

https://dspace.org/

Policy challenges affecting the electric vehicle manufacturing sector in South Africa

Mateko, Freeman Munisi

2024

University of the Witwatersrand, Johannesburg

https://hdl.handle.net/10539/44128

Mateko, Freeman Munisi. (2024). Policy challenges affecting the electric vehicle manufacturing sector in South Africa. [Masters dissertation, University of the Witwatersrand, Johannesburg]. WIReDSpace. https://hdl.handle.net/10539/44128

Downloaded from a DSpace repository. https://dspace.org/

Policy challenges affecting the electric vehicle manufacturing sector in South Africa



Freeman Munisi Mateko

2636446

Supervisor: Murray Cairns

A dissertation submitted to the Faculty of Law, Commerce and Management, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Management.

February 2024

CONTENTS

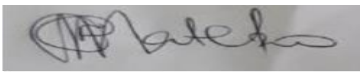
DECLARATION v
ABSTRACT vi
ACKNOWLEDGEMENTS vii
ABBREVIATIONS viii
LIST OF FIGURES x
LIST OF TABLES xi
1.1 INTRODUCTION 1
1.2 BACKGROUND OF THE STUDY 1
1.3 RESEARCH PROBLEM 8
1.4 RESEARCH PURPOSE 9
1.5 RESEARCH AIM AND OBJECTIVES 10
1.5. 1 Primary objectives 10
1.5.2 Research Questions 10
FORMAT OF THE STUDY 10
1.7 CONCLUSION 11
CHAPTER 2: LITERATURE REVIEW 12
2.1 INTRODUCTION 12
2.2 THEORETICAL LITERATURE REVIEW 12
2.2.1 History and Types of EVs 12
2.2.1.1 Types of EVs 13
2.2.2 Policy analysis process at a glance 13
2.3 Evolution of Electric Vehicle Policy in South Africa 15
2.4 OVERVIEW OF ANALYTICAL AND THEORETICAL FRAMEWORKS 16
2.4.1 INNOVATION THEORIES 16
2.4.1.1 Diffusion of Innovation Theory (DIT) 16
2.4.2 Caiazza's framework of public policies for innovation diffusion 18
2.5 EMPIRICAL LITERATURE REVIEW 19
2.5.1 Policy analysis variables 19
2.6 TECHNOLOGY ADOPTION IN GLOBAL NORTH AND GLOBAL SOUTH 20
2.7 EVs aspects in Global South and Global North 21
2.7.1 Global North Perspectives 22

2.8 NEXUS BETWEEN POLICY ANALYSIS, TECHNOLOGY AND EVs 23
2.9 CONCLUSION 25
CHAPTER 3: RESEARCH METHODOLOGY 26
3.1 INTRODUCTION 26
3.2 RESEARCH APPROACH 26
3.3 RESEARCH DESIGN 27
3.4 RESEARCH TOOLS AND THEIR APPLICATION 27
3.5 ADMINISTRATION OF INTERVIEWS 28
3.5.1 Data collection experiences 28
3.6 SAMPLING 29
3.6. 1 Sample Size 29
3.7 PROCESS OF ANALYSIS 31
3.8 LIMITATIONS, FEASIBILITY & POSITIONALITY 32
3.9 ETHICS 33
3.9.2 No harm to participants 33
3.9.3 Seeking permission 33
3.9.4 Confidentiality and anonymity 33
3.10 VALIDITY, RELIABILITY, DEPENDABILITY 34
3.11 CONCLUSION 34
CHAPTER 4: DATA ANALYSIS PRESENTATION 35
4.3.1 Findings from the literature review 38
4.4 FINDINGS FROM POLICY DOCUMENTS 39
4.4.2 Current EVs policy environment 39
4.3.2.1 EVs White paper 39
4.3.2.2 Auto green Paper 41
4.3.2.3 Automotive Production and Development Programme 42
4.3.2.4 South Africa's 2023 Automotive export manual 42
4.3.2.5 The Green Transport Strategy for South Africa (GTS) (2018–2050) 43
4.3.2.6 South Africa's new energy vehicle roadmap 44
4.5 DATA ANALYSIS : INTERVIEWS 45
4.6 THEME EXTRACTION 46
4.6.1 Theme Extraction Based on Interviews 46

4.7 CONCLUSION 56
CHAPTER 5: SUMMARY OF STUDY, CONCLUSION AND POLICY RECOMMENDATIONS 58
5.1 INTRODUCTION 58
5.2 SUMMARY OF STUDY 58
5.3 POLICY RECOMMENDATIONS 59
5.3.1 implementing and evaluating EVs policy 60
5.3.2 Producing battery EVs 60
5.3.3 Government support 60
5.3.4 Research and development 60
5.3.5 Skills Development 60
6.1 CONCLUSION 60
REFERENCE LIST 63
APPENDIX A: INTERVIEW GUIDE 77
APPENDIX B: ETHICAL CLEARANCE 79
APPENDIX C: CONSENT LETTER 80
APPENDIX D: PERMISSION LETTER 81

DECLARATION

I, Freeman Munisi Mateko, certify that this dissertation is solely my own original work, with the help of Murray Cairns' expert professional supervision. It is being submitted to the University of the Witwatersrand in Johannesburg for consideration for the Master of Management degree. It has never before been presented for a degree or examination at another university.

Signed: …  Date: 02/09/2024

ABSTRACT

The evolution of technology has brought many changes to the automotive sector on a global scale. Different economies in the Global South and Global North are making strides to adopt modern technology, such as electric vehicles, which are more efficient than internal combustion engine vehicles. Electric vehicles have zero emission levels and this is crucial for supporting climate change action. Economies that have adopted electric vehicles succeeded due to robust policies and financial incentives for car manufacturers, among other factors. The aim of this research was to explore the extent to which the policy environment facilitates for increased adoption and manufacturing of electric vehicles (EVs) in South Africa. This research is in line with various Sustainable Development Goals (SDGs). It supports SDG 7 by encouraging the use of electric vehicles for cleaner energy, as well as SDG 9 by advocating for automotive sector innovation and infrastructural development. Furthermore, the emphasis on lowering emissions coincides with SDGs 11 and 13 by promoting sustainable urban environments and climate action. In terms of the research methodology, the study was based on qualitative research techniques. Interviews and literature review were used for data collection. Six policy documents were analyzed in this study. The target population for the study were the stakeholders in the South African car manufacturing sector. Purposive sampling was used to select a total of ten participants for the study. Data was analyzed through content and thematic analysis techniques. The results of primary study demonstrated how ambiguous South Africa's current electric vehicle policy environment is. Additionally, it was determined that some factors must be considered to guarantee a seamless switch to electromobility. Developing and executing electric vehicle policies, maintaining a steady supply of energy, lowering import taxes on EV parts, skill development, providing purchase subsidies, and providing production and technological incentives are a few of these elements. In terms of policy recommendations, it was suggested that there is need for timeous implementation of electric vehicles policy, producing battery electric vehicles, promoting research and development on electric vehicles and there is need for increased government support towards car manufacturers in South Africa.

ACKNOWLEDGEMENTS

I want to thank God who enabled me to do this course. To my beautiful wife, Rachael Rukaramato and my lovely daughter, Faith Munyasha Mateko, my uncle Marufu Dhakwa thank you for being my pillar of strength. Hats off to my supervisor Murray Cairns who provided exceptional professional assistance during this arduous journey. I owe a huge thanks to my family at large and friends who supported me as well. God bless. To the all the staff at University of Witwatersrand, thank you for all you invested in me.

