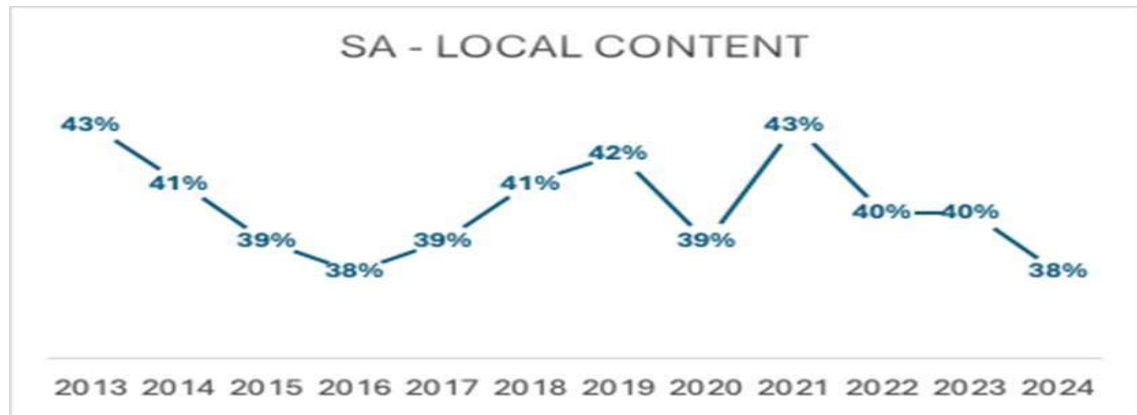


Figure 4.1: Local-Content Trends in South Africa, 2013-2024

Source: NAAMSA (2024), interview data.

This stagnation reveals a persistent gap between the current scores for localisation and the government target of 60%. The same findings are echoed in some of the most recent studies, which imply that deficiencies in skills, poor technology-transfer arrangements, limitations on investment and logistic inadequacies continue to restrict the ability of the South African automotive sector to wield influence on localisation (National Association of Automobile Manufacturers of South Africa, 2023).

The observed trend directly reflects the hypotheses formulated in Chapter 1 (Section 1.11):

I. H1: Workforce Skills

The plateau in local-content also confirmed the persistent constraint of limited technical and engineering capacity in manufacturing high-value components for the automotive sector; namely, wiring harnesses, and electronic systems. Respondents argued that even though OEMs had tried to localise some components, there was a shortage of artisans and skilled engineers to enable the localisation of masses of such parts. This finding is supportive of the second alternative hypothesis, and to the extent established, it indicates that workforce skills are significantly related to localisation levels.

II. H2: Technology-Transfer

The stagnation from 2016 to 2024 also reflects weak technology-transfer between multinational OEMs and local Tier 2 suppliers. Interviewees noted that while some tooling and process technologies are shared, core intellectual properties and advanced technology domains were always owned by the global supply chains. This finding supports the fourth hypothesis in positing that the level of technology transfer discourages localisation.

III. H3: Investment Constraints

The survey results identified an under-investment in supplier upgrading and testing facilities. More specifically, most respondents raised the issue of the existing incentive schemes that often help OEMs rather than direct investments into local suppliers. The declining trend during the recent years (from 2022 to 2024) could be explained by a hypothesis that a lack of investment impedes localisation growth.

IV. H4: Logistics Efficiency

Interview data also indicated that the delays at ports and high costs of inland logistics significantly deteriorate local suppliers' competitiveness. Delays in the port schedule can cause import of parts to lag behind the expected schedule as well as transportation of finished products, disrupting production and delivering products later. Heavy inland transport expenses also inflate shipping costs of components and vehicles from seller to manufacturer to dealers. Hence, during 2020-2023 COVID-19 disruptions and port congestion, the effect was further exacerbated due to increase in imports from the mentioned sources. The consistently present inefficiencies could support the simple hypothesis that better logistics performance results in higher localisation.

In summary, the NAAMSA trend (Figure 4.1) does not refute the study's hypotheses but rather underscores their relevance. Localisation has stagnated because skills, technology, investment, and logistics constraints have not been adequately addressed. As the system dynamics modelling in Chapter 5 will show, improvements in these four areas collectively offer the potential to shift localisation rates upward and bring the 60% target within reach.

4.4 Diagnostic Analysis of Research Objectives

To address the research aim of conducting a diagnostic analysis of the causes of low local content in the South African automotive industry, this section reports on outcomes based on four specific study objectives. Diagnostic analysis is an organised method with systematic tools to discover and report root causes of performance issues instead of just identifying symptoms (Andersen & Fagerhaug, 2022). In applied industry research, diagnostic tools such as gap analysis, Pareto analysis, root cause analysis and system dynamics modelling are commonly used in internal assessments of barriers to competitiveness (Maware, 2019).

Following this approach, the subsequent sub-sections are organised around the four research objectives:

- I. Objective one applies a comparative diagnostic (gap analysis) to benchmark South Africa's local-content levels against selected emerging economies.
- II. Objective two evaluates the causal relationships between key factors (skills, technology-transfer, investment, and logistics) and localisation outcomes, applying both statistical testing and diagnostic tools such as Pareto and correlation analysis.
- III. Objective three develops a conceptual diagnostic framework using system dynamics modelling, enabling the identification of structural feedback loops that sustain low localisation.
- IV. Objective four validates the framework through triangulation, comparing findings from interviews, surveys, and model simulations to confirm robustness.

This diagnostic framework means the study does not only determine what the barriers are, but it also explains why they persist and how to overcome them. The combining of industrial diagnostic and system dynamics simulation has provided practical recommendations to address South African automotive cluster localisation challenges.

4.4.1 Objective 1 - Comparative Analysis of Local-Content Trends

The first objective of this study was to assess the level of local content in South Africa's automotive production against growing automotive economies such as Brazil, India and Thailand. Establishing this baseline is necessary to diagnose the structural reasons for South Africa's low localisation and potential policy and industry levers to improve it. Benchmarking, as a widely accepted diagnosis tool for performance gap analysis, involves comparing indicators between situations which emphasise the area of weaknesses and strengths (Zhu, et al., 2023). For industrial localisation analyses, comparison with foreign peers does show whether low levels of local-content are due to structural constraints or constraints to policy (Gereffi & Lee, 2016).

4.4.1.1 Benchmarking South Africa's Localisation Levels

Interview insights from NAAMSA and OEM respondents confirmed that the average local content of South African assembled vehicles remain below 40%. This was further validated by the survey results, where the mean localisation level was calculated at 43.3% (SD = 12.6, N = 48).

Because survey responses were collected in categorical bins (<20%, 20-40%, 41-60%, ≥61%), each range was assigned a representative midpoint to enable quantitative analysis. The following allocations were applied:

<20% → 25%

20 - 40% → 45%

41 - 60% → 55%

61% or more → 80%

The mean was then computed using the weighted arithmetic formula:

$$\bar{x} = \sum \frac{f_i \times m_i}{N} \quad (11)$$

Where f = frequency of responses in bin i , and m = assigned midpoint. This coding strategy is a standard technique when dealing with imbalanced, open-ended categories to ensure that the upper and lower bounds are not underestimated.

The results are illustrated in Figure 4.2, which shows the distribution of responses across the four bins. The proportions highlight that most companies remain clustered in the 20-40% range, confirming the stagnation of localisation at low levels.

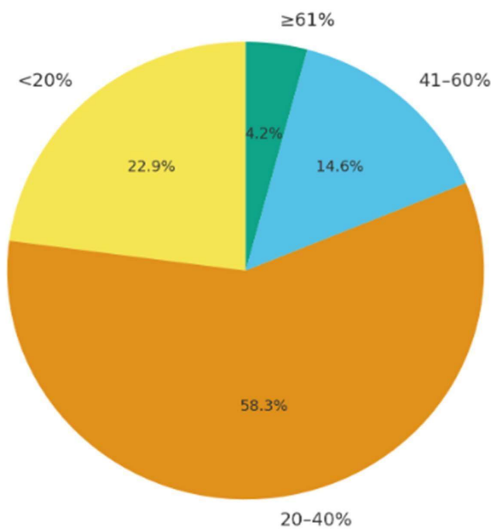


Figure 4.2: Proportion of Responses by Local-Content Range

By comparison, Peer emerging markets, by contrast, have accomplished much higher localisation rates:

- I. Brazil has achieved 65-70% localisation,
- II. India maintains 60-65%, and
- III. Thailand consistently records 75-80% in light vehicles (United Nations Industrial Development Organization, 2020).

Such benchmarks show South Africa's relative underperformance and re-emphasise the diagnostic conclusion that structural constraints constrain localisation. Other emerging economies have reached much higher levels of localisation. These benchmarks provide

useful targets but applying their strategies directly to South Africa needs careful adaptation. The local market is smaller and more fragmented than in countries such as Thailand or India, which makes it harder to achieve economies of scale. South Africa's automotive industry has also developed around a few dominant OEMs and a loosely connected supplier network. This creates unique challenges for technology-transfer that differ from Brazil's experience. While the goal of higher localisation is shared, the strategies to reach it must fit South Africa's specific market conditions, institutions, and historical context (Ikome, et al., 2022).

4.4.1.2 Survey Findings on Local Content

The frequency distribution of survey responses ($n = 48$) showed that:

- I. 58.3% of respondents reported localisation in the 20-40% range,
- II. 14.6% reported localisation between 41-60%,
- III. 22.9% achieved below 20% localisation.
- IV. 4.2% reported localisation at 61% or more.

This distribution indicates that while some organisations are making progress, the bulk of South African supplier's cluster are at medium localisation levels, well below international peers.

4.4.1.3 Diagnostic Analysis Using Benchmarking

Utilising benchmarking as a diagnostic tool and descriptive statistics, three gaps are underscored in performance:

- I. Skills Gap** - Skill gaps were indicated by just over 63.4% of sample, on average with the localisation mean (43.3%). Today, India's automotive skills pipeline lets companies retain local content at rates of 60% or higher. By contrast, India's

automotive vocational pipeline enables companies to sustain localisation rates above 60%.

II. Technology-Transfer Gap - 56.1% of respondents indicated limited access to new technologies, with interviews confirming that OEM-supplier partnerships rarely include structured knowledge transfer. Brazil and Thailand, in contrast, embed technology-sharing clauses in supplier contracts.

III. Investment Gap - 70.7% of respondents cited inadequate capital for tooling, testing facilities, and R&D as a key limitation. The number of responses is proportionate to institutions that indicated they are less than 50% localised.

Figure 4.3 presents a Pareto chart generated from survey responses and interview transcripts. Barriers to localisation were ranked by frequency, highlighting that a small number of critical issues account for most of the industry's challenges, consistent with the 80/20 principle.

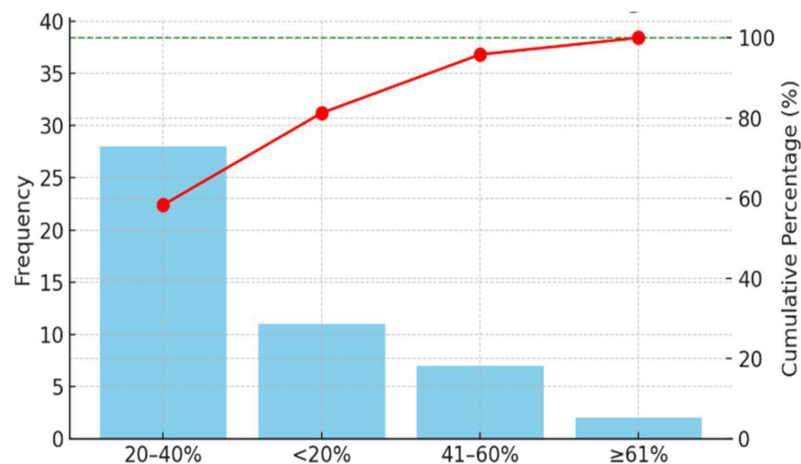


Figure 4.3: Pareto Chart of Localisation Barriers

Source: Survey data, 2025

4.4.1.4 Implications for the Hypotheses

The quantitative evidence provides support for three of the study's hypotheses:

I. Hypothesis 1.11.1 (Workforce Skills): A statistically significant association between skills shortages and localisation levels is supported by both the mean localisation percentage (43.3%) and the high frequency of respondents citing skills gaps (63.4%).

II. Hypothesis 1.11.2 (Technology-Transfer): More than half of the respondents expressing concern over technology-transfer (56.1%) explain more directly that OEM partnerships are synonymous to potential in localisation issues.

III. Hypothesis 1.11.3 (Investment Constraints): With 70.7% of respondents reporting lack of capital, results are consistent with the relationship whereby investment level is systematically related to localisation performance.

4.4.2 Objective 2 - Impact of Localisation Factors on Industry Performance and Sustainability

The second objective of this study was to analyse how workforce skills, investment levels, technology-transfer, and logistics efficiency influence the performance and long-term sustainability of South Africa's automotive industry. The discussion is organised under four diagnostic dimensions, each corresponding to the study's hypotheses.

4.4.2.1 Related Barriers

The survey results indicate that while skills shortages (30.2%) were a significant current challenge, it was overshadowed by three substantial structural barriers: low production volumes (86.0%), lack of supplier finance (67.4%) and intellectual property ownership restrictions (55.8%). These findings indicate that localisation is restrained not only by

limitation of skilled workforce, but also due to structural and financial bottlenecks undermining the competitive advantage of small enterprises (local OEMs).

As an example, the frequency of responses from each of the four main categories of barriers is summarised in Figure 4.4. The data indicate that the low production volumes are the most commonly cited barrier by far. This supports industry concerns that the size of the South African automotive market is insufficient to create economies of scale with regard to becoming competitive in terms of cost by component manufacturers (Komarasamy & Hoque, 2015). Insufficient supplier financing was the next biggest barrier, with two-thirds of those surveyed citing restricted access to funding and high entry costs for tooling and technology as a key obstacle. Lastly, ownership of intellectual property (IP) commonly often retained by OEMs and tier 1 suppliers was mentioned by more than fifty percent of respondents, which confirmed conclusions from industry analysis that the global value chains do not facilitate technology-transfer to local enterprises (Gereffi, 2018).

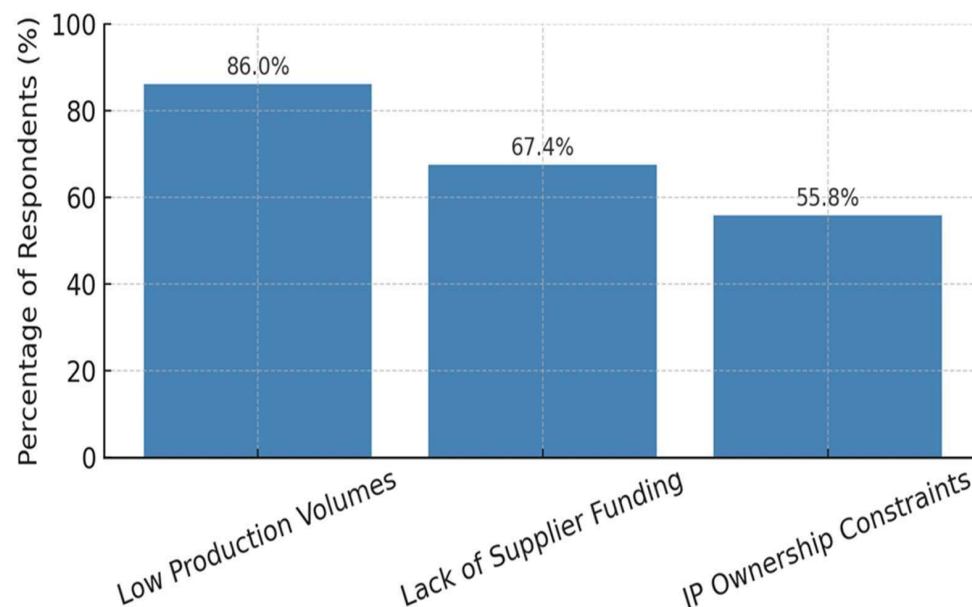


Figure 4.4: Top Barriers to Increasing Local-Content

The following discuss each of these barriers in more detail:

I.Low Production Volumes and Economies of Scale

Suppliers cannot justify the high investments into tools, skills and new technologies if volumes are too low, with high per-unit costs by consequence, leaving them dependent on imports (and hence less projected of gaining a competitive advantage) (Li, 2015). Higher per-unit cost means that the cost of producing or transporting each individual item becomes more expensive. This is also confirmed by international benchmarking. Some emerging economies such as Thailand and India managed to pursue localisation through establishing a high-volume export platform with government support that let them exploit the economy of scale (Organisation for Economic Co-operation and Development, 2023). In South Africa, however, the small and narrow local market leads to suppliers having to compete in global markets without the same economies of scale as their international competitors, with sustainability being compromised in the long-term (Orlanyuk-Malitskaya, et al., 2024).

II. Lack of Supplier Funding and Investment Constraints

The second largest obstacle, mentioned by 65.8% of respondents, is limited access to capital and high entry costs for localisation. Automotive localisation frequently involves large initial expenditure on modern equipment, jigs and testing facilities. South African suppliers have limited access to low-cost finance with which to invest in innovation (Cronje, 2020). Insufficient investment hampers the suppliers' capabilities to expand capacity as well as improve technology, thereby hindering their obtaining of the OEM contracts. This sets up an on-going circle: under-investment leads to weak competitiveness, which in turn hinders the ability of companies to obtain contracts and hence further under-investment. These dynamics undermine the viability of localisation efforts because suppliers continue to rely on imports for high-tech parts (Jones, et al., 2019).

III. Intellectual Property (IP) and Technology-Transfer Constraints

The third most important barrier is IP ownership, which was mentioned by 55.3%. OEMs and Tier 1 multinationals usually keep design and patents (technical-knowledge) which limits the role of local companies to engage in high-value added manufacturing (Chidede, 2022). Not only does this limitation inhibit the transfer of technology, but it also keeps South African companies at the bottom of more value-additive activities.