ABBREVIATIONS

APDP	Automotive Production and Development Programme
BBBEE	Broad-Based Black Economic Empowerment
BEV	Battery-Electric Vehicle
CFPPID	Caiazza's framework of public policies for innovation diffusion
EVs	Electric Vehicles
ICE	Internal Combustion Cars
ICEVs	Internal-combustion-engine vehicles
DIT	Diffusion of Innovation Theory
DSI	Department of Science and Innovation
DTIC	Department of Trade, Industry, and Competition
EVWP	Electric Vehicle White Paper
FCEV	Fuel Cell Electric Vehicle
GDP	Gross Domestic Product
GTS	Green Transport Strategy for South Africa
HEV	Hybrid Electric Vehicle
IEC	Import -Export Scheme
IT	Information Technology
MERSETA	Manufacturing and engineering Related Service Seta
MIDP	Motor industry Development Programme
NACAM	National Association of Automotive Component and Allied Manufacturers
NAAMSA	National Association of Automobile Manufacturers of South Africa
NUMSA	National Union of Metalworkers of South Africa
MISA	Motor Industry Staff Association
OEMS	Original Equipment Manufacturer
PEVs	Plug in Electric Vehicles
SACAN	South African Climate Action

SDGs	Sustainable Development Goals
SSA	Sub-Saharan African
SETA	Sector Education and Training Authorities
TIA	Technology Innovation Agency
TIPS	Trade and Industrial Policy Strategies
UK	United Kingdom
USA	United States of America
VAT	Value Added Tax

LIST OF FIGURES

Figure 1.1: Public Charging Stations in South Africa 2021……..7

Figure 2.1: Caiazza's general framework of public policies for innovation diffusion……18

Figure 2.2 Conceptual Framework……..24

Figure 3.1: Thematic data analysis steps…….…….. 31s

LIST OF TABLES

Table 2. 1: Evolution of EVs policies in South Africa…….……..15

Table 3. 1: Database and Keywords used……..……27

Table 3. 2: Inclusion and Exclusion Criteria…….……28

Table 3. 3: Summary of sample size……....30

Table 4. 1: List of policy documents…….. 36-37

Table 4. 2: Assigned codes……45

Table 4. 3: Summary of respondent's experience and qualifications…….46

CHAPTER 1: INTRODUCTION AND BACKGROUND OF THE STUDY

1.1 INTRODUCTION

The aim of this research was to explore policy environment for increased adoption of electric vehicles (EVs) in South Africa.This chapter presents the introduction and the background of the study, and the problem statement, research objectives and research questions. The conclusion comes at the end.

1.2 BACKGROUND OF THE STUDY

In this fourth industrial revolution, technological innovation is essential for achieving efficiency in production processes and solving complex challenges (Talbi, 2021). Developed economies are normally at the forefront in as far as technological adoption is concerned relative to developing economies (World Bank, 2022). The success of technological adoption is determined by several factors, such as policy consistency, the existing political environment, and governance frameworks (Hudson, Hunter, & Peckham, 2018). In order to facilitate technological innovation, government's role is to create enabling policy environments that enable innovation.

Globally, all economies are pushing to adopt environmentally friendly ways to reduce adverse climate change effects. This is supported by the Sustainable Development Goals (SDGs), particularly SDG 13 which focuses on climate change (United Nations, 2023). Greenhouse gasses are identified as a key contributor to climate change, and a major contributor to greenhouse gasses globally is the transport sector, which in Europe contributed 740 million metric tons of carbon dioxide in 2021 (Statistisches Bundesamt, 2023). Asia recorded 1.5 billion metric tons of carbon dioxide emissions from the transport sector in 2018 (Tiseo, 2023). The Sub-Saharan African (SSA) transport sector accounts for 24% of global emissions, and the sector is expected to grow, which will increase emissions (African Development Bank, 2022).

Among a number of innovations directed at reducing greenhouse gasses, electric vehicles were developed to help to reduce emissions. While the development of EVs is laudable in and of itself, in order to maximise the benefit of EVs in terms of climate change mitigation, a range of enabling policy interventions must be developed and implemented.

By 2030, 100 million EVs are expected to be deployed globally across all market segments, according to the Paris Declaration on Electro-Mobility and Climate Change (International Energy Agency, 2016: 20). Therefore, efforts are being made globally to maximize the use of EVs. Despite the apparent advantages of utilizing these vehicles, adoption is quite low in Africa (Fadeyi, Ariyawardana, and Aziz, 2022).

There are push factors for the adoption of EVs. Some of these factors are: perceived benefit in terms of climate change, and this is crucial since all economies strive to achieve SDG goal 13 of combating climate change. Other factors are potential profits for industry, as in developed economies there is increased demand for EVs. This enables car manufacturers to tap into that demand and produce EVs for export, which enables them to make profits. As car manufacturers expand their operations, more jobs are created, and this is becoming a benefit to the economy.

However, the desire to own new technology can also drive infrastructure improvements that lead to the employment of information technology (IT) specialists and engineers. On the other hand, the desire to own new technology can also drive up the cost of old technology for those who cannot afford it, especially when it comes to the consumables that go along with it (Brous, Janssen, & Herder, 2020).

South Africa is particularly concerned about the transition to electromobility since cars account for around 12% of its exports to the European Union (Chege, 2020), and because a ban on internal-combustion-engine vehicles (IC EVs) will be effected in 2030 by the EU (Burch & Gilchrist (2020). Due to a lack of infrastructure, energy challenges, and expensive technological costs, the South African car manufacturing sector has been hesitant to implement this technology (Razi & Dincer, 2022).

The country's major manufacturing industry is based on the production of vehicles and automotive components (Department of Trade, Industry and Competition, 2020). In manufacturing output for the year 2020, it made up 18.7% of the GDP. In South Africa, the sector makes up about 5% of the Gross Domestic Product (GDP) and it employs more than 117 000 workers (Le Roux, 2023; National Association of Automobile Manufacturers of South Africa, 2023). Some of the major players in the South African automobile sector are: Toyota, South African Motor Corporation, Daimler -Chrysler, Ford, Landrover, Volswagen, Nissan and BMW (Hartzeberg & Muradzikwa,

2002). These players have shown interest in the new technology of EVs and some are already producing them, for example Toyota produces the Toyota Hybrid cross and Daimler Chrsyler produces the Mercedes-Benz c class.

South Africa is going through a just transition process where it aims to achieve a low-carbon economy; however, the pace of progress is very slow and the country is still using coal and other energy sources that increase emissions (Connoly, 2022). The just energy transition centers on how South Africa's energy sector is changing as the nation moves away from coal and toward greener energy sources (Presidential Climate Commission, 2023; Winkler et al., 2023). This implies that the main aim of the just transition process is to achieve an economy with low levels of emissions. The process should also lead to job creation, social justice, and poverty reduction (Presidential Climate Commission, 2023).

Just transition therefore has long-term goals as well, especially combating climate change, which is a sustainable development goal (United Nations, 2023). This transition is supported by the policy called Just Energy Transition Investment Plan (Presidency of the Republic of South Africa, 2023). In short, this policy aims to create new jobs, attract investment, achieve energy security, and create a climate-resilient economy. The just transition process in South Africa has policy implications because different stakeholders, such as Eskom and car manufacturers, need to work collaboratively to ensure that low emission levels are achieved.

Green industrialization can be a pathway to achieving a just transition, and other best practices such as reducing effects of climate change. Green industrialization entails reducing emissions, promoting economic recovery and lessening high levels of poverty (Luken, 2019). EVs are deemed environmentally friendly because they do not produce emissions, however there are some emission from the production of EV components such as batteries (Lachvajderová & Kádárová, 2020). It is important to note that there is need for an enabling environment to ensure that the transition is a success.

EVs are a result of technological innovation, and they are regarded as environmentally friendly because of their low levels of pollution (Bienvenido-Huertas, Sánchez-García, Rubio-Bellido, & Marín-García, 2021). EVs were first reported in South Africa in 1970 but the sector did not grow until it was revived in 2013 (Electric Vehicle Industry Association, 2016; Liu, Kong, Liu, Peng &

Wang, 2015; Tongwane & Moeletsi, 2021). EVs are very useful as far as green industrialization is concerned, on a broader scale.

This study is situated in the political economy because there are a number of stakeholders in the car manufacturing sector that are involved in and are impacted by EV policy issues, as will be discussed in this study. The study is therefore interested in the general policy environment grounded in political economy issues.

However, the research will not look at political economy issues in detail but a brief overview of these aspects will be covered in the study. The scope of the study remains solely on exploring the policy environment for increased adoption of EVs in South Africa. In terms of power dynamics, the South African government does not appear to be in a very strong position because, starting in 2021, it made a commitment to develop a white paper on EVs in 90 days, but, despite the stakeholders' best efforts, the document was only released in December 2023. One can presume that a white policy document could have been published earlier than 2023 if these stakeholders had more authority. However, the government has been delaying publishing the white paper since 2021, which means that its power is weakening in the face of technology development and the market push for EVs, which will overtake the government, potentially resulting in another under-regulated industrial sector.

There are diverse stakeholders who have interest in EVs and they include government departments such as the Department of Trade, Industry, and Competition (DTIC), the community, trade unions, and car manufacturers (Bronkhorst, Steyn & Stiglign, 2013). These stakeholders have published policy documents for EVs. The South African government, through the DTIC, crafted the Auto Green Paper on the Advancement of New Energy Vehicles. NAAMSA also published documents on EVs. This research will analyse different policy documents published on the subject matter.

Government support is necessary for the increased adoption of EVs. In developed economies, for example in Norway, the government offers zero Value Added Tax charges on EVs and this helps to support increased adoption of EVs (European Commission, 2023). This makes the EVs affordable to some extent as there is no VAT charged. This has encouraged production of more EVs as well as increased employment creation (Le Roux, 2023). To add more, China is a leading supplier of EVs and high sales of its EVs generate foreign currency and also improves the country’s gross domestic product (GDP) (Sebastaian, 2021). These benefits may also accrue to South Africa

if there is the development of the much-needed technology for the manufacture of EVs for the international market. In the case of South Africa, more revenue may be earned if EVs are produced for export. This is so since local demand is still very low and not many people have the financial resources to purchase EVs but the export market is booming and there is increased demand for EVs (Hertzke, Muller, Schenk & Wu, 2018).

Research shows that South Africans with low to middle incomes who can afford cars typically spend between R150 000 and R350 000 ($10 000 and $23 333 at R15/USD), which is significantly less than the price of the cheapest new electric car available, which starts at R694 600 (or $46 306 at R15/USD for the Mini Cooper SE3 as of July 2022), almost twice the upper limit (Chege, 2021; Nel & Inglesi-Lotz, 2022).

Over 440 000 cars were illegally imported into South Africa in 2022, and in 2014 a total of 153900 secondhand cars were imported from Japan (Furlonger, 2022). This shows that some consumers still prefer internal combustion engine (ICE) cars, and this may be attributed to the fact that there is insufficient demand for EVs and people opt for ICE which they can afford. Due to low levels of income, some consumers in South Africa cannot afford pre-owned cars, and a few may opt for EVs, which are relatively expensive.

The production of EVs enables employment creation especially for chemical, electronic and electrical materials, mechanical engineers and technicians, software developers, industrial designers (TC Global, 2023). However, there are possible job losses as well for people who are employed directly or indirectly in the automobile sector. To add more, those involved in indirect manufacturing of components may be jobless since EVs may require completely different components which are not used in ICE. If EV sales reached two-thirds of the market in the USA, 117,000 net manufacturing jobs would be lost, according to predictions (Sherk & Sarget, 2023). Parts makers would be responsible for around two-thirds of those employment losses.

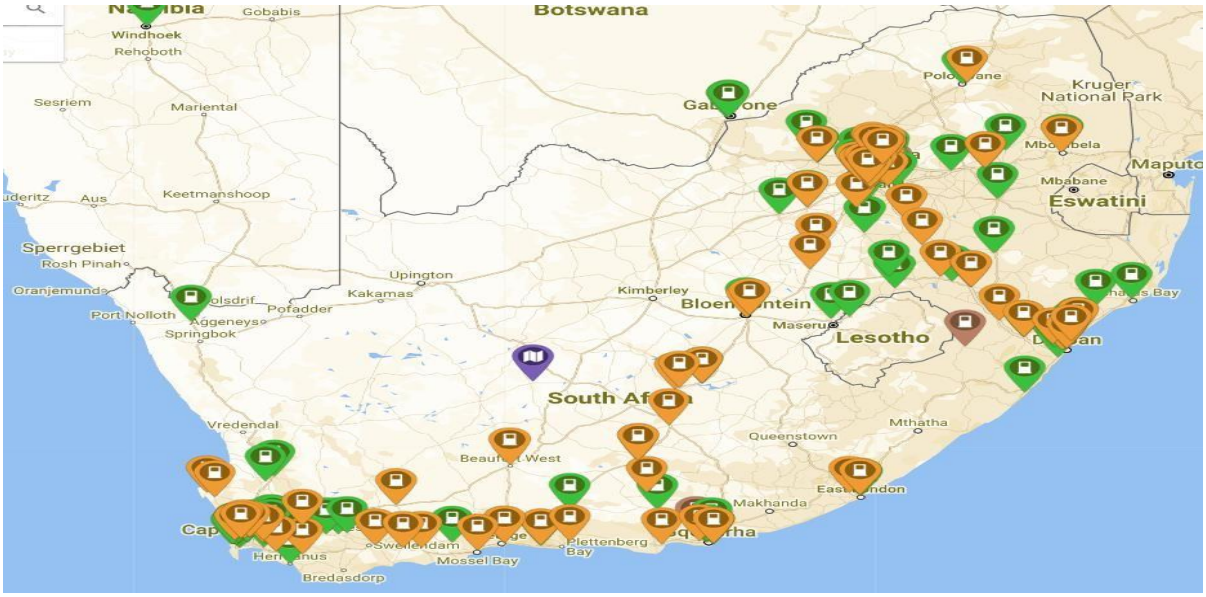
In the United States of America in terms of re-skilling some companies for example Ford has been retraining its workers on the production of EVs (Rezvani, 2022). A few training initiatives have been started in South Africa to add the necessary EV skills. Several organizations in South Africa have started EV training programs, including the Porsche Aftersales Vocational Education Training Center, Retail Motor Industry Organization, Automotive Remanufacturers' Association, and the Vehicle Testing Association (Le Roux, 2023; Malinga, 2022).

The Automotive Production and Development Programme (APDP) outlines that EVs imported components attract a 20% duty (Department of Trade, Industry, and Competition, 2022). This duty may be too high given that EV technology is still new, which may discourage the supply of EVs to the local market. Additionally, the average cost of an EV in South Africa is around R800,000, whereas the cost of a regular vehicle is over R300,000 (Biyase, 2023). This demonstrates that the price of an EV is over 37% higher than a conventional one. By 2030, the South African government wants one million EVs on the roads (Biyase, 2030). The specified target must, however, be supported by enabling policy frameworks; otherwise, it remains a pipe dream.

Researchers pointed out that current legislation creates a market barrier as far as EVs are concerned (Chege, 2021; Nel & Inglesi-Lotz, 2022). The Auto Green Paper outlines that South Africa has limited EV charging stations and the country charges 25% import taxes on EVs, which limits demand and supply of EVs and may not be sustainable for the economy in the long run (Department of Trade, Industry and Competition, 2021).

Europe is a lucrative export market for cars, and South Africa has been earning over $50 billion since 2017 through automotive industry exports (Caboz, 2019). Europe, however, has announced a ban on all petrol and diesel cars from 2030, which threatens South African exports unless there is a move to EVs (Department of Trade, Industry, and Competition, 2021; Huitema, 2023). South Africa needs to have good infrastructure for the production of EVs as well as sufficient charging points. The figure below shows the charging stations in South Africa.

Figure 4.1: Public Charging Stations in South Africa 2021



Source: Department of Trade, Industry and Competition (2023).

Key: Green dots= slow chargers; Orange dots = fast chargers

Figure 1.1 shows that there is uneven distribution of public charging stations in South Africa. Cape Town has faster and slow charging stations while the rest of South Africa has slow charging stations. Other areas such as Kimberly, Mthatha do not have charging stations. This limit demand for EVs domestically because consumers require charging infrastructure.

Good infrastructure, and EVS charging points should be complemented with an enabling policy environment that should allow the EVs producers to operate competitively. Since EVs need a consistent power source, South Africa's extreme energy shortages could have a negative effect on the country's increased EV adoption (Hanto, Schroth, Krawielicki, Oei, & Burton, 2022). Additionally, government support, human capital, EVs charging infrastructure and demand for EVs is essential for the increased adoption of EVs. Thus, there is a need to analyze the EV policies in place, determine their shortcomings, and present possible solutions that will ensure that stakeholders in the car manufacturing sector benefit fully.

This current research problem to be tackled in this study can be explained through the theoretical lens of Diffusion of Innovation Theory. The theory outlines how technology is spread in an

economy from innovators, early adopters, early majority and late majority (Dearing & Cox, 2018). From a policy-level perspective, prevailing conditions in the South African economy may have an adverse effect on the increased adoption of EVs. The study will also use the Caiazza's framework of public policies for innovation diffusion to support the discussion.

The study will therefore take a policy analysis approach, focusing on the manufacture and increased adoption of EVs in South Africa. South Africa was chosen because it is an economy with a better developed economy relative to other economies on the African continent. This research will explore the South African policy landscape to identify the challenges that need to be resolved in order to hasten the adoption of EVs for the benefit of diverse stakeholders in the car manufacturing industry. Thus, this study will shed more light on this aspect through the lens of a policy analysis approach.

1.3 RESEARCH PROBLEM

EVs are an increasingly emerging technology that is being adopted globally. This trend has the potential to adversely affect South Africa's international trade in the automotive sector if it is unable to respond to the changing needs of the international market. At the same time, South Africa must reduce its carbon emissions which are substantively contributed to by ICEs in the transport sector. In order to do this, the country has to actively move towards zero emission transport solutions, such as are represented by EVs. Thus addressing climate change which is SDG 13, potential loss of EU export market of cars are push factors for South Africa to have an increased adoption of EVs.