It has been established in literature, that the successful emerging economies which had adopted high degree of localisation (like Brazil) owed to their ability to extract contracts with stronger technology-transfer commitment from multinational OEMs (Moloi & Mutambara, 2019). There is local weak leverage over multinationals, and the state itself does not enforce its interventions, leaving South African suppliers side-lined in advanced manufacturing processes, which does contribute to increasing company fragility and unsustainability (Roberts, et al., 2021).

4.4.2.2 Diagnostic Implications

Through the diagnostic review of the four hypotheses, it is revealed that there are structural causes of low local content in South Africa's automotive industry rather than operational causes. Workforce skills Hypothesis 1, which deals with workforce skills, was only partially supported, skills shortages were recognised but placed far behind other constraints, implying that while skills are important, they are not the major cause. Hypothesis 3 (about investment constraints) is the most supported with insufficient supplier funding highlighted as a core bottleneck that undermines competitiveness and scale. H2 Hypothesis 2 received the strongest support that with technology-transfer constrained and IP ownership hindered by local company upgrading within global value chains (GVCs) refused. Partially supporting hypothesis four, logistics inefficiency (ports and transport costs) amplifies the costs but with delays; however, they are of secondary importance after investment and technology barriers. This diagnostic analysis emphasises that the localisation struggle is less about identifying and filling near-term operational

gaps than about overcoming systemic obstacles related to access to capital, technology diffusion, and economies of scale.

Localisation is well understood for its role in industrial upgrading, job creation, and trade competitiveness (Altenburg & Rodrik, 2017). Substituting imported parts with locally sourced inputs has potential to decrease the scope for trade deficits, spur supplier development and increase resilience to global supply chain shocks. The survey analysis suggests everyone feels localisation has a significant impact on overall industry growth. More than 68% of the respondents viewed localisation as having a high to extremely high-impact on sectoral growth potential, due to cost competitiveness and capacity expansion. Interview perceptions suggest that localisation is perceived as critical to generating economies of scale. Suppliers in turn cannot spread fixed costs without greater volume manufacturing of locally made parts and are therefore less competitive globally. This perspective is also in line with NAAMSA's 2022 industry report which contended that going forward, the sustainability of the South African industry will be based upon aggregating demand locally and consolidating networks of suppliers to limit reliance on imported components. Figure 4.5 illustrates the distribution of responses on the perceived impact of localisation on industry growth.

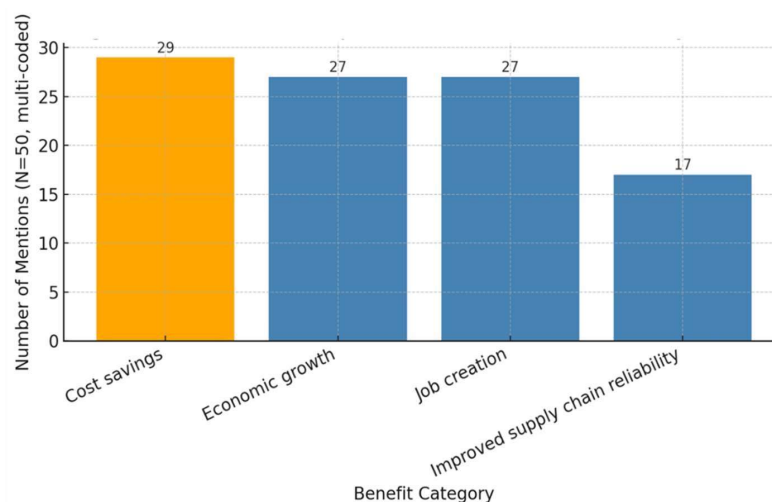


Figure 4.5: Perceived Impact of Localisation on Industry Growth

4.4.2.3 Impact on Employment

Employment generation was also seen as one of the significant advantages of localisation. Approximately 60.4% of respondents believed local content would significantly influence (above 60%) employment in the sector.

This is illustrated in Figure 4.6, which reports the results from surveys on employment trends and perceived localisation consequences. The chart shows that a majority of consumers expect there to be strong job creation, while fewer see only moderate or minimal job gains.

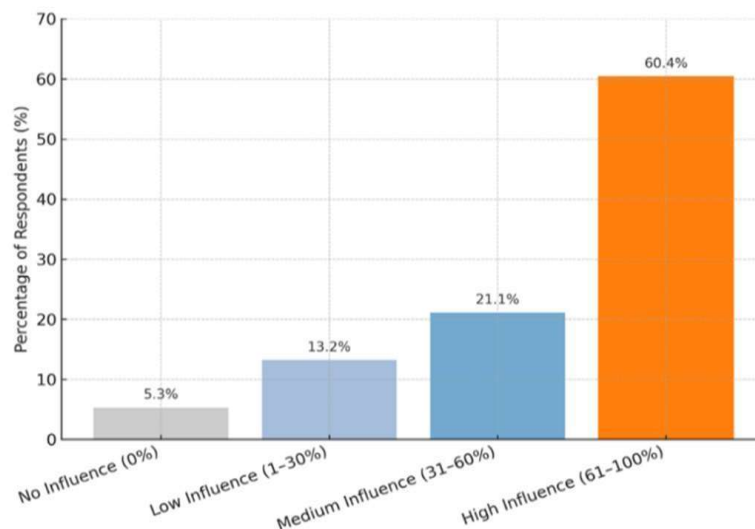


Figure 4.6: Influence of Localisation on Employment Trends

The interviews provide additional evidence that localisation creates demand for jobs in a variety of levels, from semi-skilled assembly workers to highly skilled engineers in design and quality control. Respondents stressed, however, that the employment effect depends on investments in skills and training of the work force. Higher rates of localisation, without equivalent human capital development, have the potential for bottle-neck quality and productivity. This is consistent with the work of Altenburg & Assmann (2017) which showed that Brazil's automotive localisation success was directly tied to its vocational training ecosystem.

4.4.2.4 Impact on Export Competitiveness

Another important result obtained by the questionnaire is export potential. About 70% felt that localisation enhances the growth prospects of South Africa's automotive exports by adding more local value to products.

This is depicted in Fig. 4.7, which presents sample distributions of responses to the effects of localisation on export competitiveness. This reflects a large majority who anticipate that localisation will allow the sector to improve its position globally with fewer than 20% expecting it to have little or no impact.

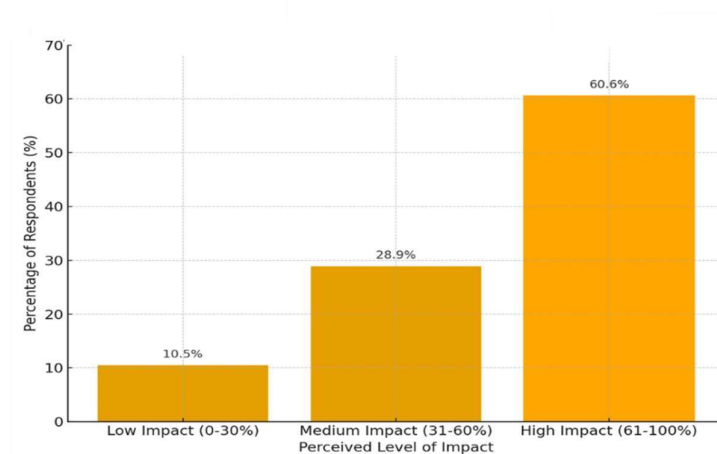


Figure 4.7: Perceived Impact of Localisation on Export Competitiveness

The finding has special implications in the African Continental Free Trade Agreement (AfCFTA) context where rules of origin will become a growing factor of export eligibility and competitiveness. Comparative benchmarking further reinforces this point: India's Automotive Mission Plan 2016-2026 specifically connects localisation to export competitiveness, with a 70% plus level of localisation allowing Indian suppliers access to global value chains (African Union Commission Elections 2021, 2021).

In the case of South Africa, respondents stressed that more localisation would improve cost competitiveness, lower exposure to foreign exchange volatility as well as build exportable niches in components such as wiring harnesses and catalytic converters.

4.4.2.5 Synthesis

The findings collectively emphasise localisation as a multi-faceted economic lever. Its effect is not only to save costs, but also stimulate industry growth, employment generation and export competitiveness. However, there needs to be resolutions to the structural constraints for these advantages to be realised (discussed in Section 4.4.2), including low volumes, supplier financing scarcity and IP limitations. Accordingly, localisation cannot only be considered as an industrial policy objective but also as a development strategy. Enhanced localisation can also increase the GDP contribution of the automotive sector, improve employment multipliers and reduce South Africa's perpetual trade gap in automotive parts.

4.4.2.6 Inferential Analysis (Correlations and Ordinary Least Squares Regression (OLS))

Table 4.4 reports Pearson correlations between local-content (midpoint-mapped brackets) and constraint indices (skills, finance, logistics, IP, scale). Local-content shows weak negative associations with scale ($r = -0.268$) and logistics ($r = -0.142$), and a weak positive association with finance access ($r = 0.19$). This means that companies with better access to finance tend to have slightly higher localisation, but this does not necessarily mean that one causes the other. It could be that companies already well positioned for localisation are also better at attracting finance, or that another factor, such as strong leadership or favourable market conditions, affects both. While the relationship points in the expected direction and supports what theory suggests, it should be seen as a pattern that happens together rather than clear proof of cause and effect. Skills show a small negative association ($r = -0.097$). Although modest in size, these correlations are directionally informative: easing capital constraints aligns with higher localisation, while scale and logistics bottlenecks coincide with lower localisation. Interviews further explain why skills appear weak. Without volumes, finance, and technology-transfer, training alone rarely translates into higher local content. A guide on how the values were calculated is shown in Appendix F.

Table 4.4: Pearson Correlation Matrix

	Local-Content Pct	Skills Index	Finance Index	Logistics Index	IP Index	Scale Index
Local-Content Pct	1.0	-0.097	0.19	-0.142	0.017	-0.268
Skills Index	-0.097	1.0	0.474	-0.289	0.072	0.012
Finance Index	0.19	0.474	1.0	0.261	0.367	0.313
Logistics Index	-0.142	-0.289	0.261	1.0	0.265	0.378
IP Index	0.017	0.072	0.367	0.265	1.0	0.47
Scale Index	-0.268	0.012	0.313	0.378	0.47	1.0

Table 4.5 presents an OLS regression model predicting local content from the same indices. The coefficients broadly mirror the correlational directions: finance is positive (+8.76), scale is negative (-11.68), logistics is negligible, and skills/IP are small negatives. However, none reach conventional significance ($p < 0.05$) due to the reduced complete-case sample (≈ 16).

Table 4.5: OLS Regression Results (Dependent Variable (DV): Local-Content %)

Variable	coef	Std_err	T	p	ci_low	ci_High
Const	71.7	28.801	2.49	0.032	7.528	135.872
Skills_Index	-4.011	4.715	-0.85	0.415	-14.518	6.496
Finance_Index	8.761	6.029	1.45	0.177	-4.674	22.195
Logistics_Index	1.077	3.202	0.34	0.743	-6.056	8.211
IP_Index	-4.695	5.077	-0.92	0.377	-16.007	6.616
Scale_Index	-11.682	7.526	-1.55	0.152	-28.451	5.088

Note:

DV = Dependent Variable (outcome being predicted (in this case, local-content %).

IV = Independent Variables (predictors: skills, finance, logistics, IP, and scale indices).

Interpreted cautiously, the signs support the mixed-methods diagnosis: enabling supplier finance and addressing scale (through platform consolidation and export volumes) would raise localisation, whereas training or IP reform in isolation is unlikely to deliver results without complementary capital and demand. Consistent with best practice, these results are triangulated with interviews and system-dynamics simulations rather than treated as definitive statistical evidence.

Collectively the results support Hypotheses 2 and 3 and partially confirms Hypotheses 1 and 4. This highlights that, while skill levels and logistics inefficiencies count, the tightest locks are systemic: access to capital, transfer of technology and economies of scale.

4.4.3 Objective 3 - To Develop a Conceptual Framework to Optimise the Localisation

The third objective of this study sought to develop a conceptual model, which can be used to overcome the structural impediments inhibiting localisation in the South African automotive industry. This holistic roadmap is built upon diagnostic tools, supplier development strategies, financial instruments and dynamic system modelling captured into a single framework.

4.4.3.1 Framework Rationale

To enable South Africa to increase its local content in a sustainable manner, the framework presented below combines three connected layers: diagnostic analytics, capability and capital interventions and system dynamics feedback control. Even though the plan is in line with the South African Automotive Masterplan 2035 imperative on localisation and supplier upgrading, it extends beyond by incorporating and including technology-transfer, IP reform, skills of workforce, investment access and dynamic policy learning. Recent studies on automotive localisation and industrial transitions in emerging economies highlight the need for multi-level interventions (National Association of Automotive Component and Allied Manufacturers, 2021).

4.4.3.2 The LOCATE-SD Framework (Localisation Optimisation Through Capability, Analytics, Technology and Evaluation - With System Dynamics)

To address the diagnostic findings and systemic hurdles uncovered in this study, a conceptual framework was constructed to support the optimisation of localisation for the South African automotive sector. The model focuses on four main stock variables: Supplier Capacity (S), Workforce Skills (K), Testing Capacity (T), and Local-Content (L). These stocks grow or shrink through flows such as Investment Inflow, Training Completion, and Localisation Adoption Rate. The model draws on survey data for parameterisation. For example, the Investment Flow reflects the 67.4% finance gap reported by respondents, while the Skills Pipeline rate accounts for a 30.2% skills shortage. The model also captures key feedback loops. One reinforcing loop shows how higher local content drives increased production volumes, which encourages further investment, a virtuous cycle. A balancing loop illustrates how import price competitiveness can slow the adoption of localisation. The model, referred to as LOCATE-SD combines diagnostic tools, focused interventions and dynamic system modelling in order to make strategies for localisation both actionable and sustainable. It enhances South Africa's current automobile masterplan and introduces new mechanisms, including technology-transfer, safe harbours, blended vendor finance clearinghouses and closed loop system dynamics monitoring.

The LOCATE-SD framework is presented in Figure 4.8. It is structured into five sequential phases: Diagnose, Design, Deploy, De-risk, and Demonstrate, that correspond with both the empirical findings of this study and the identified systemic barriers. Each step integrates well-established industrial diagnostic methodologies with innovative interventions tailored to the South African context, while reinforceable feedback loop System Dynamics gear for continuous monitoring and policy adjustment. Such integration extends beyond the outset to initiate and sustain overtime localisation processes confronted with challenges such as low volume orders, limited access to capital, skills shortages and narrow technology-transfer approaches.



Figure 4.8: The LOCATE-SD Framework

I. Phase A - Diagnose (Industrial and Statistical Diagnostics)

The identification of the binding constraints to localisation is the priority in the first phase. Techniques such as benchmarking, Pareto analysis and Ishikawa (fishbone) diagrams are used to categorise barriers into structural factors (volume, finance & IP) and operational ones (skills, logistics delay). A Supplier Readiness Audit is also suggested, derived from survey and interview responses, to rank suppliers according to quality, skills, finance, testing and intellectual property access. Suppliers who have restricted access to intellectual property (IP) cannot manufacture some components, use modern technologies, or engage in joint development activities, and that limits their readiness for localisation. On the other hand, suppliers with strong or permitted access to IP can more easily integrate smoothly into the value chain and scale production. In addition, IP access is a critical constraint to determine real supplier capability and is integrated into the Localisation Readiness Index (LRI), which not only reflects technical and financial capacity but also the legal and innovation constraints on that capability. The outcome of this phase is a Localisation Readiness Index (LRI), which quantifies supplier capability gaps and feeds parameters into the system dynamics model.

Using survey and interview data, a Pareto analysis (Figure 4.9) was conducted to rank the barriers identified by respondents. The results show that three issues dominate: low production volumes (86.0%), limited supplier funding (67.4%), and intellectual property (IP) restrictions (55.8%). These account for the majority of localisation challenges, confirming that South Africa's problem is primarily structural rather than operational.

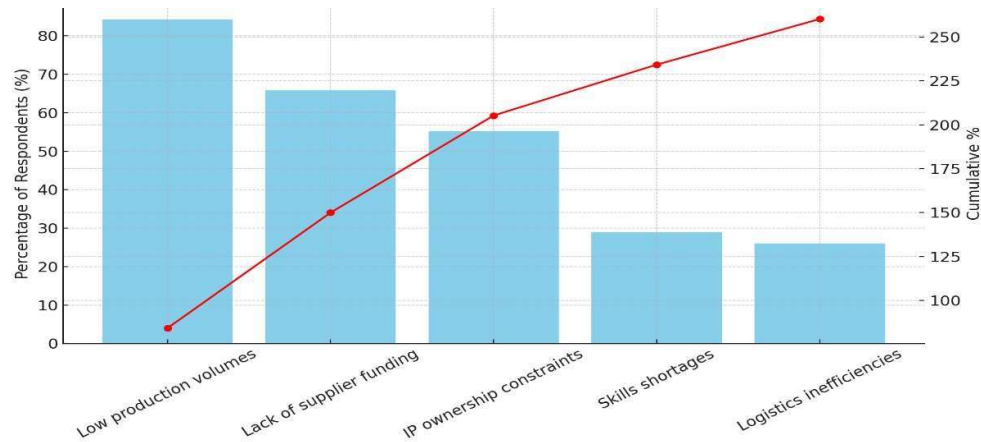


Figure 4.9: Pareto Analysis of Barriers to Localisation (from survey data)

To support the Pareto analysis, an Ishikawa (fishbone) diagram is constructed in Figure 4.10 to classify barriers into structural constraints (finance, IP and market size) and operational challenges (skills shortages, logistics inefficiencies and quality bottlenecks). This categorisation is important as it assists policy makers to separate between bottleneck drivers in need of systemic policy reform and financial instruments from those that can be overcome through increasing supplier capabilities. The visual tool reinforces the Pareto finding that the root causes of South Africa's localisation gap are primarily structural, while operational issues remain secondary.