Researchers have examined the use of EVs globally and in Africa, but there remains a knowledge gap as far as the analysis of policies for increased adoption of EV, especially in the South African context (Ayetor et al., 2021; Capuder, Sprcic, Pandzirc & Zoricic, 2020; Chachdi, Rahmouni, & Aniba, 2017; Hidayatno, Natalia, & Rahman, 2020; Tongwane & Moeletsi, 2021). This research will analyze the policy climate in South Africa with reference to the production and increased adoption of EVs. This is important because the changes happening in the automotive sector should ensure that South Africa remain competitive in exportation of cars and the adverse effects of jobs losses need to be minimized. The transition to EVs must happen but this must be carefully implemented with the aid of robust policy that will minimize the adverse effects.

In the South African context, a number of challenges such as lack of regular energy supply, few charging stations, price of EVs, and affordability of EVs have an impact on the increased adoption of EVs. Policy should therefore be implemented to provide solutions to the above challenges for increased adoption of EVs locally, though this will be a secondary focus. The primary focus should be an EV policy that allows the production of EVs for the international market, which will have a knock-on effect in terms of the local market. This is supported by the fact that there is high demand for EVs internationally, and South Africa should tap into that market (Tongwane, 2021).

On the other hand, in South Africa, there is still low demand for EVs relative to the international market. Also, since South Africa exports to the EU and UK, the production of EVs for these markets is very important for foreign currency generation. If South Africa fails to have an EV policy on time that supports the production of EVs for the export market, it will lose revenue because the EU and UK will be banning importation of ICE cars by 2030. Therefore, much focus should be biased towards the export market, and an EV policy is needed for that.

Thus policy plays a key role in the just transition of the economy and there is need for an EV policy to be well crafted and implemented timeously as the economy may lose its export market in Europe by 2030 if there is no increased production of EVs. It is therefore a delicate position for South Africa to balance increased adoption of EVs, maintain its EU export base, ensure that there is an enabling environment for EVs and to mitigate adverse effects of job losses in the car manufacturing sector.

1.4 RESEARCH PURPOSE

The purpose of the research is to explore the extent to which the policy environment facilitates the increased adoption and manufacturing of EVs in South Africa. The research uses the Diffusion of innovation technology lens. The research will also use Caiazza's framework of public policies for innovation diffusion.

Policy plays a key role since the adoption of EVs can bring diverse effects to the stakeholders in the South African car manufacturing sector and the labour industry as well. Policy should aid to reduce negative effects and maximise good effects and this should benefit different stakeholders who will be impacted by EVs increased adoption.

1.5 RESEARCH AIM AND OBJECTIVES

The main aim of the study is to explore the extent to which the policy environment facilitates increased adoption and manufacturing of EVs in South Africa.

1.5. 1 Primary objectives

To achieve the main objective of this study, the following research objectives are going to be used on this research.

- To explore the current policy environment for increased adoption of EVs in South Africa.
- To determine how policy can be developed to enable car manufacturers and related stakeholders to have a smooth transition to the use of EVs.
- To suggest possible policy recommendations on increased adoption of EVs in South Africa.

1.5.2 Research Questions

- What is the current policy environment for increased adoption of EVs in South Africa?
- How policy can be developed to enable car manufacturers and related stakeholders to have a smooth transition to the use of EVs?
- What possible policy recommendations can be suggested for increased adoption of EVs in South Africa?

FORMAT OF THE STUDY

The research will comprise of 5 chapters. The breakdown of these chapters is presented below.

Chapter 1 Introduction and background of the study: This chapter presents the research background, the problem statement, objectives and questions.

Chapter 2 Literature Review: the focus of this chapter will be on theories related to EV, variables relating to policy analysis, technology adoption literature on Global South and Global North as well as review of related literature on the subject matter.

Chapter 3: Research methodology: this chapter presents the methodology to be used in the study. The data to be used, sampling techniques, ethics and other aspects will be discussed in this chapter.

Chapter 4: Results and presentation and discussion of findings: This chapter presents the results of the study in reference to the research objectives outlined in the study.

Chapter 5: Conclusions and policy recommendations: This chapter presents the conclusions drawn from the study and recommendations arrived at basing on the research findings.

1.7 CONCLUSION

This chapter sought to present the introduction and the background of the study. The study uses a policy analysis technique and focuses on EV production and rising EV usage in South Africa. As was evident in Chapter 1, there are several obstacles affecting the growing acceptance of EVs in South Africa, including a deficiency of consistent electricity supply, a shortage of charging stations, and the high cost of EVs. Furthermore, it was shown that EV adoption can be increased if South Africa is to keep its export market share from the EU and the UK. From the discussion, it was realized that the policy environment has a bearing on the increased adoption of EVs in South Africa. The study is significant because it aims to reduce the negative consequences of employment losses while also ensuring that South Africa maintains its competitiveness in the automobile export market. The next chapter, which is chapter 2, will be the literature review.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter seeks to present the literature review, and it will be divided into two major segments. The first segment will be based on a theoretical literature review. The following aspects will be discussed: EVs at a glance, policy analysis process at a glance, practical implementation steps of policy analysis in relation to EVs, Caiazza's framework of public policies for innovation diffusion and the Diffusion of Innovation Theory (DIT). The study will be centred on the Diffusion of Innovation Theory. The second segment will address the empirical aspects that relate to EVs. This discussion will be centered on policy analysis variables, technology adoption in the global north and south, EVs aspects in the Global South and North, and the nexus between policy analysis, technology, and EVs. The conclusion will come at the end of the chapter.

2.2 THEORETICAL LITERATURE REVIEW

2.2.1 History and Types of EVs

The development of EVs can be split into various periods. The first period is the early pioneers of electric mobility (1830–1880), and the second period is a transition to motorized transport (1880–1914) (Van Barlingen & Simpson, 2021). The third phase was the rise of the internal combustion engine (1914–1970), and the following phases took place after: the return of EVs (1970–2003), the electric revolution (2003–2020), and the tipping point (2003–2020). The last stage is the period 2021 and beyond (Van Barlingen & Simpson, 2021). The tipping point is where issues such as climate change, clean transport and use of renewable energy comes into play.

Finally, the evolution of electric vehicles represents a complex interplay of technology advancement, societal demands, and environmental concerns. From the early pioneers of electric mobility to the dominance of the internal combustion engine, each era has affected the course of EV development. The current tipping point emphasizes the importance of tackling climate change and moving to more sustainable transportation systems. As we go beyond 2021, the emphasis on innovation, infrastructure expansion, and renewable energy integration will be critical in defining the future of electric mobility. This continuous shift not only provides a road to cleaner transportation, but it also represents an important chance to reshape our relationship with energy and the environment for future generations.

2.2.1.1 Types of EVs

Battery EVs and plug-in hybrid EVs are the two primary categories of EVs (IRENA 2017: 8). According to Un-Noor, Padmanabas, Mihet-Poppa, Mollah, and Hossain 2017: 3, EVs can be divided into four further categories, and these are discussed below:

Plug in EVs (PEV) - It is also known as a battery-electric vehicle, or BEV and it uses power from the battery and must be plugged for recharging United States of America (USA), Department of Energy (Department of Energy, 2014: 17).

Hybrid Electric Vehicle (HEV) - This car has no capability to charge its batteries using an external energy source and can operate solely on internal combustion engine power (ICE), solely on batteries, or a combination of the two (Eberhard & Tarpenning 2006: 2; Momoh & Omoigui 2009: 1288).

Plug-In Hybrid Electric Vehicle (PHEV)- A plug-in hybrid electric vehicle (PHEV) is a HEV that has the capacity to refuel its energy storage system using power from an external energy source (Department of Energy 2014: 17).

Fuel Cell Electric Vehicle (FCEV): FCEVs are only propelled by electric motors; however, they also use hydrogen as a fuel source to produce electricity (Tanç, Arat, Baltacıoğlu, and Aydın 2019: 10121). In this research the term EVs refers to all the four types of EVs that were discussed under this section

2.2.2 Policy analysis process at a glance

Policies can be designed and implemented using different steps, but in this research, the focus will be on a 5-step process. The 5-step process comprises: agenda setting, formulation stage, adoption stage, implementation stage, evaluation, and termination phase (Tossun & Treib, 2018). In particular, the agenda for EV was set by the South African government and other stakeholders in the car manufacturing sector, hence the focus of the study will be on adoption and implementation stage. This is also justified that the government finally published the EVs white paper in December 2023.

Policy analysis can be done from a prospective perspective, where the focus is on analyzing the possible outcomes of a proposed policy (Patton, Sawicki, & Clarke, 2017). Research also shows that policy analysis can be prescriptive, where the main aim is to provide recommendations that will have certain impacts (Patton et al., 2017). Schober (2017) said that prescriptive policy analysis is useful and applicable when there is a need to design a new policy or to suggest proposals for a policy. Marume, Mutongi, Jubenkanda, and Chikasha (2016) outlined that prescriptive policy analysis is divided into a rationale model, an incremental model, and a mixed scanning model. In short, a rationale model can be applied if there is knowledge of what the community prefers in terms of policy; an incremental model is applicable if there is a need to address the shortcomings of the current policies; and lastly, a mixed model can be applied to address the limitations of the incremental and rational models (Marume et al., 2016).