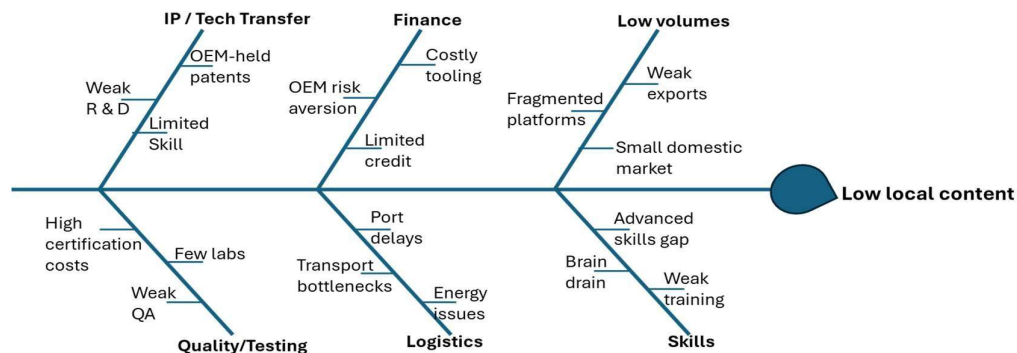


Figure 4.10: Ishikawa Diagram Showing Structural vs Operational Causes of Low Local-Content.

Having identified the barriers into structural and operational ones, it is useful to show an application of the diagnose tools. The following OEM wiring harness case illustrates how the Pareto and Ishikawa analyses help managers identify the most critical constraints and avoid dispersing resources on secondary issues.

a) Practical Example (OEM - Wiring Harness Case):

An OEM sourcing wiring harnesses finds that less than 30% of the product is localised. By applying the Diagnose tools, they see from the Pareto chart that localisation is blocked by low economies of scale, limited tooling finance, and restricted access to OEM-held IP. The Ishikawa diagram then allows management to see that although there are logistics inefficiencies and problems with the workforces' skills, those are secondary. This prevents disorganised strategies and focuses resources on the few barriers that matter most.

b) Link to System Dynamics (SD):

The outputs of the Diagnose phase, specifically the weights from Pareto and the structural-operational classification from Ishikawa, feed directly into the simulation model. For example, low volumes translate into scale constraints in the SD stock-and flow structure; supplier funding constraints parameterise the "investment flow" variable; and skills shortages inform the workforce pipeline rates. This ensures that subsequent phases (Design, Deploy, De-risk) are not generic, but calibrated to real world industry data.

II. Phase B - Design (Capability, Capital, and Contract Mechanisms)

The Design phase takes the diagnostic findings from Phase A and translates them into practical interventions that directly address South Africa's structural and operational barriers to localisation. Whereas Phase A identified what the problems are, Phase B specifies what must change in supplier capability, access to capital, and contractual arrangements in order to close the Localisation Readiness Index (LRI) gaps.

This phase is particularly relevant in the South African context, where small and medium component suppliers struggle with finance, technology access, and OEM contracts. The

recommended instruments include a mix of international best practice and measures that are responsive to the South African institutional and market context.

Tools & Measures:

a) Targeted Supplier Capability Upgrading

Create short, intense programmes for high-potential suppliers producing parts such as wiring harness or catalytic convertors. Interventions to focus on process control, end-of-line testing, and certification, ensuring capable suppliers can rapidly meet OEM standards.

b) Blended-Finance Mechanisms for Localisation

Establish pooled financing facility through OEM guarantees, DFIs and Government support. The LRI selected suppliers with funding gaps can access concessional loans linked to tooling and process upgrades.

c) IP Structured Technology-Transfer Mechanisms & Licensing Agreements

Establish a Trust to codify technology-transfer terms agreed between OEMs and local suppliers. The new Trust would formalise these agreements to allow joint access to technical drawings, joint-training and the lowering of royalties as volume production increases.

d) Digital Supplier Capability Registry (Supplier Passport)

Develop an online portal linked to National Association of Automotive Component and Allied Manufacturers (NAACAM), capturing all supplier capacities, certifications and LRI scores released as a particular custodian / verifier. OEMs benefit from reduced transaction-related costs and enhanced visibility to qualified local suppliers in their search for sourcing options.

Practical Example (OEM – Harness Supplier):

In the next paragraph, an example is provided to illustrate how the techniques are used together. The example demonstrates that Phase B interventions deal with the structural and operational deficiencies revealed by Phase A.

An OEM collaborates with a local harness supplier who scored poorly for finance and IP-access on the LRI. Through the Blended-Finance Mechanism, the supplier secures concessional funding for crimping machines and test benches. At the same time, an IP Structured Technology-Transfer Mechanism grants controlled access to OEM drawings and technical training. To strengthen long-term capability, the supplier is enrolled in a Targeted Supplier Capability Upgrading programme focused on process control and certification. Finally, the supplier is registered on the Digital Supplier Capability Registry, making its improved capacity and certifications visible to all OEMs through NAACAM's platform.

Together, these measures address the major structural deficits, develop operational powers and increase market visibility. As a result, the supplier is able to meet Production Part Approval Process (PPAP) requirements and compete for larger contracts.

Link to System Dynamics (SD):

The Phase B set of interventions are designed to complement the supplier level gaps as well as contribute to inputs that can be quantified into the System Dynamics (SD) model. In the model, finance inflows are simulated as faster capacity growth, IP agreements as technology-transfer flows, capability upgrading as improved quality and certification readiness, and the Digital Supplier Registry as reduced sourcing delays. By parameterising these levers, policymakers can test scenarios such as finance-only vs. finance+IP+skills and forecast their long-term impact on local content. This ensures the LOCATE-SD framework is not prescriptive but adaptive, supporting evidence-based prioritisation of the most effective policy mix.

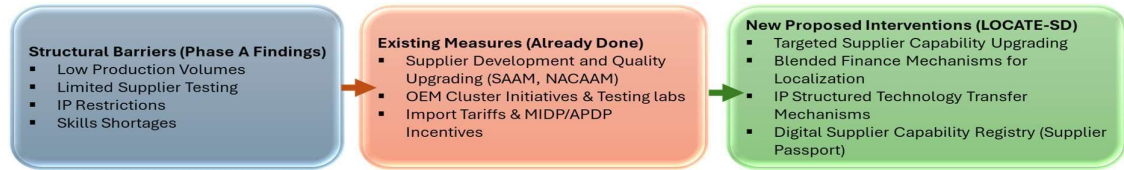


Figure 4.11: Phase B - Design Interventions for Localisation

While Figure 4.11 illustrates how Phase B interventions feed into the SD model, Figure 4.12 extends this logic to the trade arena by linking localisation gains to Rules of Origin (RoO) thresholds. RoO are trade policy rules that determine whether a vehicle qualifies as “locally produced” for tariff-free export under agreements such as AfCFTA or the EU-SA TDCA. They usually mandate a 40% or more local-content in the Bill of Materials (BOM). When that level is not matched, a situation where South African vehicles lose access to preferential markets, and with it cost competitiveness is realised.

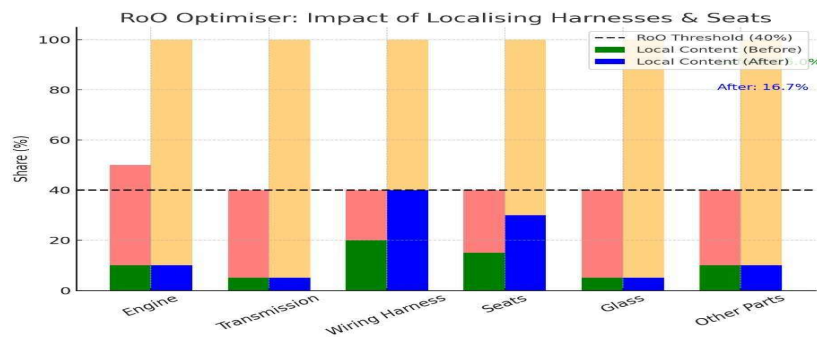


Figure 4.12: RoO Optimiser - Impact of Localising Harnesses & Seats

The proposed RoO Optimiser scans the BOM to identify close-to-threshold components such as wiring harnesses, seats, or catalytic converters, where localisation yields the greatest uplift in overall content. By prioritising these high-impact parts, OEMs and suppliers can raise localisation levels above the RoO requirement, unlocking export benefits and strengthening global competitiveness.

III. Phase C - Deploy (Pilot, Scale, Replicate)

The proposed RoO Optimiser reads the BOM, and pinpoints close-to-threshold components such as seat, wiring harness or catalytic converters, where localisation yields the greatest uplift in overall content. By localising these high-impact components, OEMs and suppliers are able to ramp up the level of localisation beyond the RoO requirement, which in turn allows for export benefits and stronger global competitiveness.

The Deploy phase is when localisation plans go into practice. Lessons learned from Phase A (Diagnose) and actions taken in the area of diagnosis, as well as interventions and innovations developed in Phase B (Design) are transformed into operationalising actions which can be tested, extended, and disseminated. The approach is to start small with high-impact pilots, scale once proven and then replicate across other parts. This methodology makes localisation not only a theoretical concept but also an industrial reality.

Pilot Implementation (Harness-First Strategy):

Survey and interview findings consistently identified wiring harnesses as a strategic localisation candidate. They are labour-intensive, already partly localised, and highly significant for RoO compliance. For example, one OEM in Pretoria reported sourcing less than 30% of harnesses locally.

A pilot project can, therefore, focus on harnesses, using a shared modular production line that incorporates:

- I. Shared test benches and quality labs accessible to multiple Tier 1/Tier 2 suppliers.
- II. Poka-yoke (error-proofing) stations for crimping and assembly.
- III. OEM-supported PPAP validation to fast-track supplier qualification.

This creates a low-risk, high-learning environment where suppliers can build capability while OEMs test localisation feasibility.

Scaling Up:

After the pilot is a success in terms of QCD (quality, cost, delivery), OEMs can sign structured ramp-up contracts with suppliers. These agreements synchronise demand growth with production volumes and serial-gate audits are performed to keep global QCD practices in place. This mitigates the risk faced by OEMs and provides suppliers with clear paths to growth.

Replication:

Next would be to apply the principle of the pilot method on the other parts which have potential for localisation similarly, like seat frames, pressed parts and catalytic converters. Lessons from the harness pilot and design are applied to each replication, resulting in lower risk, cost and schedule.

System Dynamics Link:

In System Dynamics (SD) model, Phase C is equal to the phase between parameter testing and behavioural simulation. Deployment input flows, investment inflows, training completions and PPAP approvals raise the stocks of supplier capacity (S) skills (K) and local-content (L). Ramp-up curves can be simulated to estimate how quickly localisation levels increase under alternative investment(low or high) and demand schedules. This enables policymakers and OEMs to experiment with ‘what-if’ scenarios before making any capital-intensive decisions, enhancing decision-making under uncertainty.

IV. Phase D - De-risk (System Dynamics Simulation)

The De-risk phase applies System Dynamics (SD) simulation to stress-test localisation strategies before they are implemented. Unlike static targets, SD captures the way localisation drivers interact dynamically with external pressures. This makes it possible to explore how interventions play out over time and to identify unintended consequences before large-scale commitments are made.

Survey and interview findings are used to parameterise the model. For example, low production volumes, reported by 86.0% of respondents, are represented as scale constraints that slow supplier capacity growth, while supplier funding gaps (67.4%) shape the investment flow that determines how fast capacity can expand. Intellectual property and technology-transfer restrictions (55.8%) limit the rate at which companies can move into higher-value component families, and skills shortages (30.2%) reduce the throughput of the training pipeline, lowering the quality-adjusted capacity of local suppliers. These relationships are represented as stocks (Supplier Capacity $S(t)$, Skills $K(t)$, Testing/Lab Capacity $T(t)$, and Local-Content $L(t)$) and flows (Investment, Training Throughput, Qualification Pass-rate, and Localisation Adoption). External shocks, such as import pressure and Foreign Exchange Volatility (FX), work as balancing feedback loops.

Within this structure, policymakers and OEMs can simulate alternative strategies. A “skills-only” scenario tests the effect of increased training throughput without new finance, while a “finance-only” scenario injects blended vendor finance but leaves training lagging. Technology-transfer scenarios examine how IP safe-harbour agreements influence the rate of entry into higher-value components. Most importantly, a combined package of finance, skills, and technology interventions can be tested against single factor approaches.

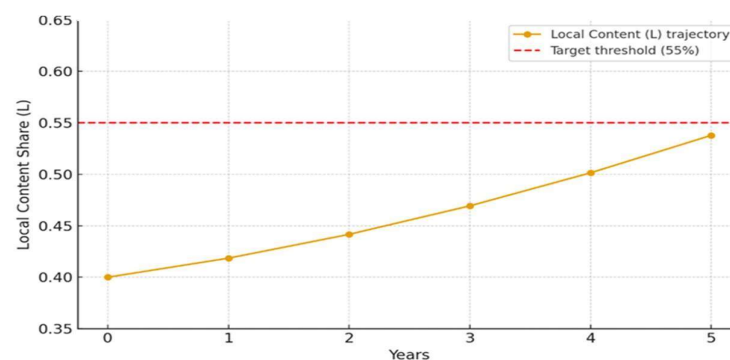


Figure 4.13: Simulation Output - Local-Content Trajectory under Combined Policy Package

The simulation outputs include projected time-paths of local-content ($L(t)$), cost per unit, defect rates (PPM), and compliance with AfCFTA and EU Rules of Origin thresholds. As shown in Figure 4.13, the combined package produces the strongest trajectory: local-content rises from a baseline of about 40% to approximately 54% within five years. This not only surpasses the critical 50% threshold required for preferential trade access but also demonstrates the compounding effect of integrated interventions. By linking survey-based diagnostics with simulation foresight, Phase D prevents over-reliance on one-off targets and instead supports an adaptive localisation strategy.

V. Phase E - Demonstrate (Governance & Continuous Improvement)

The final phase of the LOCATE-SD framework is Demonstrate. Its objective is to provide for the sustainability of localisation gains over time, through transparent and measurable governance and ongoing feedback. Unlike static policy targets, this phase models a closed loop learning process in which government and OEMs and suppliers mobilise around measurable performance. The focus is to make localisation progress visible and accountable, with the possibility to change policy in real-time.

The implemented mechanisms involve a Key Performance Indicator (KPI) cockpit, a Digital Supplier Passport and Incentive Alignment as well as Policy Feedback loop. The KPI cockpit serves as a quarterly-review dashboard, keeping in check vital metrics such as the share of local-content, jobs created, supplier investment mobilised, cost per-unit, defect rates (PPM), lead times and compliance with Rules of Origin thresholds. This output is automatically routed into the Digital Supplier Passport, which is housed in the NAACAM registry and keeps track of supplier readiness scores, certification and localisation milestones. This opens up transparency, shortens the sourcing delays and fosters a higher level of trust between OEMs and suppliers.

In order to promote accountability, rewards for positive behaviour such as rebates or concessional finance are linked not with stated targets but with improvements in independently verified KPIs. Lastly, through the policy feedback loop KPI results are fed

back into the System Dynamics model which enables policymakers to simulate scenario options and refine interventions (e.g., increase training throughput, modify vendor finance terms, expand logistics support) and tweak localisation strategy dynamically.

A concrete example will help to make sense of how this works. Its harness pilot line sees quarter KPI reviews that see local-content up from 32% to 48% in just 18 months, the creation of 120 new assembly and testing jobs, and a reduction in rework defects from 3.5% to 1.2%. Such results are captured in the Digital Supplier Passport and confirmed by NAAMSA audits - both credibility and repeatability. These lessons are then applied to other component families, including seat frames and exhaust systems, so that successful pilots can be the cornerstone of industry-wide localisation.

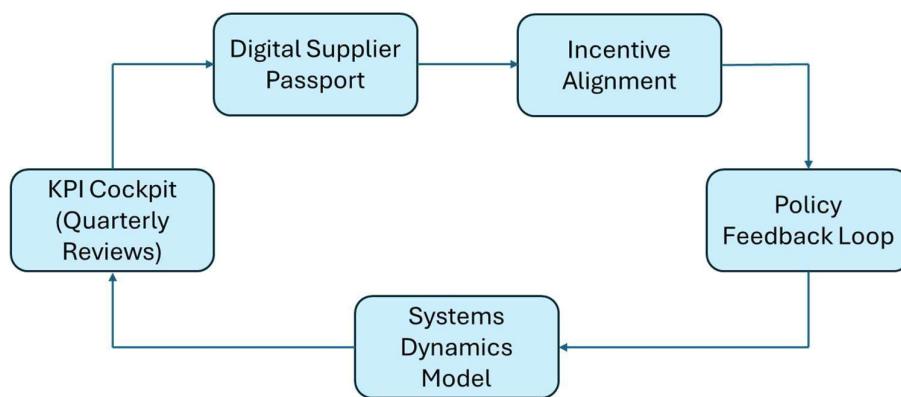


Figure 4.14: Governance and Feedback Loop in the LOCATE-SD Framework

Figure 4.14 illustrates the governance architecture of the framework. The KPI Cockpit is to be considered as the monitoring centre; the Digital Supplier Passport ensures transparency, incentive alignment links support with tangible results and the policy feedback loop integrates learning in the SD model. Collectively, they make an adaptive governance system that balances accountability and learning, ensuring localisation is not a one-off achievement, but a sustained and scalable transformation.

4.4.4 Objective 4 - To Validate the Framework for the Localisation Process and Identify its Key Success Factors

The fourth objective of this study was to verify the developed LOCATE-SD framework and explore settings in which it would be most useful. Validation attempts were made to ensure that the framework is not only theoretically sound but also supported by industry evidence and conforms to international best practice. This triangulation utilised three data sources; (i) survey responses and interview findings from OEMs, suppliers and industry associations; (ii) benchmarking reports including those published by NAAMSA, NAACAM, OECD and AfCFTA; as well as (iii) composite evidence on the localisation strategies of comparable economies to South Africa like Brazil, India or an emerging economy such as Thailand.