The study will take a prescriptive policy analysis approach that will be incremental in nature because the focus will be on providing recommendations for the design of an EV policy that will ensure that South African car manufacturers produce more EVs for the export market while local demand increases gradually. This is important because South Africa gains more revenue from car exports to the United Kingdom and the European Union (Mashilo, 2019; Posada, 2017). The local demand for EVs is still low in South Africa, so South African car manufacturers should not lose the international market; hence, this study will provide a prescriptive policy approach to suggest recommendations on EV policy for increased adoption of EVs for international market first and the domestic market too.

The prescriptive policy approach will be incremental in nature because a number of policies exist in the South African automotive sector. For example, the Auto Green Paper, the Automotive Production and Development Programme, the Green Transport Strategy for South Africa, and the 2023 Automotive Export Manual. However, all these policies have shortcomings in that they do not adequately show a clear roadmap to be followed for increased adoption of EVs for the export market first and for local consumption. Thus, the current study will use a prescriptive policy approach and an incremental technique to suggest recommendations for the development of an EV policy for increased adoption of EVs.

2.3 Evolution of Electric Vehicle Policy in South Africa

A number of policies were introduced in the South African automotive sector between 1961 to date. These are presented in the table below.

Table 2. 2: Evolution of EVs policies in South Africa

Period	Name of Automotive Policy	Brief description
June 1961 -February 1989	Phase 1-V Local content programme	Policy aimed to promote local production of vehicles.
March 1989- August 1995	Phase V1- Structural adjustment programme	Policy led to implementation of import -export scheme (IEC).
September 1995- June 2000	Motor industry Development Programme (MIDP) phase 1	Local content regulation were removed, exports credits were increased. Incentives for small vehicles were introduced. Tariffs were phase remained in place up to 2007.
June 2000- 2012	MIDP phase 2	Productive asset allowance introduce, Incentives for small vehicles were removed, duty free allowance was removed.
January 2013 – date	Automotive Production and Development Programme	Policy offers production incentives to the car manufacturers.
December 2023- date	EVs policy	Policy outlines different incentives and subsidies and other non-financial support targeted at production of EVs in South Africa.

Source: Simon & Damoense (2004)

From a policy standpoint, a number of local content initiatives, extremely high tariff protection, and a move away from import substitution and toward export orientation have propelled the South African automobile sector. The local content program was the first policy implemented in the South African automotive sector between 1961 and 1989. The policy enabled the production of 13 OEMs to fully operate in South Africa, resulting in the employment of over 15800 people as well as the sale of over 300,000 cars (Lamprecht, Rudansky-Kloppers, & Strydom, 2011).

This policy was replaced by a structural adjustment program. The structural adjustment program was implemented and was in use for 6 years. The policy helped stimulate exports and reduce imports. This policy was replaced by the MIDP. Tariffs were lowered by the MIDP, which also strongly encouraged exports, and as a result, exports increased quickly, but the industry is still susceptible to dwindling funding (Barnes & Black, 2014). The Automotive Production and Development Programme replaced the MIDP, and it is still operational. One important thing to note is that from 1961 to 2013, policies were implemented in a successive manner.

2.4 OVERVIEW OF ANALYTICAL AND THEORETICAL FRAMEWORKS

There are a number of analytical and theoretical frameworks that can be used in this research. These are political economy, policy analysis, diffusion of innovation theory, and Caiazza's framework of public policies for innovation diffusion. This study will be centered on the diffusion of innovation theory and Caiazza's framework of public policies for innovation diffusion only. These are the only two dominant theories to be applied in this research.

2.4.1 INNOVATION THEORIES

This section seeks to present a discussion of the two major theories used in the study and these are the Diffusion of Innovation Theory and the Caiazza's framework of public policies for innovation diffusion (CFPPID).

2.4.1.1 Diffusion of Innovation Theory (DIT)

The theory was developed by Rogers in 1962 (Rogers, 1962). According to Acikgoz, Elwalda, and De Oliveira (2023), the DIT explains how new scientific, technological, and other innovations spread between civilizations and cultures before becoming widely employed. The idea clarifies how and why novel ideas and approaches proliferate over possibly protracted periods of time (Menzli, Smirani, Boulahia, & Hadjouni, 2022). This theory also explains how quickly technology spreads and, in large part, how innovations are conveyed to various societal segments and the subjective perceptions attached to them (Fahad & Shahid, 2022).

The theory outlines that diverse techniques can be used to promote innovation. DIT further outlines that there are 5 categories of adopters of technology: innovators, early adopters, early majority, late majority, and laggards (Rogers, 1962). Innovators are people who try new

technology first and are risk-takers. On the other hand, early adopters accept new technologies after they learn from the innovators (García-Avilés, 2020; Rogers, 1962). The early majority of people accept new technology, provided they have evidence that it is beneficial. Lately, the majority are extremely risk-averse and accept new technology after it saturates the market. Finally, laggards are skeptical about accepting and adopting new technology (Dearing & Cox, 2018; Rogers, 1962).

The DIT outlines that the drivers of innovation are relative advantage, compatibility, complexity, triability, and observability (Fahad & Shahid, 2022; Rogers, 1962). On relative advantage, the DIT states that innovation should bring more benefits to the users and producers, and this can be in terms of profit, better social status, or other aspects that improve life. In the context of this research, previous discussion has shown that EVs bring a number of advantages, and these benefits can fully materialize in South Africa if there is increased adoption of EVs supported by an EVs policy.

In terms of compatibility, the DIT theory outlines that innovation should meet the needs and expectations of consumers. On complexity, the theory states that new innovations that are difficult to comprehend may not be easily accepted and adopted by people, and a high degree of complexity becomes a barrier (Menzli et al., 2022). Triability implies the extent to which new technology can be tried on the market. In relation to this study, EVs have been on the market since 2013, but there is a slow uptake (Tongwane & Moeletsi, 2021). Finally, on observability, the DIT theory states that the results from innovation should be visible so that others can be inspired to adopt the new technology.

Research points out that developed economies, for example, Norway, Sweden, Netherlands, China, and Iceland, have been at the forefront as far as the usage of EVs are concerned (Remme & Jackson, 2023; Mangipinto et al., 2022; Martins, Henriques, Figueira, Silva, & Costa, 2023). In the context of this theory, such economies can be classified as innovators because they pioneered the development of EVs. South Africa has also adopted the technology of producing EVs, though growth is still limited (Brönner, Ampofo, Fries, & Lienkamp, 2020).

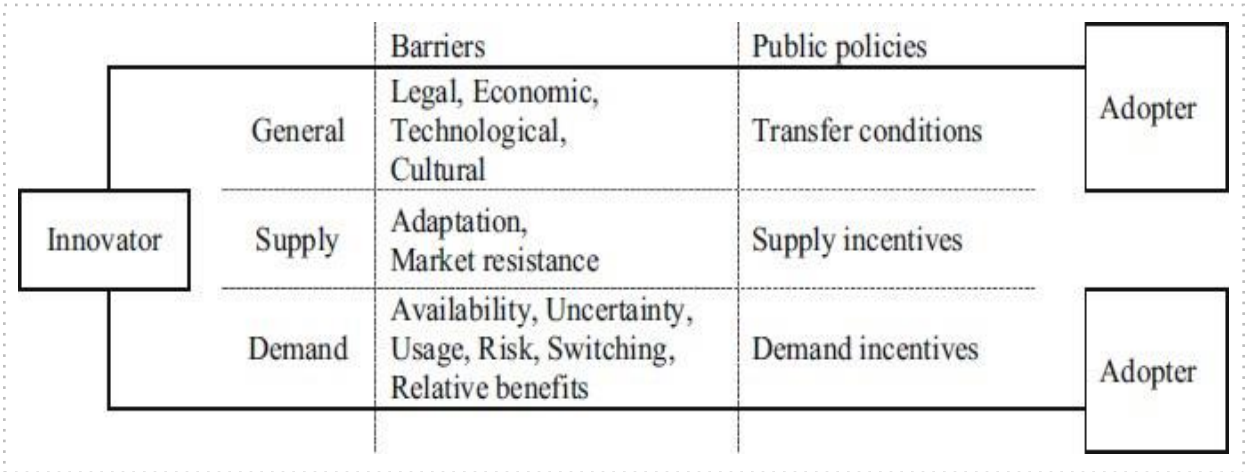
It can be pointed out that increased diffusion of EV technology, especially in South Africa, will be possible if the diverse challenges affecting increased adoption of EVs, as discussed previously, are

dealt with. Thus, EV technology can fully diffuse, provided certain policy challenges have been addressed. This theory is germane to this study because unless a policy analysis is done to explore the current policy environment for EVs, the rate of technological adoption may remain low in South Africa and this may lead to revenue loss as other economies may tap into the booming international market for EVs.