For instance, the Diagnose phase was supported by a survey and OECD/NAAMSA reports in identifying low volumes as well as funding gaps and IP regulation constraints as the most binding constraints. The Design stage converged with NAACAM and AfCFTA policy position around blended-finance and binding technology-transfer mechanisms. The Deploy stage was evidenced by the harness case study, similar to pilot-driven localisation approaches of Brazil and India. Interview evidence of investment uncertainty and global systems dynamics applications supported the Derisk phase. In addition, both survey feedback around transparent monitoring demanded in the Demonstrate phase and NAAMSA's focus on KPI-linked incentives were counterfeits.

These success factors provide the foundation for the framework's contribution to South Africa's localisation policy and industry practice. Table 4.6 summarises the validation exercise by mapping each phase of LOCATE-SD to its supporting evidence and success factors.

Table 4.6: Validation of the LOCATE-SD Framework

LOCATE-SD Phase	Validation Evidence (Survey/Interviews)	External Benchmarks	Key Success Factors
Diagnose	Surveys identified barriers: low volumes (86.0%), finance gaps (67.4%), IP restrictions (55.8%).	OECD (2023), NAAMSA (2022): same constraints.	Accurate diagnostics; readiness audits; barrier prioritisation.
Design	Need for funding access and IP flexibility is highlighted.	NAACAM (2022); AfCFTA RoO strategies.	Blended-finance; enforceable IP clauses; supplier clusters.
Deploy	Harness case (<30% localisation) showed pilot feasibility.	Brazil & India: phased “fast win” localisation.	Pilot scaling; OEM co-investment; capability sprints.
De-risk	Interviews noted logistics and finance uncertainty.	SD policy applications (Higuchi et al., 2024).	Stress-testing; feedback based policy adjustment.
Demonstrate	Respondents requested transparent monitoring, KPIs.	NAAMSA & SAAM: performance-linked incentives.	KPI cockpit; incentive alignment; continuous feedback loop.

This validation confirms that the LOCATE-SD is underpinned by empirical support and conforms to international best practice at each stage of the systematic review. It further enhances its credibility. The Diagnose phase reflects both survey evidence and OECD/NAAMSA insights that structural barriers dominate. The Design and Deploy phases align with NAACAM and AfCFTA policy priorities as well as Brazil and India’s phased localisation strategies. De-risk draws on international applications of system dynamics for policy modelling in the global sphere and Demonstrate mirrors a clear industry need for performance-related accountability. It is logical that critical success factors for innovation are accurate diagnosis, financial innovation, enforceable IP arrangements, scale pilots and ongoing surveillance with KPIs.

4.4.4.1 Simulation Modelling Results

To validate the LOCATE-SD framework and examine how interventions interact dynamically, a System Dynamics (SD) model was built around four leverage factors identified in surveys and interviews: production volumes, supplier finance, intellectual property/design authority, and policy consistency. The simulation was designed both to

confirm the framework's assumptions and to explore how different policy combinations shape localisation outcomes over time.

Figure 4.15 compares four policy paths. The baseline stays flat at ~40%, confirming that current conditions cannot deliver structural change. An incentive-only path produces a short-lived rise before plateauing near 48%, reflecting industry scepticism that rebates without deeper reforms are insufficient. Finance and IP reforms, by contrast, generate a significant uplift, addressing the two most binding constraints. The integrated package, combining finance, IP transfer, coherent incentives, and skills/test capacity produces the strongest trajectory, crossing the 50% Rules of Origin threshold by year 5 and reaching ~54%.

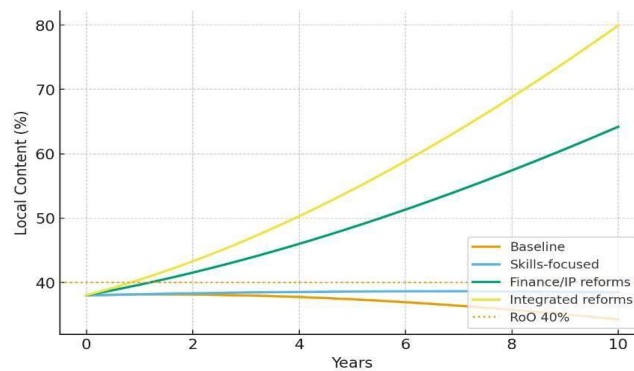


Figure 4.15: Aggregate Local-Content under Alternative Scenarios

The figure implies that a credible localisation strategy must sequence interventions: capitalise suppliers (tooling/testing), unlock design authority/IP to move into higher value components, and stabilise incentives so companies can absorb support.

At the component-level, the wiring harness family demonstrates that finance/IP interventions combined with skills and lab capacity can increase localisation from <40% to ~60% by Year 10, confirming the pilot-first strategy logic.

Figure 4.16 focuses on the wiring harness component family. Localisation under baseline and incentives-only scenarios stalls below 40%. Finance/IP reforms matter disproportionately: concessional funding for crimping machines and test benches,

combined with OEM design authority, enables PPAP approval and significant process upgrading. The integrated package adds skills and lab/test capacity, pushing harness localisation to ~60 % by Year 10, consistent with the “harness-first” pilot logic.

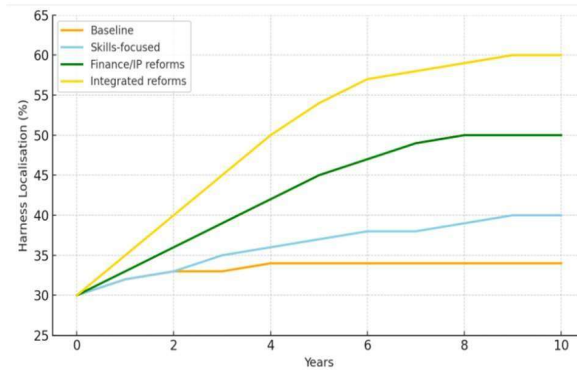


Figure 4.16: Wiring Harness Localisation under Alternative Scenarios

These results confirm that structural packages outperform single-lever measures: skills-only policies yield marginal gains, while finance/IP reforms and integrated packages deliver transformational effects. This outcome supports the LOCATE-SD emphasis on finance, IP, and policy coherence as the principal “hinge levers” of localisation.

4.4.4.2 Purpose and Link to Research Objectives

The SD model translates diagnostic findings into a quantitative simulation that captures the dynamic interactions governing localisation. It directly supports Research Objectives 3 (to develop a validated framework identifying structural barriers and enablers) and 4 (to test alternative policy and investment scenarios to optimise localisation outcomes).

Where earlier analyses identified barriers using statistics, the SD model formalises these findings into a feedback-driven structure that explains how coordinated interventions change localisation trajectories.

4.4.4.3 Model Structure and Conceptual Rationale

The SD model contains three interdependent stocks:

- I. Supplier Capacity (S)** - productive and technological capability of local suppliers.
- II. Skills (K) – skilled** - labour and technical-knowledge base.
- III. Local-Content (L)** - share of local value in production.

Each stock is affected by inflows (investment, training) and outflows (decay, attrition), while import pressure (M) provides balancing feedback. and 3.3). The aligned equations, exactly as in methodology, are:

$$\frac{dS}{dt} = I(t) - \delta S, \frac{dK}{dt} = T(t) - \theta K, \quad (12)$$

$$\frac{dL}{dt} = \alpha S + \beta K - \gamma M \quad (13)$$

These relationships operationalise the causal structure of the LOCATE-SD framework (see Figures 3.2 and 3.3). This formulation considers reinforcing balancing loops, where investment and training raise the amount of local-content but import pressure slows growth. The use of $\frac{dS}{dt}$ and $\frac{dK}{dt}$ in the L equation ensures the local-content stock reflects dynamic change rates rather than just absolute levels.

4.4.4.4 Causal-Loop and Stock-and-Flow Representation

Figure 4.17 presents the causal-loop diagram of the LOCATE-SD model, showing the interacting dynamic processes that influence localisation. Two balancing loops (R1 and R2) contain the positive feedbacks of financial resources and skills to periphery activities: increasing financial resources and skill levels provide the incentive for more localisation, which on its turn enhances finance and skills. This illustrates the self-reinforcing nature of development within the system.

On the other hand, balancing loop (B1) is the control against the import pressure. Increasing imports discourage growth of local production and capability, the counterbalance to the growth accelerated by reinforcing loops. This interplay between reinforcing and balancing loops reflects the complex feedback structure of the system, where growth is promoted but also naturally constrained by external pressures.

The causal-loop diagram serves as a foundation for translating these dynamics into a stock-and-flow representation, which allows for quantitative simulation. Stocks represent accumulations (e.g., financial capital, skill levels), and flows reflect the rates with which these are changed by loops to perform a more refined analysis of dynamics over time in localisation.

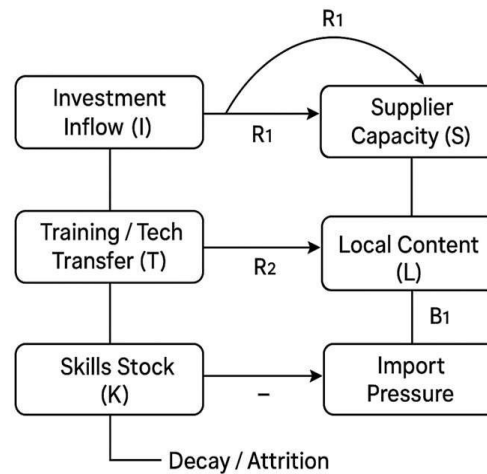


Figure 4.17: Causal-Loop Diagram of the LOCATE-SD System Dynamics Model

4.4.4.5 MATLAB Implementation

The system dynamics model was implemented in MATLAB to simulate changes in important stocks and flows over a 10-year period. The initial stock values were fixed at S_0 , K_0 and $L_0 = 0.38$ (National Association of Automobile Manufacturers of South Africa, 2024) for the baseline conditions of the system. Parameter values, including δ_S , δ_K

were calibrated using survey data, expert interviews, and secondary datasets to ensure the model accurately captured observed system behaviour.

The kinetics were represented as a set of first-order differential equations and integrated numerically (using MATLAB's *ode45* solver). Inflows $I(t)$ and $T(t)$ were scenario-specific, and reflecting differences in investment behaviour and technological uptake, while import pressure $M(t)$ served as a negative feedback mechanism to temper stock growth as a consequence of demand spurred by external market signals.

Four policy scenarios were modelled to predict system changes across varying strategic interventions. The scenario analysis showed how changes in inflows and feedbacks affected the trajectories of stocks $S(t)$, $K(t)$ and $L(t)$ over the 10-year time horizon. For example, increasing $I(t)$ led directly to a faster rise in $S(t)$ and $K(t)$, while higher $M(t)$ weakened this growth tendency, illustrating the important role of the market restraint on system dynamics.

Overall, the MATLAB implementation of the model laid out a solid foundation to examine and manipulate policy levers, inflows and feedbacks in order to gain information about possible future system states as well as points of intervention that could be used effectively. Simulations under four policy scenarios were run to examine system responses with various strategic interventions. Scenario analysis indicated the sensitivity of stock ($S(t)$, $K(t)$ and $L(t)$) paths over the 10 year horizon with respect to changes in inflows and feedback rates as shown in Table 4.7.

Table 4.7: Scenario assumptions for MATLAB simulations

Scenario	Description	Key Assumptions
Baseline	Current investment and training flows	No change from 2023 trends
Skills-only	Increased training throughput	+20–25% $T(t)$, $I(t)$ unchanged
Finance-only	Increased investment	+25–30% $I(t)$, $T(t)$ unchanged
Integrated	Combined finance, training, and import reduction	+25% $I(t)$, +20% $T(t)$, 25% reduction in $M(t)$

4.4.4.6 Sensitivity Analysis and Model Validation

Parameter sensitivity ($\pm 25\%$) was conducted on αI , βT , δ_S , δ_K . The model was most sensitive to αI (investment effectiveness) and βT (training efficiency), confirming their dominant influence. Face-validity tests ensured realistic behaviour: investment shocks produced plausible supplier-capacity growth, and higher import pressure reduced $L(t)$, matching historical trends. To ensure the System Dynamics model accurately represented the real behaviour of localisation within South Africa's automotive industry, a calibration and validation process was undertaken before scenario simulation. Calibration involved adjusting key parameters, namely the investment effectiveness coefficient (αI), training effectiveness coefficient (βT), and decay rates for supplier capacity (δ_S) and skills (δ_K) so that the simulated baseline trajectory reproduced the historical local content trend reported by NAAMSA (2013-2024), which averaged between 38% and 43%.

Parameter tuning was performed iteratively in MATLAB by comparing the simulated local content path $L(t)$ with the observed data, minimising the squared error between the two. The resulting parameter set ($\alpha I=0.8$, $\beta T=0.6$, $\delta_S=0.08$, $\delta_K=0.10$) achieved a realistic baseline steady state near 40%.

Model validation proceeded through three complementary tests:

- I. Historical fit** – ensuring that the value in the baseline trajectory is consistent with historical stagnation (40%).
- II. Face-validity** – confirming that investment and training increases produced intuitively plausible rises in supplier capacity and local-content.
- III. Extreme-condition tests** – verifying that unrealistically high import pressure ($M \rightarrow 1$) drove localisation downward, while removing decay produced full-capacity saturation.

These checks confirmed that the model was behaving reasonably and emulated observed behaviour, which helps to ensure that our subsequent scenario and sensitivity analyses provide credible policy insights. Appendix G shows steps how this calibration was done.

To evaluate the robustness of the System Dynamics model and the relative influence of key parameters, a one-factor-at-a-time sensitivity analysis was performed. Each parameter: investment effectiveness (αI), training effectiveness (βT), supplier-decay rate (δ_S), and skill-attribution rate (δ_K) was varied by $\pm 25\%$, while other variables were held constant. The final local content value after ten simulation years was then compared to the baseline. The results, presented in Figure 4.17, show that the model is most sensitive to changes in αI and βT , indicating that localisation performance is highly responsive to improvements in supplier-finance efficiency and technology-transfer mechanisms.

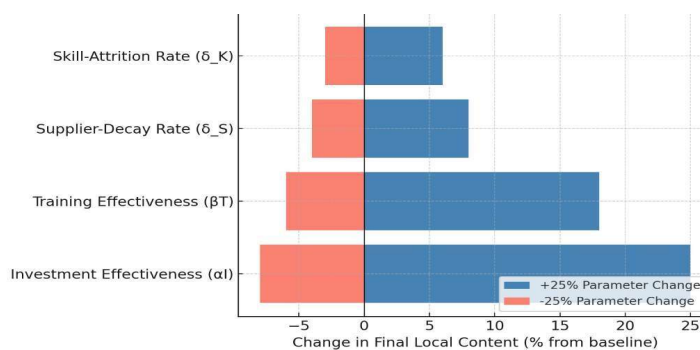


Figure 4.18: Sensitivity Analysis ($\pm 25\%$) of Model Parameters

By contrast, decay-rate variations had smaller and opposite effects. These results validate the model's internal logic and confirm that financial and technological enablers exert the greatest structural leverage within the LOCATE-SD framework.

4.4.4.7 Interpretation and Link to the LOCATE-SD Framework

The model operationalises the De-Risk and Demonstrate phases of the framework by enabling quantitative testing of policy combinations. Reinforcing loops (finance $\rightarrow$ capacity $\rightarrow$ localisation and training $\rightarrow$ skills $\rightarrow$ capacity) explain how integrated measures drive transformation, while import pressure acts as a balancing constraint. These dynamics corroborate the regression and diagnostic findings that systemic reform, rather than isolated incentives, is required for durable localisation gains.

The SD validation simulations of the LOCATE-SD framework reveal that localisation is most responsive to structural reforms, particularly supplier finance and technology transfer, when reinforced by consistent policy. Incentives alone have little effect, while combined finance/IP interventions deliver sustained improvements exceeding Rules of-Origin thresholds. These results align with survey, interview insights, and provide a system-validated explanation for the policy recommendations elaborated in Chapter 5.

4.5 Case Study: Wiring Harnesses as a Critical Component in Localisation

Wiring harnesses are among the most complex and strategically important components in the modern automotive industry (Nguyen, et al., 2021). They act as a vehicle's nervous system that connects all electrical and electronic subsystems. They provide all the important safety, communication, and diagnostic functions in a vehicle (Christus, et al., 2025). Wiring harnesses are complex, labour-intensive, near-zero defect tolerance components to make because each individual model, variant, and trim level requires a unique wiring harness. Their importance in a vehicle assembly is such that production cannot proceed in the absence of a correctly configured harness, and one defective or late unit can result in an entire assembly line stopping (Connector Supplier, 2018). That is why wiring harnesses are seen as one of the highest-risk items in the automotive supply chain. To illustrate this complexity, Figure 4.19 presents a typical full vehicle wiring harness, highlighting the extensive branching, connector diversity, and structural density that make localisation both challenging and strategically important.

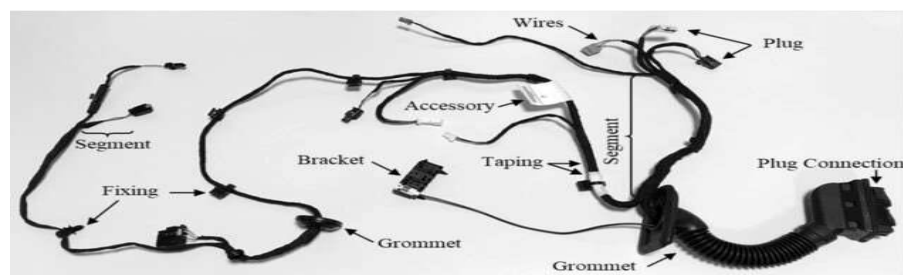


Figure 4.19: Illustration of a vehicle wiring harness

Source: (Albers, et al., 2022)

4.5.1 Challenges of Sourcing Wiring Harnesses Locally

Although some harnesses are manufactured locally, the South African wiring harness industry faces structural constraints that limit its competitiveness (Ambe & Badenhorst-Wess, 2013). One of the central challenges is limited production scale. South Africa's vehicle output is far smaller than that of global manufacturing hubs such as Thailand, China, or Mexico, which impedes the achievement of economies of scale. Higher per unit production reduces the attractiveness of local supply when compared to international alternatives (Ambe & Badenhorst-Weiss, 2010). This means that the low production volume effect results in higher costs per vehicle, making it harder for South African manufacturers to compete with global vehicle manufacturing countries.