2.4.2 Caiazza's framework of public policies for innovation diffusion

The ability of innovators to force their innovations onto the market (supply-side) and users' capacity to adopt new technology (demand-side) are the two main factors that influence the diffusion of innovation, according to Caiazza (2015: 1408) (citing Rogers 2003; Zahra & Nielsen 2002; and Hall and Khan 2003). Rogers (2003, cited in Caiazza 2015: 1407) described innovation diffusion and adoption as "the spread of new products, values, policies, or processes beyond the locus of their original success." The theoretical framework essentially argues that there cannot be economic success at the corporate or national levels without the diffusion of innovations. The framework also highlights how crucial it is for policymakers to pursue and implement a wide range of legislative initiatives in order to encourage or hasten the dissemination of innovation. Figure 2.1 below shows Caiazza's framework of public policies for innovation diffusion (CFPPID) which is relevant to this study because it explains the interlinkages between public policy and innovation.

Figure 5.1: Caiazza's general framework of public policies for innovation diffusion



Source: Caiazza (2015: 1410)

Figure 2.1 shows that legal, economic, technological and cultural barriers can limit innovation, and these are regarded as general or institutional factors. In South Africa, the lack of EVs policy was an institutional barrier that limited increased adoption of EVs from 2021 -2023. On the supply side, resistance and adaption are the major factors (Caiazza 2015: Mohubedu, 2021). To address such supply side issues, supply incentives must be offered. These incentives must be stipulated in public policies.

This research is premised on exploring the extent to which the policy environment facilitates for increased adoption and manufacturing of EVs in South Africa. On the demand side, availability, uncertainty, usage, risk benefits and switching are the major factors that affect innovation. The demand side challenges on adoption of technology can be solved by offering demand side incentives. In South Africa there are no demand side incentives offered for increased adoption of EVs. Caiazza (2015) further outlined that policy makers play a role by implementing policies that are innovation related. According to Caiazza (2015: 1411), in order to promote the interests of the entire economic system, governments should act as catalysts in the diffusion of innovation by defining policies that set guidelines for interactions between innovators, adopters, and other stakeholders. In the current era, the automobile sector of South Africa has been waiting for the government to develop the EVs policy from 2021 when the Autogreen paper was published.

2.5 EMPIRICAL LITERATURE REVIEW

This literature will cover three essential segments. The first discussion is going to be based on a review of the policy analysis literature. Afterwards, a discussion on technology adoption literature and then EV literature will be discussed. This literature will be reviewed from the Global North and South perspectives. The less developed economies such as Somalia, Zimbabwe, Sudan, Ethiopia and others are generally referred to as the "Global South" (Sovacool, 2023). While the Global North includes the highly developed, wealthy, and powerful economies such as Netherlands, Germany and others (Odeh, 2010).

2.5.1 Policy analysis variables

Policy analysis plays a key role in uncovering the challenges and strengths of a policy and providing possible solutions. It also serves the role of determining the best action to take, which yields more benefits for different stakeholders. To carry out policy analysis, one may need to look

at the different policy variables. Patton et al. (2017) pointed out that policy analysis is crucial to ensuring that the designed policy meets the required targets.

Policies are designed to meet diverse goals, and different policy documents will be analyzed in this study. The published documents on EVs contains essential variables that are useful for analysis in this study. This analysis will take into account the following factors or variables: financial cost, people's demand, technological infrastructure, equipment requirements, facilities, and institutional frameworks. These parameters were adopted from Patton, Sawaicki & Clarke, (2012).

In terms of people's demands, the focus will be on checking whether there is effective demand for EVs as compared to conventional ones. With regards to technological infrastructure, research shows that EVs require modern technology, and there is a need to check if the current policy in place offers enough support from a technological point of view (Sousa et al., 2023). Additionally, government structures are essential on issues related to tax and import duty.

2.6 TECHNOLOGY ADOPTION IN GLOBAL NORTH AND GLOBAL SOUTH

Government support is an essential ingredient for technological adoption. This is so since government plays a key role at the national level, and the various ministries and departments have a bearing on the success or failure of technological adoption both in the Global North and South economies. As said, Jenny, Springel, & Gopal (2018) concur with the above assertion and go on to point out that government support in the form of incentives proved fruitful for increased adoption of EV technology in the USA. Yan (2018) also agrees with the above sentiments and points out that in Japan, an increase in tax incentives offered by the government led to a high sales volume of battery-electric automobiles. Thus, South Africa may need to offer incentives to enhance increased adoption of EVs.

Financial resources are also crucial to supporting technological adoption. However, in the Global South, some governments tend to commit limited financial resources, which limits technological adoption. On the contrary, some of the economies in the Global North devote more financial resources to supporting technological initiatives that positively impact the economy. Palmer, Tate, Wadud, and Nellthorp (2018) agree with the above assertion, and their research on the costs of ownership of EVs in the United Kingdom (UK), USA, and Japan proved that Battery EVs have

achieved cost parity in the UK, California, and Texas, but Plug-in Hybrid EVs, which do not get as much financial support, have not been able to do the same (Palmer, 2018). Most of these studies find that incentives help to hasten the adoption of EVs in the US, with rebates demonstrating to be more successful at doing so than income tax credits, aligning with consumers' preference for present usage over future consumption (they have a high time discounting factor).

Finally, a lack of supportive institutional frameworks hinders technological development and adoption, especially in the Global South. This is supported by Amankwah-Amoah's (2019) research on the technological development challenges in Africa. The study identified a number of factors that impede the development of sound policies, such as weak regulatory enforcement frameworks, a lack of easily accessible financial credit, and restricted banking services, all of which have accelerated the development of new technologies (Amankwah-Amoah, 2019). These research findings are on par with the views of Ruch (2020), who posited that some emerging economies lack financial resources, which are key to supporting policy initiatives. Research also shows that poor government policies and a lack of training are huge stumbling blocks as far as technological policies are concerned in emerging economies (Ejiaku, 2014).

2.7 EVs aspects in Global South and Global North

The success of EVs in the Global South requires a holistic approach where diverse stakeholders must collaborate to ensure that all issues that relate to EVs are clearly defined. Failure to incorporate essential elements or key enablers will limit the increased adoption of EVs. Tongwane & Moeletsi, (2021) support the above sentiments in their research on EVs in South Africa. Research indicates that in 2040, a decarbonized power system and a rise in electrified vehicles will cause the mitigating impact of EVs in South Africa to start rising (Tongwane & Moeletsi, 2021). The research ignored the status of the policy climate that can adversely affect car manufacturers and related stakeholders. Thus, this research gap will be closed by the current study.

For increased adoption of EVs, it is essential to look at the financial aspects and demand in an economy. If in the market there is less demand and EVs are more costly than non-EVs, it may take long for car manufacturers to record high sales of EVs. This also applies to accessing lines of credit for purchasing EVs. Chachdi, Rahmouni, & Aniba, (2017) support the above views in their research on socio-economic uses of EVs in Morocco. Research findings indicated that EVs were

expensive and the respondents viewed EVs as environmentally friendly (Chachdi et al., 2017). It was realised that lack of charging terminals were an obstacle in the adoption of EVs (Chachdi et al., 2017). Thus, there is need for a supporting environment that ensures EVs adoption increase.

Diverse stakeholders in the car manufacturing sector in any economy should work collaboratively to ensure that EVs adoption becomes a reality. These stakeholders may be research institutes, policymakers, trade unions, government departments, non-governmental department among others. The aforementioned opinions are backed by Brönner, Hagenauer, & Lienkamp (2019) who researched on the sustainability of EVs in Sub-Saharan Africa. According to Brönner et al. (2019), it has been determined that for EVs to be sustainable in Africa, collaboration with local government agencies and research institutions is essential, as is the creation of new technologies.

EVs have a bearing on diverse stakeholders in the political, social, economic, and environmental arena. Different stakeholders in these fields are impacted differently and it is crucial to note that failure to capture potential effects may lead to low rates of adoption of EVs. The aforementioned opinions are supported by Capuder, et al (2020) who carried out research on the assessment of the EVs integration policy goals in Morocco. Research findings depicted that there are political, economic, social, environmental, technical, and legislative aspects that must be taken into consideration in ensuring a sound EVs policy is achieved (Capuder et al, 2020).

EVs can bring some benefits to diverse stakeholders in the Global South. This is supported by Collett, Hirmer, Dalkmann, Crozier, Mulugetta, & McCulloch (2021) who researched on the utility of EVs in SSA. Despite obstacles brought on by an unstable electrical infrastructure and a lack of funding, research findings showed that EVs could be advantageous to governments, energy networks, and owners-operators of paratransit (Collett et al., 2021). According to Collett et al. (2021) the study also found that EVs could be particularly advantageous for Sub-Saharan Africa, as they offer benefits such over 90% reductions in car emissions.