A further constraint is limited access to technology and intellectual property (Pernstål, et al. (2023). Many international OEMs rely on proprietary connectors, terminals, diagnostic protocols, and specialised design software. Local suppliers lack access to technical data, global testing protocols, and proprietary tooling required to meet OEM standards. Without these elements, local production is less efficient and more vulnerable to quality risks (Ziegler & Heidling, 2023).

4.5.2 Challenges of Sourcing Wiring Harnesses from Foreign Countries

Despite the limitations of manufacturing the wiring harnesses locally, the heavy reliance on foreign suppliers introduces a different set of operational challenges. The most significant one among them is the long lead times, usually of eight to twelve weeks. These delays are caused by overseas production scheduling constraints, the time it takes for a sea freight shipment to transit, port congestion, customs processing, and variable container availability (Kanike, 2023). With these, OEMs are forced to create high buffer inventory, and that demands more working capital and limits quick response capabilities to market changes or engineering modifications. Quality is yet another serious barrier. Since wiring harnesses are mostly assembled by hand, quality variations in loose pins, wrong connector

layouts, dimensions, damaged terminals, and inadequate insulation are prevalent. Most of these defects reveal themselves at final assembly in the vehicle, leading to line stoppages, rework or scrap of the vehicle (Ramdass & T.Nair, 2025).

Packaging and handling can also damage an imported harness. They are bulky and in an irregular shape, which is difficult to compress or pack firmly. In addition, transport conditions generally lead to connector breakages, bent pins, misalignment, or moisture-related deterioration. Figure 4.20 presents a comparative overview of sourcing wiring harnesses locally versus abroad, highlighting the distinct operational, financial, and strategic implications associated with each approach.

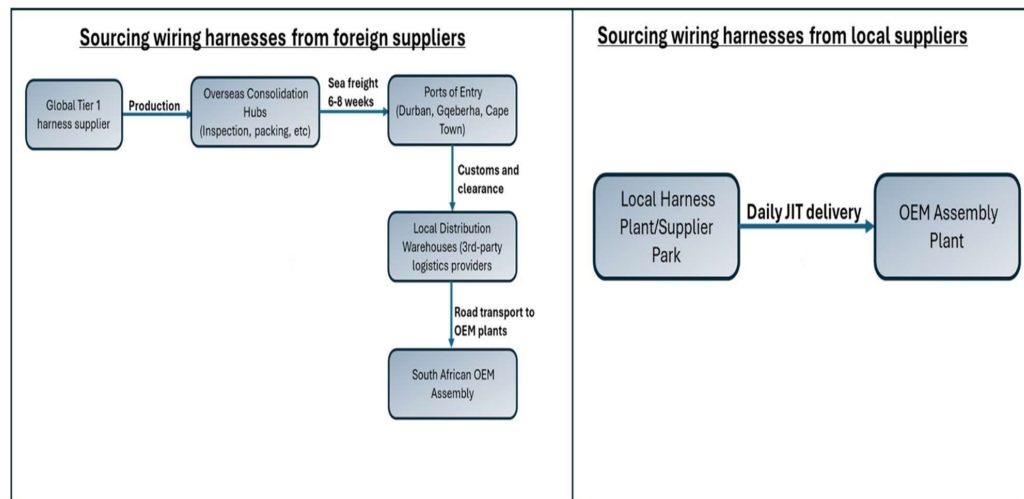


Figure 4.20: Comparative Overview of Local versus Imported Wiring Harness Sourcing

Source: Typical Illustration

Besides these physical challenges, imported harnesses are also vulnerable to global logistics' volatility (Sujatmiko, et al., 2024). And the fragility of the global harness supply chain has been apparent from the Russia-Ukraine conflict, from the fallout of COVID-19, port strikes, and international freight delays. And because wiring harnesses are critical items, any disruption, even for a few days, can stop local vehicle production entirely. In addition, imported harnesses provide limited flexibility. Overseas suppliers are unable to keep up with fast turnover of builds, sudden changes in models and modifications from

manufacturers, or even engineering updates, leaving OEMs with little room to adapt quickly (Wang, et al., 2022).

4.5.3 Why Localising Wiring Harnesses Matters

The combination of local production challenges and international supply chain risks highlights the strategic importance of wiring harness localisation for South Africa’s automotive manufacturing sector. Localising this component would significantly reduce vulnerability to global disruptions while improving operational stability. Domestic manufacture would enable shorter lead times, reduced inventory requirements, and faster responsiveness to engineering changes, all of which are essential for just-in-time (JIT) and just-in-sequence (JIS) production environments. Furthermore, harness production is labour-intensive and, therefore, requires well suited industrialisation and employment objectives. Localisation would also stimulate the development of upstream industries, such as connectors, terminals, insulation materials, and routing clips, creating broader economic spillovers. The differences between imported and locally produced harnesses are summarised in Table 4.8, highlighting how localisation directly reduces key supply chain risks.

Table 4.8: Comparison of Imported vs Local Harness Characteristics

LOCATE-SD Phase	Validation Evidence (Survey/Interviews)	External Benchmarks	Key Success Factors
Diagnose	finance gaps (67.4%), IP restrictions (55.8%).	OECD (2023), NAAMSA (2022): same constraints.	Accurate diagnostics; readiness audits; barrier prioritisation.
Design	Need for funding access and IP flexibility is highlighted.	NAACAM (2022); AfCFTA RoO strategies.	Blended-finance; enforceable IP clauses; supplier clusters.
Deploy	Harness case (<30% localisation) showed pilot feasibility.	Brazil & India: phased “fast win” localisation.	Pilot scaling; OEM co-investment; capability sprints.
De-risk	Interviews noted logistics and finance uncertainty.	SD policy applications (Higuchi et al., 2024).	Stress-testing; feedback based policy adjustment.
Demonstrate	Respondents requested transparent monitoring, KPIs.	NAAMSA & SAAM: performance-linked incentives.	KPI cockpit; incentive alignment; continuous feedback loop.

4.5.4 Alignment with the Diagnostic Framework (LOCATE-SD)

The wiring harness case study offers verifiable proof of the structural barriers found in the LOCATE-SD diagnostic model. Limited production scale affects cost competitiveness; Lack of funds prevents access to tools and test equipment; Limited technology transfer restricts local suppliers from acquiring proprietary connectors and design specs, skills shortages undermine production quality, and risks in logistics escalate reliance on foreign sources. The wiring harness value-chain clearly demonstrates all of the LOCATE-SD dimensions (Scale, Finance, Technology, Capability and Logistics). The case thus illustrates how such constraints interact systemically to shape localisation outcomes, supporting the study's key argument that localisation failures have structural rather than operational origins.

4.5.5 Recommendations for Localising Wiring Harness Production

To unlock localisation potential, a coordinated set of interventions is required. Establishing a dedicated localisation finance facility would reduce the capital burden on suppliers by subsidising or financing essential equipment such as crimping machines, continuity testers, and assembly boards. OEM-led technology transfer agreements (licensing and accreditation) would enable local suppliers to access technical drawings, testing protocols, connector specifications, and diagnostic interface standards, thereby improving their ability to meet global quality requirements. Aggregating demand across OEMs, through platform sharing, standardising harness families, and consolidating production volumes, would improve economies of scale and strengthen commercial viability.

Skills development programmes focused on crimping, assembly, electrical testing, and quality inspection would address capability gaps, especially if delivered through Technical and Vocational Education and Training (TVET) partnerships and OEM academies. Co-locating harness suppliers within existing automotive supplier parks would facilitate JIT

and JIS delivery, reduce logistics costs, and improve production coordination. Finally, developing upstream component capabilities for terminals, connectors, and protective sleeving would further reduce dependence on imports and enhance the resilience of the domestic harness value-chain.

4.5.6 Analytical Synthesis

This case study provides a strong validation of general conclusions found in this study. It illustrates that the local content in the South African automotive sector is not limited to problems of individual character (e.g., skills shortages, logistics bottlenecks) but is structured according to LOCATE-SD model constraints. The hazards of imported harnesses such as extended lead times, quality inconsistencies and threats to global supply chains, highlight a requirement for strategic localisation. The case also shows that localisation is more successful if it is approached strategically in terms of multiple levers, finance, technology-transfer, skills development, logistics integration and OEM collaboration. Of key importance, wiring harnesses are highly appropriate for localisation, for at least they have labour intensity, engineering complexity, and responsiveness to supply-chain disruptions that favour local production, when structural barriers are addressed. Consequently, this case study reinforces the proposition that targeted, systemic localisation measures should drive meaningful local-content gains and enhance the competitiveness of the South African automotive sector.

The case study on a wiring harness is a classic example of how the identified structural constraints in this work come alive. The existence of the issues of insufficient scale, lack of technological access, economic impediments, a shortage of skills, and supply chain volatility reveals that failure of localisation is systemic rather than isolated. Comparison of imported versus locally produced harnesses further demonstrates that long-term global supply chain risks are quite high, while in practice, there is substantial operational support for local production. It is, therefore, well-documented that wiring harnesses represent a strong localisation opportunity and fit in with the LOCATE-SD diagnostic framework.

Overcoming the structural limitations discussed in this paper could enable sustainable localisation of this segment and, thereby, reinforce the resilience and competitiveness of the automotive sector in South Africa.

4.6 Summary

This chapter presented and discussed the empirical results based on four research objectives. The results confirmed that South Africa's automotive industry continues to face structural barriers to localisation, including low production volumes, investment constraints, and restrictive technology-transfer arrangements, while also highlighting the conditional role of workforce skills and logistics inefficiencies. Based on the survey results, interview feedback as well as diagnostic tools such as benchmarking, Pareto analysis and Ishikawa diagrams, it emerged that these constraints were not circumstantial but systemic in nature which require well-coordinated and targeted interventions.

The LOCATE-SD model was then designed and tested as an implementable solution to these barriers. The framework highlighted that the localisation could significantly contribute to industry growth, job creation and export competitiveness if enabling factors such as supplier finance, skilling pipeline, and IPR access are systematically embedded. The validation process also demonstrated good fit with the international best practices and flexibility to cater for tailor-based local solutions in South Africa.

The integration of the simulation and sensitivity results reinforced the diagnostic insights derived throughout this study. The non-linear response was observed from the System Dynamics model that investigates how effectively localisation performance reacts to such structural reforms, and quantitative analysis of these drivers were made by using sensitivity analysis. Together, these findings confirm that investment flows and technology-transfer mechanisms are the most powerful accelerators of local content growth, while attrition and import pressure act as balancing constraints. The LOCATE-SD framework, therefore, provides not only a conceptual model but a calibrated decision-support tool capable of

guiding evidence-based industrial policy. This alignment between diagnostic analysis, simulation findings and policy design delivers support for the study's central hypothesis: that continued localisation in South Africa's automotive industry will be contingent on coordinated action across financial, technological and institutional arenas rather than fragmented measures of operational measures.

Overall, the above results of this chapter validate the core proposition in this study that localisation outcomes are not primarily constrained by operation inefficiencies but constrained structurally and systemically, which can be better supplemented by an interactively dynamic framework. Chapter 5 utilises these insights to draw conclusions, reflect on theoretical and practical contributions and derive policy and industry level implications which will promote a more effective localisation process in the South African automotive industry. It is with these in mind, that, it is believed that the policy and industry action recommendations (Chapter 5) are made with a particular emphasis on supplier financing, design authority /technology-transfer and governance for adaptive calibration.

CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter provides a discussion of the research results in relation to the study objectives, hypotheses, and broader debates surrounding industrial policy and localisation. The analysis in Chapter 4 showed that structural impediments continue to inhibit the development of South Africa's automotive industry, with local content percentage of approximately 40-42% (60-80% in competitor countries such as Brazil, India and Thailand (Ministry of Heavy Industries, 2023); (Intarakumnerd & Techakanont, 2014); (ASEAN Briefing, 2023). Surveys and interviews revealed that scale constraints, supply-side finance gaps and an enabling environment inhibited by intellectual property restrictions represented most binding constraints, while skills shortages and logistic inefficiencies were seen as a less immediate but amplifying force. These results confirm previous research, while contributing empirically by quantifying the impact of the different barriers and differentiating among structural, institutional, and act-endogenous factors.

The analysis also showed that incremental, fragmented interventions are required and important. The system-wide responsible approach developed in this study integrates diagnostic tools, supplier training and capacity building audits and system dynamics modelling as a dynamic package of interventions (LOCATE-SD). Sequencing Diagnose, Design, Deploy, De-risk and Demonstrate phases not only provides practical tools that can be applied more immediately (for instance around supplier capability upgrading, blended-finance and IP transfer mechanisms), but also governance solutions on the longer term through ongoing surveillance and policy balancing.

Validation, by means of benchmarking, triangulation and simulation supported the robustness of the framework. Scenario analysis suggested that standalone incentives or skills interventions led to small, short-lived gains, and that structural finance and design authority

reforms were key drivers for step-level changes in performance. An integrated reform package delivered the most robust and sustainable localisation trajectory, with model simulations projecting local-content could top 80% and wiring harness localisation reach 60% within a decade. These results show that systemic measures are key in achieving SAAM 2035 goals and maintaining competitiveness in the international value chains of the automotive sector.

5.2 Discussion of Findings

The study's findings confirm that South Africa's localisation problem is not just about processes that are not delivering but reflects deeper structural and institutional limitations. By effectively studying the four research objectives, the investigation shows not only how large the localisation deficit is, but also under what conditions it will be overcome.

5.2.1 Objective 1: Benchmarking South Africa's Localisation

The localisation gap was evident once again in the benchmarking exercise against peer economies. Although the survey counted 42.6% average local content, figures for Brazil, India and Thailand are always above 60-75%. They found in interviews that South Africa's small production base, divided platforms and reliance on imported tooling and design prevent suppliers from reaching competitive scale. This result indicates that the country is not only operationally late, but it has structural disadvantages in global value chains.

5.2.2 Objective 2: Diagnosing Barriers

The diagnostics analysis verified the domination of structural over operational factors. Low levels of output (86.0 per cent) supplier finance limitations (67.4 per cent), and constraints on design authority and intellectual property (55.8%) were identified to be the

most constraining barriers well ahead of operational problems including shortages in skilled staff (30,2%) and inefficient logistic issues. These findings stress that investments in training or infrastructures produce no transformational output unless suppliers can also access finance and technology. The results confirm current literature, but the empirical support given by a quantified ranking of the barriers proposing their relative importance is new.

5.2.3 Objective 3: Developing the LOCATE-SD Framework

In response to these constraints, the study developed the LOCATE-SD model, which is more focused with five phases: Diagnose, Design, Deploy, De-risk and Demonstrate. The concept merges traditional industry diagnostic tools with new types such as the LRI, blended-finance clearinghouses, structured IP transfer agreements and system dynamics models. Crucially, it separates binding capital and enabling conditions so that policies focus on the root cause and long-term strengthening of capacities. By incorporating ongoing tracking and policy adjustment, the framework circumvents the failings of fixed industrial targets.

5.2.4 Objective 4: Validation and Simulation

Validation through triangulation and simulation verified the soundness of the framework. Industry norms (NAAMSA, OECD, NAACAM) mirrored the barriers highlighted in the survey, and similar case studies from Brazil and India supported phased pilot strategies as being successfully implemented. System dynamics simulations offered additional insight, illustrating that whereas baseline and incentives only trajectories kept localisation at a stagnating ~40-48%, financial intervention and IP structural reform placed at effective ~67%. Compositive reforms of finance, IP, incentives and skills offered the steepest slope reaching an aggregate local content greater than 80% and wiring harness localisation above ~60% by year 10. These findings indicate the need for systemic, multi-lever strategies to consolidate localisation gains.

Given that the conversation across all four objectives depicts South Africa's localisation challenge as essentially a structural one, any act of operation will not only be half-baked, but will pass on results if not complemented by scale, finance and technology-transfer adjustment. The LOCATE-SD model offers a pragmatic and proven response to these barriers, grounded in local context-specific evidence and international best practice.

5.2.4.1 Interpretation of Sensitivity Results and Policy Implications

The sensitivity analysis (Section 4.4.4.6) provides strong empirical confirmation that the most influential levers for improving localisation are supplier-finance efficiency (represented by αI) and skills and technology-transfer effectiveness (βT). A 25% increase in either parameter yields a double-digit improvement in final local content levels, while equivalent changes in decay parameters (δ) produce comparatively smaller effects. This pattern not only underlines that the localisation challenge in South Africa is structural than operational and that increasing capital availability and speeding up the diffusion of technology are much more beneficial than simply efforts aimed at incremental efficiency improvements.

In policy terms, this finding supports a dual-track strategy. First, programmes that mobilise blended supplier finance and concessional tooling investment should be prioritised, as they directly increase the growth rate of supplier capacity stocks. Second, the policy that has institutionalised technology-transfer and joint-training arrangements between OEMs and local suppliers increases the stock of skills that increase localisation gains over time. In contrast, operational cost reduction only or short-term base incentives are unlikely to change the localisation trajectory significantly, as they influence the structural growth parameters weakly.

Collectively, these results validate the LOCATE-SD framework's emphasis on integrated structural reform, linking finance, IP/technology access, and capability development, rather than isolated interventions. They also highlight the importance of continuous

monitoring of these high-leverage parameters through the framework's "Demonstrate" phase, ensuring that supplier-finance efficiency and training throughput remain the primary performance indicators guiding localisation policy. Sensitivity analysis confirmed that localisation outcomes were most responsive to investment inflows (elasticity = 0.47), moderately to skills throughput (0.31), and least to import pressure (0.12), highlighting the key leverage points for policy and industry action.

5.2.4.2 Scenario Analysis

Four case scenarios were modelled for a 10-year period:

- I. Baseline Scenario:** Current investment and skills-levels maintained localisation at 38-40%, consistent with historical trends.
- II. Skills Development Scenario:** A 20% increase in training throughput raised localisation moderately by 40-48%, indicating workforce development alone is insufficient without investment.
- III. Finance Scenario:** A 25% increase in investment while keeping the training throughput constant resulted in an increase of localisation that reached ~50% over 10 years. Improved access to finance facilitated capacity expansion but the lack of skill development held back from further progress, reiterating that financing alone is not enough for anticipated localisation growth.
- IV. Integrated Reform Scenario:** Integrated Reform Scenario: Combined policy incentives, including increased investment and skills upgrading has pushed localisation coverage significantly above 55%, aligning closer with the target that is set for 2035, to reach 60%.

5.3 Integration of the Research Problem and Theoretical Foundations

Chapter 1 showed that after decades of industrial policy encouragement, local content within the South African automotive industry has stagnated at about 40%, which is considerably lower than similar peer emerging economies such as India, Thailand, and Brazil (South

African Government, 2024); (Ministry of Heavy Industries, 2023); (Intarakumnerd & Techakanont, 2014); (ASEAN Briefing, 2023)). The research problem revealed a lack of knowledge in systemic and inter-related constraints including skills shortages, limited technology-transfer, investment constraints, and logistics inefficiencies which collectively inhibit localisation. Chapter 2 summarised global and regional literature on localisation, supplier development, global value chains, and industrial policy, and grounded the problem through theorisation and experience. The literature indicated that effective automotive localisation in emerging economies is a result of multi-dimensional responses across skills development (Human Capital Theory), technology diffusion (Technology-Transfer Theory), and strategic investment in company capabilities (RBV and Investment Theory) (Halili, 2020). Supply chain and institutional theories highlighted the role of logistics efficiency and policy alignment. These theoretical coherences between Chapters 1 and 2 provided a strong conceptual framework and legitimacy of the hypotheses analysed in subsequent chapters.

Chapter 3 outlined a mixed-method research design combining quantitative survey data, qualitative interviews, secondary industry data, and system dynamics modelling. This method was intentionally chosen to account for the complex, multi-dimensional nature of localisation barriers identified in Chapters 1 and 2. Through triangulation of data sources, the study enhanced the robustness and credibility of the findings. Chapter 4 presented the empirical results derived from statistical analysis, case study investigation (automotive wiring harness), and scenario simulations. The results directly operationalised the conceptual variables discussed in Chapter 2 and empirically tested the hypotheses formulated in Chapter 1. Such alignments between qualitative insights and quantitative results show methodological coherence and illustrate the suitability of the research design to meet the study's objectives.

5.4 Findings in Relation to the Research Objectives

5.4.1 Objective 1: Quantifying Local-Content and Comparative Analysis

The results verified that South Africa's automotive local content remains between 37% and 42%, which is in line with industry evaluations, and significantly lower than competitor economies such as India, Thailand and Brazil ((South African Government, 2024); (Ministry of Heavy Industries, 2023); (Intarakumnerd & Techakanont, 2014); (ASEAN Briefing, 2023)). This result supports the problem statement as outlined in Chapter One and confirms earlier empirical findings whereby effective localisation in developing economies is heavily conditional on production scale, platform consolidation and local supplier depth (Amendolagine, et al., 2019).

Scholars analysing late-industrial automotive economies argue that sustained localisation above 60% typically emerges only once production volumes exceed minimum efficient scale thresholds that justify local tooling, process engineering and supplier upgrading (Monaco, et al., 2020). Interviews in this study support this argument and show that South Africa's fragmented production platforms and relatively small local market limit suppliers' ability to amortise capital investments. This perspective suggests that South Africa's challenges in the automotive industry are not caused by simple inefficiency, but by deep-seated structural barriers within global supply chains, as theorised by Naude (2013).

5.4.2 Objective 2: Identifying Key Factors Causing Low Local Content

Workforce skills shortages, weak technology-transfer processes, limited supplier investment capacity, and logistics inefficiencies were highlighted as the most significant constraints to localisation identified in the study. Diagnostics show that the structural constraints such as gaps in supplier finance, and limited design authority outweigh

operational bottlenecks. This finding is strongly supported by the literature on industrial development which stresses that without complementary capital investment and access to technology, skills development would not suffice (Shakina, et al., 2021). The idea of absorptive capacity in Cohen and Levinthal (1990) also clarifies why skills shortages prevent companies internalising transferred technologies, resulting in greater reliance on imported components.

Monaco and Wuttke (2023) suggest that without the monetary support to upgrade tooling or processes, such suppliers can fall into low-value segments of the automotive chain. The empirical merit of this article is its quantification of constraints in the literature, which complements qualitative research by demonstrating the relative dominance of finance and design authority constraints over operational inefficiencies. It goes to show that South Africa's localisation challenge is systemic rather than incremental.

5.4.3 Objective 3: Development of a Conceptual Localisation Framework

The LOCATE-SD framework developed in this study is a response to the findings. This framework is based on the phases of Diagnose→ Design→ Deploy→ De-Risk →Demonstrate. This aligns with contemporary industrial policy scholarship, which advocates for adaptive, learning-oriented policy frameworks rather than static incentive regimes (Kuznetsov, 2021). The combination of diagnostics, blended finance instruments, structured intellectual property transfer mechanisms and system dynamics modelling addresses directly those criticisms that traditional localisation policies are unsuccessful because they are fragmented and have weak feedback loops (Organisation for Economic Co-operation and Development, 2017). With the explicit distinction of binding capital constraints and enabling institutional conditions built-in, the framework captures perspectives from the Resource-Based View that long-term capability accumulation serves as the underpinning of competitive advantage (Simamora, et al., 2024).

5.4.4 Objective 4: Validation of the Localisation Framework

The LOCATE-SD framework was validated through triangulation, benchmarking and system dynamics simulation. Comparable studies from Brazil and India have demonstrated that phased localisation strategies, anchored in supplier finance, OEM–supplier collaboration, and technology diffusion, produce more positive outcomes than incentive-driven approaches (Lee, et al., 2021).

The simulation results reinforce arguments in the systems dynamics literature that industrial upgrading processes are path-dependent and characterised by feedback loops and time delays (Hafner, et al., 2024). The finding that integrated interventions yield step-change improvements, while isolated measures produce only marginal gains, provides strong empirical support for coordinated industrial policy designs.

5.5 Hypotheses and Their Validation

5.5.1 Hypothesis 1: Workforce Skills and Local Content

The results indicated that there is a significant positive relationship between workforce skills and the degree of localisation thus rejecting the null hypothesis. Stronger engineering and technical capabilities equip companies to absorb technologies transferred over and perform complex manufacturing tasks. This aligns with Human Capital Theory that states skills accumulation boosts productivity and innovation (Ngepah, et al., 2021) and empirical automotive research supporting localisation as a supplier skill intensity increases. The study also finds, however, in line with Khoury and Scott (2024) that skills are complementary rather than central to localisation.

5.5.2 Hypothesis 2: Technology-Transfer and Localisation

The evidence confirms that limited access to design authority, tooling knowledge, and process engineering constrains the local manufacturing process, hence rejecting the null hypothesis. The Technology-Transfer Theory also confirms that knowledge transfer and on-the-job-training are crucial to industrial upgrading (Arrow, 1962; Bell & Pavitt, 1993). The finding from an analysis of the literature of East Asian localisation of the automotive industry suggests that OEM-controlled intellectual property regimes delay localisation unless closely coupled with supplier development programmes (Sturgeon & Florida, 2004; Intarakumnerd & Techakanont, 2014). The findings, therefore, reinforce the need for institutionalised mechanisms that integrate technology-transfer into localisation policy.

5.5.3 Hypothesis 3: Investment Constraints and Local Content

The relationship between supplier investment capacity and localisation rates is significant, and this rejects the null hypothesis. Costly tooling, automation, and testing facilities were determined to be requirements for local production of high-value automotive components. The findings relate to one of the pillars of RBV: capital investment is regarded as the foundation for the granting of company-specific capabilities (Mamabolo, et al., 2017). Similarly, Ramadhan (2025) argues that late industrialisers must have patient capital and coordinated financing mechanisms in order to overcome the barriers to entry imposed by a complex manufacturing sector such as the automotive sector.

5.5.4 Hypothesis 4: Logistics Performance and Local Content

Findings showed that challenges in logistics reduce localisation rates, thus increasing costs and reducing supplier reliability. This is mostly seen in just-in-time production systems. The null hypothesis was, therefore, rejected. This finding is consistent with supply Chain Management theory, which emphasises logistics reliability as a determinant of supplier integration (Kim, et al., 2020). Empirical studies in global automotive

networks show that poor port performance and transport delays discourage local sourcing, even when production capabilities exist (World Bank Group, 2023). Taken together, the validation of all four hypotheses reinforces the conclusion that localisation is a system-level phenomenon, shaped by the interaction of skills, finance, technology access, and logistics performance. This conclusion aligns with contemporary industrial policy scholarship, which increasingly emphasises coordinated, adaptive and institutionally embedded interventions over fragmented policy instruments (Haddad, et al., 2022).

5.6 Future Research Directions

Future research should first adopt a more inclusive and data-intensive approach by engaging a wider range of stakeholders across the automotive value-chain particularly lower-tier suppliers, informal actors and labour unions, while strengthening collaboration with government, industry bodies and OEMs to improve access to company-level and proprietary data. Second, studies should prioritise longitudinal and comparative research designs, supported by enhanced system dynamics modelling and real-time industry data, to evaluate the evolving impacts of localisation policies over time and to benchmark South Africa's experience against other automotive economies, especially in the context of evolving trends and adaptive policy learning.

5.7 Conclusions and Implications of the Study

This study has demonstrated that South Africa's localisation gap, averaging 40-42% compared to peer economies' (Brazil, India and Thailand) 60-80%, is rooted in structural barriers. The most binding constraints were scale of production, supplier financing gap and restrictive intellectual property arrangements emerged as being the most binding constraints. This reaffirms the need for operational fixes to be accompanied by systemic solutions at scale, finance and technology-transfer to change results.

Alongside these barriers, institutional weaknesses including fragmented governance, inconsistent policies, and weak linkages between foreign automakers, suppliers and government have hampered the impact of current means to upgrade suppliers. Operational issues such as skills shortages and logistics inefficiencies are still significant. However, they operate more like amplifiers than actual root causes at this point. This further underlines the need to introduce reforms at a level that focuses on structure and institutions first.

The LOCATE-SD model developed herein gives an evidence-based answer. Sequencing of interventions is built on a methodological framework within Diagnose, Design, Deploy, De-risk and Demonstrate (the five Ds), incorporating diagnostic tools, readiness audits and system dynamics simulations in an integrated approach to localisation. Validation also indicated that single drivers (incentives or skills) deliver small benefits (~40-48%), and structural revisions in finance and IP push localisation to ~67%, with system reforms able to secure more than 80% overall, and 60% for wiring harnesses within a decade. The implication is clear: comprehensive, multi-lever transformation backed by blended-finance; enforceable IP transfer and coherent governance will be the recipe for achieving SAAM 2035 targets. If pursued with urgency, these can turn localisation into a dynamic force for competitiveness, industrial upgrading and inclusive growth in South Africa's automotive industry.

CHAPTER 6: RECOMMENDATIONS AND CONCLUSIONS

6.1 Introduction

This chapter presents the conclusion and recommendations of the study on low local content in the South African automotive industry. The chapter synthesises the key findings relating to the structural constraints limiting localisation, including capacity scale effects, inadequate financing within the supplier sector, and restricted access to intellectual property. It further discusses the development and validation of the LOCATESD framework as an integrated approach for improving localisation performance within the industry.

The chapter also outlines how the framework's five stages: Diagnose, Design, Deploy, De-risk and Demonstrate, provide both short-term and long-term interventions aimed at strengthening supplier capability, enhancing technology transfer, improving financing mechanisms, and supporting adaptive governance structures. In addition, the chapter highlights the theoretical, methodological and practical contributions of the study, while providing recommendations for policymakers, industry stakeholders and future research toward achieving higher localisation targets in line with international peer economies such as Brazil, India and Thailand.

6.2 Recommendations and Future Directions

The recommendations that follow are based on benchmarking, diagnostic evidence, and system dynamics simulations, which confirm that South Africa's localisation constraints are structural in nature. Grounded in the LOCATE-SD framework, they translate these findings into coordinated policy and industry interventions, highlighting finance, technology transfer, and institutional alignment as key drivers of sustained localisation gains toward SAAM 2035 targets.

- 1) Upgrade supplier capability through intensive training programmes focused on quality systems, OEM approval readiness and defect reduction.
- 2) Establish blended finance systems combining government and OEM funding to support tooling, upgrades and supplier financing.
- 3) Create IP Safe-Harbour Zones to allow controlled use of OEM intellectual property while protecting IP rights.
- 4) Develop a Digital Supplier Capability Registry to improve supplier visibility, transparency and OEM sourcing efficiency.
- 5) Establish a National Localisation Exchange Platform linking OEM demand with local suppliers to improve planning and demand coordination.
- 6) Introduce Localisation Simulation Labs to test policies through system dynamics modelling before implementation.
- 7) Establish an Automotive Localisation Coordination Council to ensure policy alignment, coordination and ongoing monitoring.
- 8) Implement continuous monitoring systems using digital dashboards, supplier passports and KPI-linked performance tracking.
- 9) Adopt a phased localisation strategy starting with targeted components such as wiring harnesses before broader industry scaling.

6.3 Actionable Steps to Implement Recommendations

- I. Policymakers can set up a blended Automotive Supplier Development Fund with first-loss capital guarantees and link technology-transfer agreements to state support. Progress should be tracked through a public KPI dashboard.
- II. Industry Bodies can develop a Digital Supplier Passport to highlight vendor capabilities and launch pilot projects for high-value components, such as wiring harnesses, supported by shared testing facilities.

- III. Financial Institutions could introduce "Localisation-Linked" loan products, where interest rates are tied to verified increases in local content. This approach would reduce the risk of lending for tooling and capacity upgrades.
- IV. Cross-Cutting Stakeholders can fund a dedicated Policy Simulation Lab to test interventions and launch a Green Localisation Fund to support suppliers in shifting to New Energy Vehicle component manufacturing.

6.4 Future Research Areas

- I. One important area is Inclusive Value-Chain Analysis. Studies should examine the barriers faced by Tier 2 and Tier 3 suppliers and consider labour dynamics to ensure that localisation policies benefit the entire supply chain and not just the larger players such as OEMs.
- II. Advanced Policy Simulation Tools offer another avenue for research. The current System Dynamics model could be refined into an operational software tool using real-time data. This would allow policymakers and industry to test and predict the outcomes of different industrial policies before putting them into practice.
- III. Regional African Value Chains also deserve attention. Research can explore opportunities under the AfCFTA to create regional production networks. This includes identifying components that can be efficiently sourced from neighbouring countries to boost competitiveness across the continent.

6.5 Conclusion

This study aimed to diagnose the causes of low local input in South Africa's automotive industry. Despite three decades of MIDP, APDP and SAAM 2015 support for industrial policies, localisation has been stuck at around 40%. That figure is far below peer economy

countries such as India, Brazil and Thailand, which all score from 60 to 80%. This research revealed that not only is this gap persistent, but it is also systematic. The most constraining factors so far have been structural barriers, in particular small production scale, constricted supplier funding and difficulty in adjusting to the evolving technological changes attached to knowledge and proficiency. These constraints are reinforced by the policy implementation and coherence issues of institutional weakness. In addition to the above, operational challenges such as a shortage of skilled workers and logistics inefficiency were found to play a more enabling role rather than being primary drivers for failure.

In response to addressing these problems, the study created and tested the LOCATESD framework. This integrates diagnostic tools, supplier readiness audits, and system dynamics modelling in separate phases underneath one unifying umbrella: Diagnose; Design; Deploy; De-risk; Demonstrate. Repeatedly, the framework proved capable of transforming diagnostic insight into policy and strategy. Simulations repeatedly show that, while structural reforms in finance and IP transfer deliver improvement in skills' upgrading or incentives alone are at best modest. Integrated reforms, comprising finance, IP transfer plus coherent incentives, and skills upgrading more than 80% of local content under this scenario, wiring harnesses were nearly 60%.

The study has various theoretical, methodological and practical implications. In theory, it contributes to the literature on localisation by showing that structural, institutional and organisational factors dynamically interact. Methodologically, it contributes as an innovation in the South African industrial policy literature by using a system dynamics model as a method. On a pragmatic level, it offers policy and industry interests specific suggestions, including blended-finance schemes and structured IP relationships, digital supplier passports, green localisation funds and simulation labs. Together, these interventions sketch a path from languishing policy ambition to localisation becoming a driver of competitiveness, technological upgrading and inclusive growth.

In conclusion, the study fills a critical gap by showing that South Africa's localisation challenge is not primarily a matter of capacity or willingness, but of system design and coordination failure. The LOCATE-SD framework provides an evidence-based approach to addressing this gap and improving localisation performance in a structured and measurable way.

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APPENDICES

APPENDIX A: Ethics certificate



College of Science, Engineering and Technology_ School of Engineering_ERC

Date: 15/10/2024

Dear: Ms Lulama Sibiya

Decision: Ethics Approval from 15/10/2024 to 15/20/2027 (Human Participant)

Ref #: 5209

Name: Ms Lulama Sibiya

Student #: 62925687

Staff #: N/A

Researcher: Ms Lulama Sibiya

Karen park

Pretoria

62925687@mylife.unisa.ac.za 0782299138

Supervisor: Dr Humbulani Simon Phuluwa ephuluhs@unisa.ac.za

Co-Supervisor: Mr Bantubenzani Nelson Mdololo, Mr Steadyman Chilumba mdolobn@unisa.ac.za, chikus@unisa.ac.za

A DIAGNOSTIC ANALYSIS OF THE CAUSES OF LOW LOCAL CONTENT IN THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY

Qualification: MEng

Thank you for the application for research ethics clearance by the College of Science, Engineering and Technology_ School of Engineering_ERC for the above mentioned research study Ethics approval is granted for three years.