2.7.1 Global North Perspectives

Indonesia is one of the Global North economies that produces and sells EVs. If all key issues that relate to EVs are properly tackled, more benefits must accrue to society due to EVs. Hidayatno, et al (2020) agree with the above opinion in their study, where they researched the policy challenges of EV adoption in Indonesia. The study revealed that the availability of infrastructure, the cost of

buying an EV, and the social advantages that customers would receive were the main influences on policy on EVs (Hiyatno et al., 2023).

EV production should be embedded in a strategic plan that ensures sustainability. The most important thing to note is that any changes in the micro or macro environment that impact EVs production should always be taken into consideration. This is on par with the views of Ahman (2006). Ahman (2006) investigated the development of EVs in Japan. The study revealed that the Japanese government has developed a comprehensive strategy that is driven by long-term strategic plans and includes research and development, demonstration programs, and market support. The study concluded that cooperation, technological flexibility, and adaptation are essential for the successful adoption of EVs (Ahman, 2006).

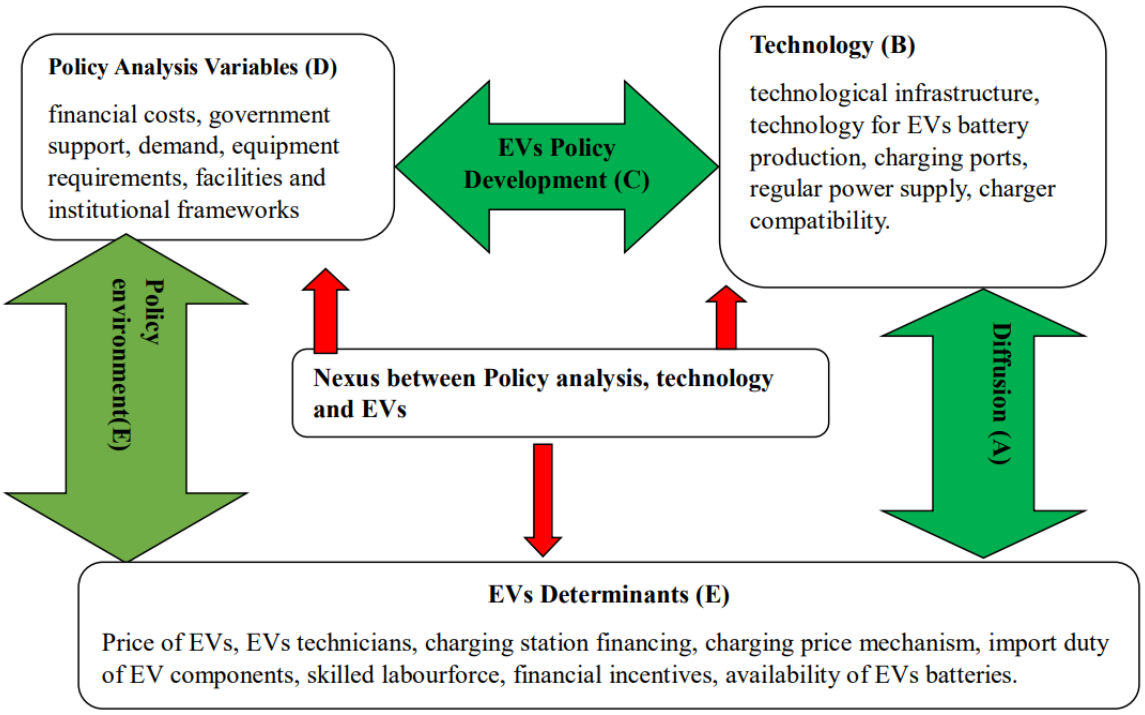
Finally, EVs require a regular power supply as well as sufficient charging ports. The energy crisis is affecting several economies globally. Thus, this must be addressed to ensure that owners of EVs do not suffer from a lack of power. This is necessary to stimulate demand for EVs. Saele & Petersen (2018) share similar views too. Saele & Petersen (2018) researched EVs in Norway. From the research, it was realized that the charging of EVs posed a capacity problem as far as energy consumption is concerned (Saele & Petersen, 2018). This shows that a durable solution should be put in place to avoid an energy crisis or overloading of the energy grid. An option may be of producing renewable energy and this helps to increase energy supply, however, this is dependent on a nation's ability to invest financial and non- financial resource for the production of renewable energy.

This discussion on elements of the policy experience of EVs from different global perspectives, policy analysis, and technological aspects will be connected in an analytical framework. This framework will show the mechanisms by which the various elements of this literature are going to be brought together into this study. This is discussed and presented in the section below.

2.8 NEXUS BETWEEN POLICY ANALYSIS, TECHNOLOGY AND EVs

The discussion presented above shows that there is a link between policy analysis, technology and EVs. The framework below will be used to explain these linkages. An explanation is going to be provided under figure 2.1 below.

Figure 2.2 Conceptual Framework



Source: Researcher's Construct (2023).

Figure 2.2 shows that EVs are a result of technological innovation. Technology is embedded in a policy environment, and this is shown as E. A number of policy variables have a bearing in as far as technological diffusion and EVs are concerned. Some of these policy variables are financial costs, demand, equipment requirements, facilities, and institutional frameworks. Financial costs are incurred by car manufacturers when they produce EVs, and the production of these vehicles is demand-based. This is shown as D on figure 2.2. To add more, certain equipment and facilities are required for the production of EVs, and there should be sufficient institutional support from the government and other stakeholders. This is shown as D on figure 2.2 and such policy variables must be captured together with the technological needs (B) for the development of an EVs policy (C).

From a technological perspective, diffusion can only happen if there is a sound and effective policy. In the context of this study, published policy documents on EVs such as the Auto Green Paper, EV white paper among others have a bearing on EVs production in South Africa. The policy

has an impact on EV production, sales and related aspects. The high import duty stated in the Auto Green Paper on EV components partially contributes to the high price of EVs.

Furthermore, it is costly to service EVs since there are only a limited number of EV technicians (Harto, 2020). These aspects pose a threat to the sustainability of EVs in South Africa. It is also important to note that charging station financing and charging price mechanisms are key EV issues that must be carefully addressed from a policy perspective so as to ensure that the policy climate is conducive to increased adoption of EVs. These are called EV determinants (E) and they are crucial for the development of EVs policy in South for increased adoption of EVs. Figure 2.2 also shows the key factors that determine the success of EVs in South Africa. These are: technological infrastructure, charging ports, regular power supply, and charger compatibility. This presented under technology (B). There is a need for sufficient modern infrastructure that allows car manufacturers to fully shift to the production of EVs. This should be complemented by a regular power supply as well as sufficient charging ports across the nation. Lastly, EV chargers vary, and they must be compatible with the current charging stations.

2.9 CONCLUSION

This chapter sought to present the literature review. Chapter 2 provides a brief description of the diverse types of EVs. The policy analysis process was also discussed, and the research uses a prescriptive policy analysis approach. A number of policies that were introduced in the South African automotive sector were discussed, and these were: the local content program, the structural adjustment program, and the motor industry development program, among others. In terms of the theoretical approach, the research used the diffusion of innovation theory and Caiazza's framework of public policies for innovation diffusion only. Under the empirical literature review, it was established that high rates of technology adoption in the Global South and Global North are dependent on government support, the availability of financial resources, and supportive institutional frameworks. From the discussion, it was also established that the diffusion of EV technology, especially in South Africa, will be possible if the diverse challenges affecting increased adoption of EVs are dealt with from a policy perspective. The next chapter, which is Chapter 3, will be based on research methodology.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

The purpose of this section is to outline the research methodology used in the study. The study approach, research design, data collection procedure, research instruments and their use, sampling, sample size, process analysis, and ethics will all be covered in detail. Conclusion will be presented at the end.

3.2 RESEARCH APPROACH

According to Creswell (2014), research approaches encompass a range of tactics and methodologies, spanning from broad hypotheses to particular techniques for data collection, analysis, and interpretation. According to Downs (2017), who concurs with the description given above, research methodology refers to the methods or techniques used to locate, pick, organize, and evaluate data on a subject. Research can be done using qualitative, quantitative, or mixed methods. The goal of qualitative research methodology is to observe, evaluate, and attempt to comprehend the underlying meaning and purpose of human behavior and experience, including competing views, attitudes, and feelings (Bazen, Barg, & Takeshita, 2021).