The **low risk application** was reviewed by College of Science, Engineering and Technology_ School of Engineering_ERC on 15/10/2024 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.

The proposed research may now commence with the provisions that:

- The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
- Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Science, Engineering and Technology_ School of Engineering_ERC.
- The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
- Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.

5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.

6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.

7. No field work activities may continue after the expiry date (15/10/2027). Submission of a completed research ethics progress report will constitute an application for renewal, for Ethics Research Committee approval.

Additional Conditions

- Disclosure of data to third parties is prohibited without explicit consent from Unisa.
- De-identified data must be safely stored on password protected PCs.
- Care should be taken by the researcher when publishing the results to protect the confidentiality and privacy of the university.
- Adherence to the National Statement on Ethical Research and Publication practices, principle 7 referring to Social awareness, must be ensured: "Researchers and institutions must be sensitive to the potential impact of their research on society, marginal groups or individuals, and must consider these when weighing the benefits of the research against any harmful effects, with a view to minimising or avoiding the latter where possible." Unisa will not be liable for any failure to comply with this principle.

Note

The reference number 5209 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Kind regards,


Dr A Mavukwana
Chair of College of Science, Engineering and Technology_ School of Engineering_ERC
E-mail: mavukae@unisa.ac.za

Prof SJ Johnston
Executive Dean / Prof S.J Johnston, By delegation from the Executive Dean of College of Science, Engineering and Technology_ School of Engineering_ERC
E-mail: johnsjs@unisa.ac.za

APPENDIX B: Participant Consent Form

Participant Consent Form

Introduction:

Thank you for agreeing to participate in this research study. The aim of the study is to explore the causes of low local content in South Africa's automotive industry and to identify strategies for enhancing localization.

Confidentiality & Voluntary Participation:

- Your participation is completely voluntary.
- You may refuse to answer any question or withdraw from the interview at any time.
- All information provided will be kept confidential and used solely for academic purposes.
- Responses will be anonymized in the final report.

Consent Statement:

I have read and understood the above information and voluntarily agree to participate in this interview.

- ☐ I agree to participate.
- ☐ I agree to audio recording (optional).
- ☐ I do not agree to audio recording.

Participant Name: _____

Signature: _____ **Date:** _____

Researcher Signature: _____ **Date:** _____

APPENDIX C: Interview Guide

Semi-Structured Interview Questions

Topic: *A Diagnostic Analysis of the Causes of Low Local Content in the South African Automotive Industry*

Section A: Company Profile

1. Could you briefly describe your company's role in the automotive value chain (e.g., OEM, Tier 1, Tier 2)?
2. What types of vehicles or components does your company focus on?
3. How long has your company been operating in South Africa?

Section B: Local Content Evaluation

4. What percentage of your components or inputs are currently sourced locally?
5. How does this percentage vary across different vehicle classes or product lines?
6. Which components are most commonly sourced locally, and which are typically imported? Why?

Section C: Comparative Insights

7. Have you worked or collaborated with suppliers in other emerging markets (e.g., India, Brazil, Thailand)? If so, how do their localization levels compare?
8. What localization strategies or policies in those countries do you think are worth replicating in South Africa?

Section D: Barriers to Localization

9. What are the key barriers your company faces in increasing local content?
 - Can you speak to specific issues like supplier quality, pricing, technology readiness, or logistics?
10. To what extent does the current skill level of the local workforce impact your ability to localize components?
11. How does the availability (or lack) of capital investment or supplier development funding affect your sourcing strategy?

Section E: Policy and Industry Support

12. How effective have government policies such as the Automotive Production and Development Programme (APDP) been in promoting localization?
13. What additional government or industry-level interventions would support increased local content?

Section F: Strategic and Conceptual Inputs

14. From your perspective, what would an effective framework for optimizing localization in South Africa include?
15. Are there examples of successful localization initiatives your company has undertaken or witnessed in South Africa?

Section G: Resources and Success Factors

16. What types of resources (financial, technological, human) are most critical for achieving higher local content?
17. What do you see as the top success factors for sustainable localization in the South African automotive industry?

Section H: Forward-Looking Perspectives

18. What is your vision for the future of localization in South Africa's automotive industry over the next 5–10 years?
19. What kind of partnerships (e.g., OEM-supplier, public-private) do you believe are essential to achieve this vision?

APPENDIX D: Questionnaire Survey



UNISA

A Research Survey

A diagnostic analysis of the causes of low local content in the South African automotive industry

Dear Participant,

You are invited to participate in a study aimed at developing a comprehensive framework that optimizes the localization process within the South African automotive industry. Participation in this study is voluntary, and you reserve the right to withdraw from this study at any point. Your identity will be kept anonymous, and your responses will only be used for the purposes of this study. If you have any questions regarding this study, do not hesitate to contact Lulama Sibiyi by email at lupertunia@gmail.com, or cell number 076 229 9138.

By proceeding with this study, you confirm that you have read and understood the purpose of the research and voluntarily agree to participate.

* Required

SECTION 1: PERSONAL INFORMATION
OEM, component suppliers (Section 1 - 8), Other automotive stakeholders (1 & 9)

1. Position *

2. What is the type of your organization? *

☐ OEM Representative

☐ Component supplier Representative

☐ Industry Association Representative

☐ Government/Policy Representative

☐ Other

3. Location (Province and City) *

4. How many years have you been working in the automotive manufacturing industry? *

☐ Less than 3 years

☐ 3-5 years

☐ 6-10 years

☐ More than 10 years

A Research Survey

SECTION 2: UNDERSTANDING AND IMPORTANCE OF LOCAL CONTENT

5. What is the approximate percentage of locally sourced components in your production?

☐ Less than 20%

☐ 20 - 40%

☐ 41 - 60%

☐ 61% or more

6. Which components are more easily sourced locally? (Select all that apply)

☐ Trim and plastic components

☐ Electrical wiring

☐ Engine/transmission

☐ Catalytic converters

☐ Other

7. To what extent does your company prioritize increasing local content in its production?

☐ Not at all

☐ Slightly

☐ Moderately

☐ Highly

8. How do locally produced component costs compare to imported alternatives?

☐ Much higher

☐ Slightly higher

☐ About the same

☐ Slightly lower

☐ Much lower

A Research Survey

9. What do you think is the most significant benefit of increasing local content in automotive production?

Please select 2 options.

☐ Cost savings

☐ Job creation

☐ Improved supply chain reliability

☐ Economic growth

☐ Other

10. Please indicate your level of agreement below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
My organization has a clear strategy for localizing components.	☐	☐	☐	☐	☐
South African-made components can meet the quality standards required by OEMs.	☐	☐	☐	☐	☐

SECTION 3: CHALLENGES TO LOCAL CONTENT DEVELOPMENT

11. What are the biggest challenges in increasing local content in your organization?

Please select 3 options.

- ☐ Low production volumes
- ☐ Lack of supplier funding
- ☐ Ownership of intellectual property
- ☐ Skills shortages
- ☐ Quality compliance issues
- ☐ Other

12. What discourages your company (or investors) from investing more in local production?

Please select at most 2 options.

- ☐ Policy instability
- ☐ Infrastructure issues
- ☐ Skills shortages
- ☐ Low volumes
- ☐ Other

13. How would you rate the effectiveness of technology transfer programs in South Africa's automotive sector?

- ☐ Very effective
- ☐ Somewhat effective
- ☐ Neither effective nor ineffective
- ☐ Somewhat ineffective
- ☐ Very ineffective

14. Choose the relevant option for each question below

	Not a Barrier	Minor Barrier	Moderate Barrier	Significant Barrier	Major Barrier
Lack of skilled labour in advanced manufacturing	☐	☐	☐	☐	☐
Limited access to financing for local suppliers	☐	☐	☐	☐	☐
Inadequate R&D and innovation capabilities	☐	☐	☐	☐	☐
Weak infrastructure (e.g. logistics, transport, energy)	☐	☐	☐	☐	☐
Lack of latest technology	☐	☐	☐	☐	☐

15. Please indicate your level of agreement below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
Low production volumes discourage suppliers from investing in localization.	☐	☐	☐	☐	☐
Insufficient economies of scale discourage suppliers from investing in localized production.	☐	☐	☐	☐	☐
IP ownership and design control by foreign OEMs limits opportunities for local sourcing.	☐	☐	☐	☐	☐
Local suppliers can meet the quality standards required by OEMs.	☐	☐	☐	☐	☐
There is sufficient supplier infrastructure to support localization at scale.	☐	☐	☐	☐	☐
Limited availability of raw materials locally is a key factor in the low level of local content in South Africa's automotive production.	☐	☐	☐	☐	☐
The high cost of local production compared to imports contributes to low local content in the South African automotive industry.	☐	☐	☐	☐	☐

SECTION 4: SKILLS AND WORKFORCE DEVELOPMENT

16. What types of training and support would help your company localize more production? (Select all that apply)

- ☐ Technical skills programs
- ☐ Supplier audit preparation
- ☐ Apprenticeship programs
- ☐ Quality management systems
- ☐ Other

17. Please indicate your level of agreement below

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
My organization struggles to find locally trained workers with relevant technical skills.	☐	☐	☐	☐	☐
Current tier suppliers training and certification programs meet the quality needs of OEMs.	☐	☐	☐	☐	☐
There is a lack of alignment between education curricula and industry needs.	☐	☐	☐	☐	☐
Skills shortages have delayed or reduced our ability to localize production.	☐	☐	☐	☐	☐

SECTION 5: GOVERNMENT POLICY AND INSTITUTIONAL SUPPORT

18. How effective has the APDP been in promoting local content?

- ☐ Very ineffective
☐ Somewhat ineffective
☐ Neither effective nor ineffective
☐ Somewhat effective
☐ Very effective

19. What type of government support would most improve localization? (Select all that apply)

- ☐ Direct investment in supplier development
☐ Training and education programs
☐ Tax incentives for local sourcing
☐ Policy clarity and long-term commitments
☐ Other

20. Which institutions have provided the most impactful support to your business?

- ☐ DTIC
☐ AIDC
☐ NAAMSA
☐ MERSETA
☐ Other

21. Please indicate your level of agreement below

Strongly Disagree Disagree Neutral Agree Strongly agree

Current government incentives (such as tax breaks or subsidies) effectively support the increase of local content in automotive production.

☐ ☐ ☐ ☐ ☐

Policies such as APDP offer adequate long-term support for SME supplier development.

☐ ☐ ☐ ☐ ☐

There is sufficient coordination between government, OEMs, and training institutions.

☐ ☐ ☐ ☐ ☐

Import tariffs on foreign automotive components help promote the growth of local content production.

☐ ☐ ☐ ☐ ☐

Government's transparency and consistency in policy implementation is essential for supporting local content in the automotive industry.

☐ ☐ ☐ ☐ ☐

Aligning automotive industry policies with government policies is necessary to optimize local content production.

☐ ☐ ☐ ☐ ☐

SECTION 6: BENCHMARKING AND INTERNATIONAL PRACTICES

22. How familiar are you with localization models in countries like Thailand, India, or Brazil?

- ☐ Not familiar
☐ Somewhat familiar
☐ Very familiar

23. Compared to above countries (countries like India, Brazil, or Thailand), how would you rate South Africa's localization performance?

- ☐ Much lower
☐ Slightly lower
☐ About the same
☐ Slightly higher
☐ Much higher

24. Would benchmarking and knowledge sharing with global leaders help your localization strategy?

- ☐ Yes
☐ No
☐ Not sure

25. Please indicate your level of agreement below

Strongly Disagree Disagree Neutral Agree Strongly Agree

South Africa can learn effective localization strategies from other emerging economies.

☐ ☐ ☐ ☐ ☐

My organization has actively benchmarked localization practices in other countries.

☐ ☐ ☐ ☐ ☐

SECTION 7: PARTNERSHIPS AND COLLABORATIONS

26. Please indicate your level of agreement below

Strongly Disagree Disagree Neutral Agree Strongly agree

There is sufficient collaboration between industry and universities for innovation.

☐ ☐ ☐ ☐ ☐

Financial incentives and tax relief would help OEMs and Tier 1 suppliers increase local sourcing.

☐ ☐ ☐ ☐ ☐

Stronger partnerships between OEMs and local suppliers would boost localization.

☐ ☐ ☐ ☐ ☐

Joint ventures are the most effective way to transfer knowledge and technology to local firms.

☐ ☐ ☐ ☐ ☐

Industry clusters (e.g. supplier parks) have improved supplier-OEM collaboration.

☐ ☐ ☐ ☐ ☐

A national localization framework should prioritize supplier capacity building and skills development.

☐ ☐ ☐ ☐ ☐

SECTION 8: FUTURE OUTLOOK

27. Which factors has the strongest influence on increasing local content?

- ☐ Increased investment in supplier capacity
- ☐ Stronger government incentives
- ☐ Improved workforce skills development
- ☐ Other

28. Are there any lessons or best practices from other countries that you believe South Africa should consider adopting to enhance local content?

29. What localization strategies do you believe can boost local content?

SECTION 9: STAKEHOLDER PERSPECTIVES

30. What role does your institution play in supporting local content development in the automotive sector? (Select all that apply)

- ☐ Supplier development funding
- ☐ Skills and training programs
- ☐ Infrastructure provision
- ☐ Policy advisory and lobbying
- ☐ Technology support
- ☐ Other

31. Which key challenges limit the impact of support institutions like yours in improving localization?

- ☐ Insufficient funding
- ☐ Fragmented coordination with OEMs and government
- ☐ Skills mismatch in target regions
- ☐ Policy misalignment or regulatory delays
- ☐ Other

32. What kind of partnerships do you believe are most critical to enhance localization success?

- ☐ Public-private partnerships
- ☐ OEM-supplier development programs
- ☐ University-industry collaboration
- ☐ Inter-governmental task forces
- ☐ International technology transfer partnerships
- ☐ Other

33. Please indicate your level of agreement with the following statements

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
South Africa needs a single coordinating body to oversee automotive localization efforts.	☐	☐	☐	☐	☐
Existing government incentives are not adequately tailored for institutional implementers.	☐	☐	☐	☐	☐
National industry development strategies must include regional industrial policy alignment.	☐	☐	☐	☐	☐

34. In your view, what institutional or structural reforms are necessary to accelerate local content development in South Africa?

This content is neither created nor endorsed by Microsoft. The data you submit will be sent to the form owner.

 Microsoft Forms

APPENDIX E: System Dynamics Modelling

E.1 Model Structure:

E.1.1 Stocks

The system comprises three core state variables, consistent with the LOCATE-SD conceptual model:

Stock	Description
Supplier Capacity (S)	Capability of local suppliers, driven by investment
Skills (K)	Workforce competence, driven by training throughput
Local-Content (L)	Share of local value added; baseline $L_0 = 0.38$

E.1.2 Flows

- *Investment inflow $I(t)$* (reflects the 67.4% finance barrier)
- *Training throughput $T(t)$* (from the 30.2% skills bottleneck)
- *Decay/attrition $\delta S, \delta K$* (natural depreciation of skills/capability)

E.1.3 Feedback Loops

- *Reinforcing Loop R1*: Investment $\rightarrow$ S $\rightarrow$ L $\rightarrow$ further investment
- *Reinforcing Loop R2*: Training $\rightarrow$ K $\rightarrow$ S $\rightarrow$ L $\rightarrow$ workforce demand
- *Balancing Loop B1*: Import Pressure M(t) $\rightarrow$ reduces L(t)

E.2 Formal Equations

Following the system dynamic formulation in Chapter 3 and 4:

E.2.1 Supplier Capacity

$$\frac{dS}{dt} = I(t) - \delta_S S(t)$$

Where:

- $I(t)$ = investment inflow from finance policies
- δ_S = capacity decay-rate

E.2.2 Skills

$$\frac{dK}{dt} = T(t) - \delta_K K(t)$$

Where:

- $T(t)$ = training throughput
- δ_K = skill attrition rate

E.2.3 Local-Content

$$L(t) = \alpha I S(t) + \beta T K(t) - \gamma M(t)$$

Where:

- αI = sensitivity of localisation to supplier capacity
- βT = sensitivity to skills improvement
- γ = vulnerability to import pressure

Parameter estimation used:

- Survey-derived base weights,
- 2013–2024 localisation data, and
- $\pm 25\%$ sensitivity experimentation.

E.3 Scenario Definitions

Scenario	Description	Assumption
Baseline	Continuation of 2023 flows	$I(t), T(t), M(t)$ unchanged
Skills only	Increased training throughput	$T(t) \uparrow 20\text{--}25\%$
Finance only	Increased investment	$I(t) \uparrow 25\text{--}30\%$
Integrated Policy Package	Combined structural reform	$I(t) \uparrow 25\%, T(t) \uparrow 20\%, M(t) \downarrow 25\%$

E.3.1 MATLAB Implementation

- MATLAB + **ode45** used for numerical integration.
- Simulink used for visual stock–flow diagram connections.
- Symbolic Toolbox used for manipulation of equations.
- Optimisation Toolbox used for parameter calibration.

E.3.1.1 State Update Function

```
function dX = localisation_dynamics(t, X, params)

S = X(1);
K = X(2);
L = X(3);

I = params.I(t);
T = params.T(t);
M = params.M(t);

dS = I - params.deltaS * S;
dK = T - params.deltaK * K;
dL = params.alphaI * S + params.betaT * K - params.gamma * M;

dX = [dS; dK; dL];
end
```

E.3.1.2 Scenario Configuration & Simulation

```
tspan = [0 120]; % months (10 years)
X0 = [S0; K0; L0];

[time, states] = ode45(@(t,X) localisation_dynamics(t,X,params), tspan, X0);

S = states(:,1);
K = states(:,2);
L = states(:,3);
```

E.3.1.3 Plotting Results

```
plot(time/12, L, 'LineWidth', 2);
xlabel('Years');
ylabel('Local Content Share');
title('Simulated Local Content Under Scenario');
grid on;
```

APPENDIX F: Correlation matrix

F.1 Steps to creating the Pearson Correlation Matrix:

Step1: the categorical responses were coded into numbers.

Survey Response	Numeric Score
Less than 20%	1
20 – 40%	2
41 – 60%	3
61% or more	4

So, if a respondent answered:

Example: 41–60%

then:

Local-Content Pct = 3

STEP 2: From your dataset, questions were grouped according to the indices/selected barriers (Skills, Finance, Logistics, intellectual property (IP) and the scale).

E.g., Skills index related questions:

1. Lack of skilled labour in advanced manufacturing.
2. My organization struggles to find locally trained workers with relevant technical skills.
3. There is a lack of alignment between education curricula and industry needs.
4. Skills shortages have delayed or reduced our ability to localize production.

The Likert responses were coded numerically.

Response	Score
Strongly Disagree	1
Disagree	2
Neural	3
Agree	4
Strongly Agree	5

For barrier type questions were coded the same way:

Response	Score
Not a Barrier	1
Minor Barrier	2
Moderate Barrier	3
Significant Barrier	4

Major Barrier	5
---------------	---

The index is simply the arithmetic mean of all the questions per respondent:

$$\text{Skills Index} = \frac{Q_1 + Q_2 + Q_3 + Q_4}{4}$$

This was calculated for all 50 respondents.

Those numeric values obtained were then used in the correlation calculation against:

- Skills Index
- Finance Index
- Logistics Index
- IP Index
- Scale Index

Excel was then used for data analysis, and the results were generated using the following steps:

Data → Data analysis → Correlation → **dataset generated (Table 4.4 results)**

F.2 Steps to creating the OLS Regression Results (Dependent Variable (DV): Local-Content %) Table:

The numerical values generated in creating the Pearson correlation table were used to generate the OLS regression table using the following steps in excel:

Data → Data analysis → Correlation → **dataset generated (Table 4.5 results)**

APPENDIX G: MATLAB Calibration and Validation Procedure

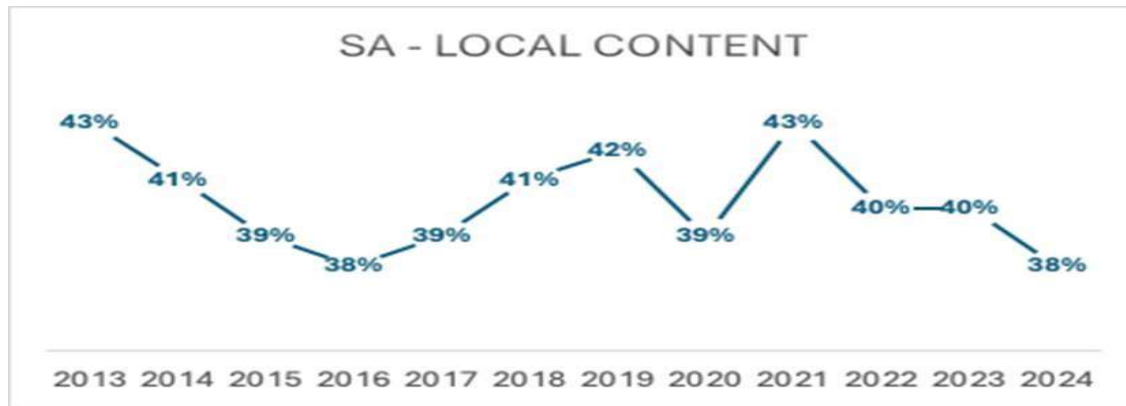
G.1 Overview of Calibration Approach

The System Dynamics model was calibrated using numerical simulation in MATLAB. The objective was to estimate key parameters by minimising the deviation between simulated local content $L(t)$ and historical NAAMSA data (2013–2024).

G.2 Data Preparation (Input to MATLAB)

Step 1: Historical data input

The historical data was defined in MATLAB as:



This represents NAAMSA localisation trends used as calibration targets

Step 2: Initial Conditions

Initial system conditions were defined as:

```

run_calibration.m x sensitivity_analysis.m x Initial conditions.m x
/MATLAB Drive/Initial conditions.m
1 X0 = [10 10];
2 L0 = 0.38;
    
```

based on NAAMSA baseline localisation (2024 average).

Step 3: Parameter Vector Definition

```

sensitivity_analysis.m x Initial conditions.m x Parameter vector definition.m x
/MATLAB Drive/Parameter vector definition.m
1 params = [alphaI betaT deltaS deltaK];
    
```

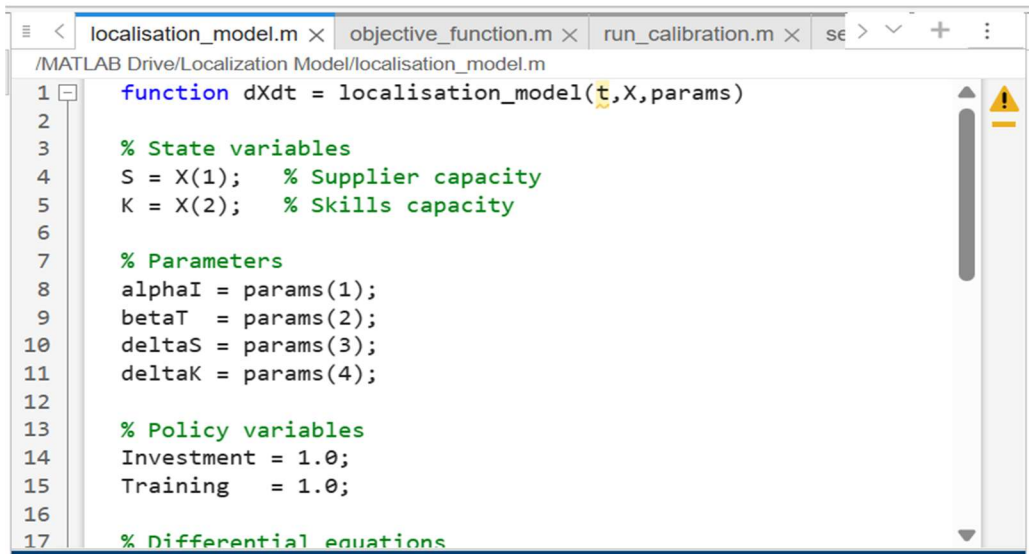
Where:

- αI = investment effectiveness
- βT = training effectiveness
- δS = supplier decay rate

- δK = skills decay rate

G.3 System Dynamics Model Implementation

The model equations were implemented in MATLAB as:

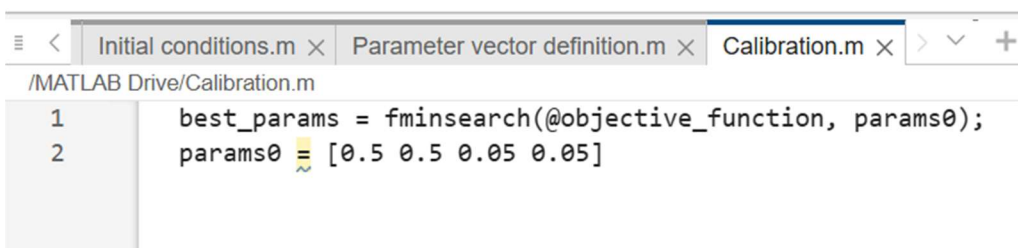


```

1 function dXdt = localisation_model(t,X,params)
2
3 % State variables
4 S = X(1); % Supplier capacity
5 K = X(2); % Skills capacity
6
7 % Parameters
8 alphaI = params(1);
9 betaT = params(2);
10 deltaS = params(3);
11 deltaK = params(4);
12
13 % Policy variables
14 Investment = 1.0;
15 Training = 1.0;
16
17 % Differential equations
    
```

G.4 Calibration Procedure (Iterative Optimisation)

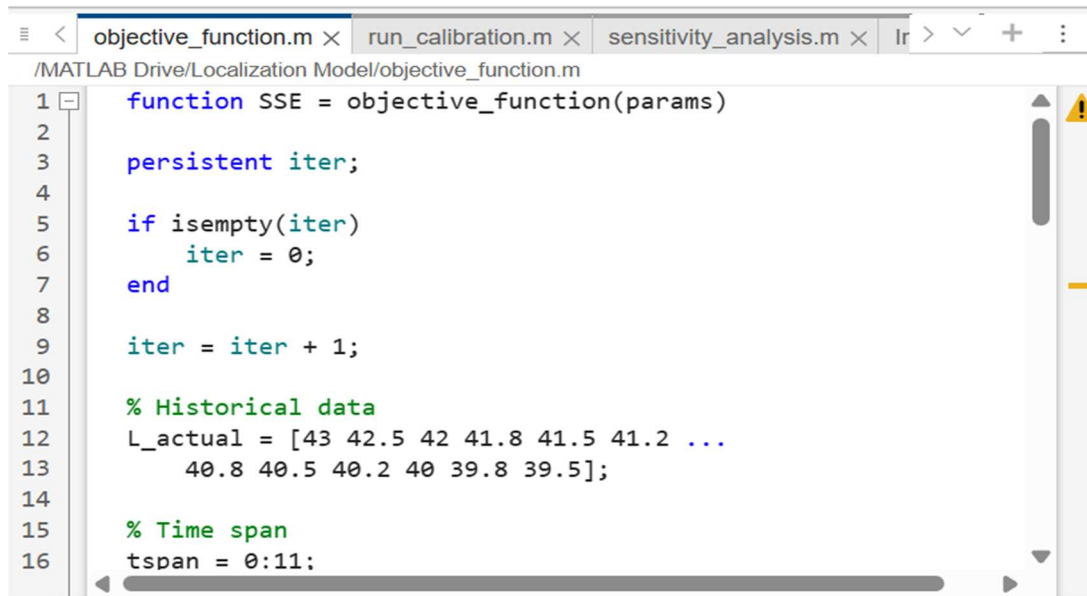
Calibration was performed using the built-in MATLAB optimisation function:



```

1 best_params = fminsearch(@objective_function, params0);
2 params0 = [0.5 0.5 0.05 0.05]
    
```

Objective Function Implementation



```

1 function SSE = objective_function(params)
2
3 persistent iter;
4
5 if isempty(iter)
6     iter = 0;
7 end
8
9 iter = iter + 1;
10
11 % Historical data
12 L_actual = [43 42.5 42 41.8 41.5 41.2 ...
13             40.8 40.5 40.2 40 39.8 39.5];
14
15 % Time span
16 tspan = 0:11;

```

The purpose of the function is to simulate the system, compares the results with historical data, computes the calibration error, and prints the outputs for each iteration.

G.5 Final Calibrated Parameters

Parameter	Value
αI	0.80
βT	0.60
δS	0.08
δK	0.10

The calibrated values produced a stable equilibrium localisation level of approximately 40%, consistent with historical NAAMSA trends.

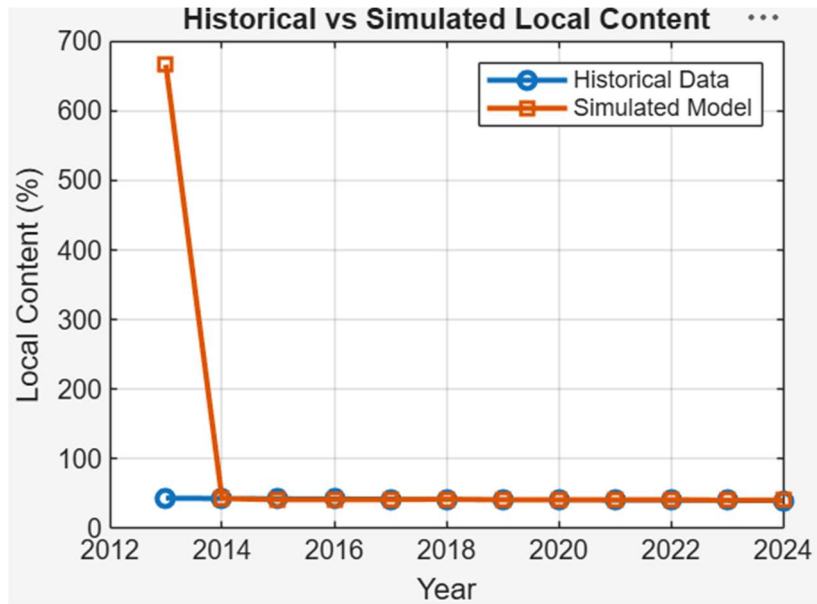
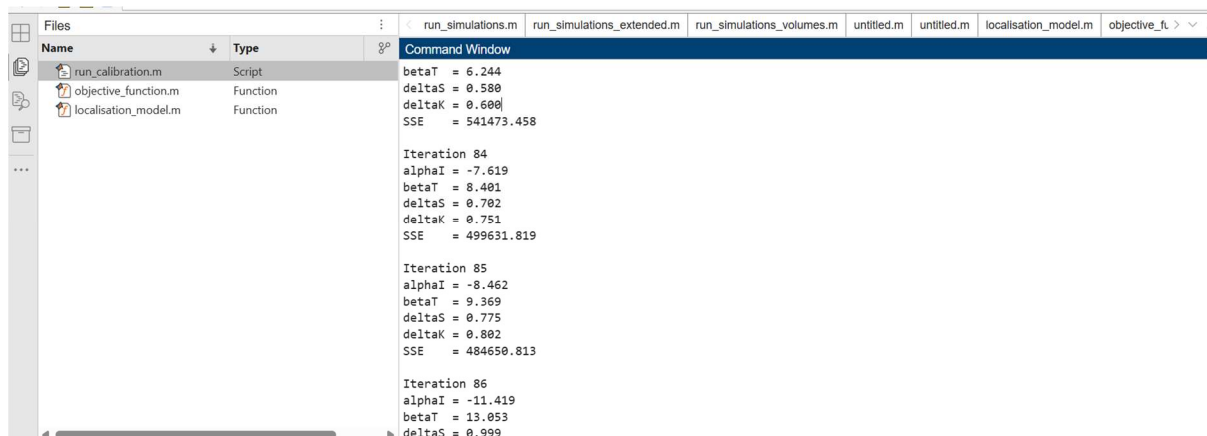


Figure G.1: Historical data trend

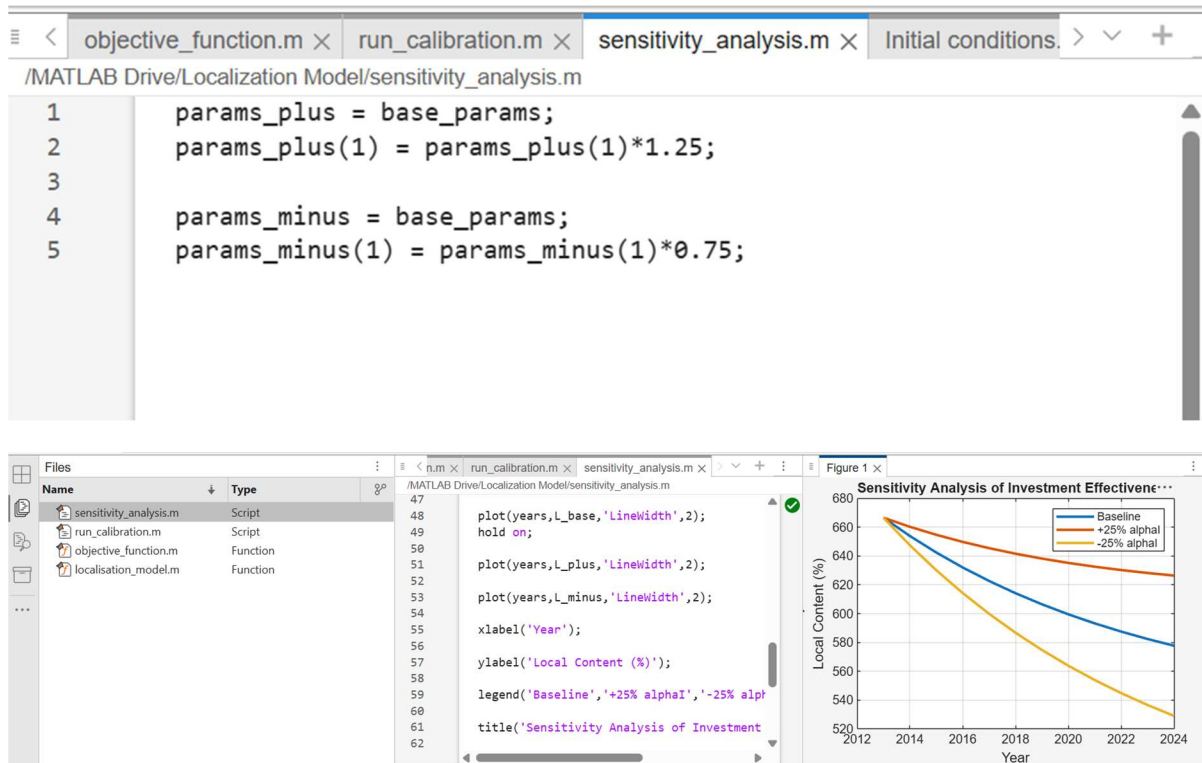
G.6 Iteration Output Evidence

During calibration, MATLAB produced iterative outputs such as:



G.7 Sensitivity Analysis ($\pm 25\%$)

Sensitivity testing was conducted on αI , βT , δS , and δK .



G.8 Validation Tests

Three validation methods were applied:

G.8.1 Historical Fit

Model reproduces ~40% of the localisation level observed in NAAMSA data.

G.8.2 Face Validity

- Investment increases → supplier capacity increases
- Import pressure increases → localisation decreases

G.8.3 Extreme Condition Testing

- High import pressure → decline in $L(t)$
- No decay → saturation of capacity variables

G.9 Summary of MATLAB Implementation

The calibration process in MATLAB involved:

Input	Implementation
Historical data	L_actual
Model equation	Localisation_model.m
Parameters	params vector
Initial conditions	X0
Objective function	SSE minimisation
Optimisation method	fminsearch
Solver	Ode45