Quantitative research is based on gathering data and converting it into numbers in order to make quantitative measurements and draw conclusions (Smith & Hasan, 2020). Mixed research makes use of numerical and non-numerical data to answer identified research questions and meet the objectives of a study (Doyle, Brady, & Byrne, 2009). This research adopted a qualitative research method. This method was selected because it enables the researcher to combine semi-structured interviews along with documentary analysis to gain a deep understanding of the topic matter. Because the researcher wants to learn about the benefits of the topic from a policy perspective, the study adopted an interpretivist epistemology in terms of the research paradigm. While policy research is well understood and can be addressed with a quantitative approach, in the case of EVs, the unfolding policy is relatively new, and this research sought to explore the qualitative views of a range of stakeholders in the EV environment.

3.3 RESEARCH DESIGN

Exploratory research design is a type of research design that helps researchers understand the situation at hand by studying a research subject that is not well defined or known (Gellar et al., 2012). This study's design was chosen because it made it possible to employ a variety of data sources and contributed to a comprehensive knowledge of the policy issues affecting South African automakers and related stakeholders. Semi-structured interviews and documentary analysis were also used to gather data for this study. This made it possible for the researcher to identify the various policy barriers that South African automakers face. Because the interviewer has more opportunity to ask pointed questions, interviews provide for rich data collecting.

3.4 RESEARCH TOOLS AND THEIR APPLICATION

The methodical process of compiling and analyzing data from multiple sources to create a comprehensive and precise image of a subject of interest is known as data collection (Buchanan, 2016). Interviews, observations, surveys, and databases are some of the methods that can be used to gather data. Data for this study were gathered through interviews and a literature review, which is a summary of existing academic works on the topic. The database that was used and the inclusion and exclusion criteria are displayed in Tables 3.1 and 3.2 below, respectively.

Table 3. 4: Database and Keywords used

Database	**Keywords**
Science Direct Scopus Web of Science Google Scholar	Electric vehicles, automotive industry policy analysis South Africa.

Source: Researcher's Construct (2023)

Table 3.1 shows that Scopus, Google Scholar and others are the main repositories that were used for the collection of research articles that examine EVs in South Africa. The focus was on documents published between 2014- 2023.

Table 3. 5: Inclusion and Exclusion Criteria

Criteria	Eligibility	Exclusion
Type of literature	Government publications, Green papers, white papers, Journals, conference papers, company publications on EVs.	Editorials, conference papers, book chapters, and commentaries
Language	English	If not reported in English
Publication dates of research articles	Articles published between 2014-2023	Articles published before 2014
Country	South Africa	South Africa
Title and abstract	Articles which focused on EVs in South Africa and other countries globally.	Articles that did not focus on EVs in South Africa and globally.

Source: Researcher's Construct (2023)

Table 3.2 shows that articles written in English that focuses on EVs in South Africa, published between 2014-2023 were included in the study. These were: government publications, green papers, journals, conference papers, company publications on EVs. Literature that focused on EVs from a global perspective were also used in the study because they contained critical information for the current study useful for comparison and influencing the EV policy for South Africa.

3.5 ADMINISTRATION OF INTERVIEWS

The researcher used Zoom and Microsoft Teams to conduct semi-structured interviews. Because there are no transportation expenses, virtual interviews were chosen due to their cost-effectiveness. They also permitted flexibility, and these semi-structured interviews with participants were done at a convenient time. Every session was audiotaped, and the appropriate procedures for data processing and transcribing were followed. The recording was stored for three years in an encrypted file before being deleted.

3.5.1 Data collection experiences

Data collection commenced from July 1, 2023, to 25 October 2023. The researcher faced some challenges during the data collection exercise. Load shedding affected the smooth running of

virtual interviews, and some interviews were rescheduled. Some of the organizations took a long time to grant permission for interviews to be carried out due to bureaucratic processes. Other potential interviewees did not confirm if they were willing to take part in the interviews. Another obstacle faced was that one interviewee requested to voluntarily withdraw from being interviewed, and the researcher agreed. To mitigate that, the researcher found a replacement in the same organization. The interviewer initially wanted to get at most two respondents from each organization, but only one interviewee was allowed. All the interviewees gave their consent for the audio recording of the interviews. All the interviews were carried out thoroughly and probing questions were asked to ensure that the reliability of the study is not compromised.

3.6 SAMPLING

In statistical analysis, sampling is the process of choosing a subset of data from a larger population (Marella & Pfeffermann, 2019). According to Showkat and Parveen (2017), there are two primary types of sampling: probability sampling and non-probability sampling. Various sample strategies, including purposive, quota, and snowball sampling, fall within these two overarching categories (Suryananda & Yudhawati, 2021). Purposeful sampling is the deliberate selection of participants or sources according to their ability to elucidate a certain subject, concept, or phenomenon (Alonge et al., 2017). This approach was selected due to its low margin of error, suitability for the research setting, and ability to minimize time when gathering data (Ward & Guthrie, 2019). The investigator deliberately chose papers including publications on electric vehicles from a variety of online repositories, including Google Scholar and Scopus. To add to this, a number of stakeholders in the auto industry were specifically chosen for interviews as part of this study.

3.6. 1 Sample Size

A sample size is a representative part extracted from a well-defined target population (Söderberg, Tillmar, Johansson, Wernvik, Jönsson, and Druid, 2020). The target population for this research were the stakeholder in the South African car manufacturing sector. A total of ten (10) participants formed the sample size of this study. Participants and the companies they work for were all anonymized in this research hence their real names were not disclosed. Research shows that there are seven major car manufacturers in South Africa (Christianson, 2022). Two companies were selected using purposive sampling. The trade unions in the car manufacturing sector of South

Africa comprise of the Motor Industry Staff Association (MISA), the National Association of Automobile Manufacturers of South Africa (NAAMSA), the National Association of Automotive Component and Allied Manufacturers (NAACAM), and the National Union of Metalworkers of South Africa (NUMSA). One trade union was selected for the semi -structured interviews.

One governmental department also formed part of the sample. Civic organizations play crucial roles in influencing policies on EVs, and one South African civic organization was incorporated into the sample frame. Financial institutions in South Africa provide credit funding for the purchase of vehicles. One financial organization that offers loans to customers in the automotive sector was included in the sample. One academic institution was included in the sample, as shown in Table 3. South Africa has different Sector Education and Training Authorities (SETA), and they play a key role in the design and implementation of different policies. One representative from one of the SETAs and one independent energy expert were included in the sample size as well. It is important to note that there are many stakeholders who are impacted by EVs, and for this research, only the aforementioned ones were used. It was not feasible to include all the stakeholders. This is because getting ethical clearance from many stakeholders may take a long time, and the researcher has time constraints to complete the master's program. The table below shows the summary of the sample size used in the study.

Table 3. 6: Summary of sample size

Stakeholders	**Number of Respondents**
Car manufacturer A	1
Car manufacturer: B	1
Trade unions 1	1
Training Authority SETA	1
Academic institution 1	1
Financial institution	1
Government	1
Civic organisation	1
Independent energy expert	2
Total	10

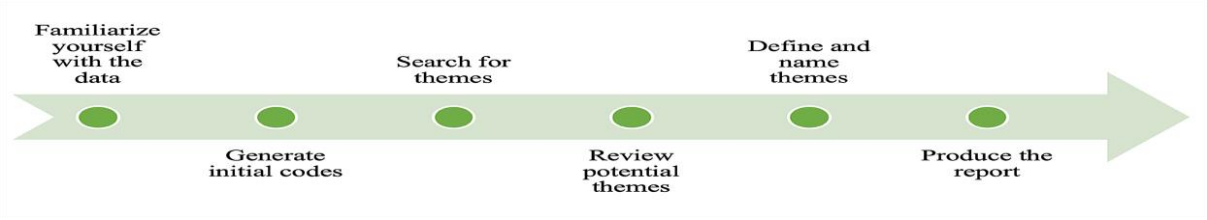
Source: Researcher's Construct (2023)

3.7 PROCESS OF ANALYSIS

Reviewing or modifying raw data to produce relevant information for use in qualitative or quantitative research applications is known as data analysis (Belotto, 2018). Thematic data analysis approaches, content analysis, and narrative analysis are methods used for data analysis (Galazzi et al., 2023). In order to arrive at logical conclusions, content analysis aims to arrange and interpret the information acquired (Bengtsson, 2016).

In this research, content analysis was used for data analysis. This technique was chosen because it allowed exact analysis of specific content and provides insights from 6 policy documents on EVs (Bengtsson, 2016). The method provides rich historical insights that are useful to answer the research questions of (Aacharya, 2022). The research also employed thematic data analysis to analyze the data collected through semi-structured interviews. Finding themes or trends in qualitative data was the main objective of the thematic data analysis. This approach was helpful in this study since it enabled an in-depth examination based on the different themes obtained (Castleberry & Noleen, 2023). Additionally, the use of the stakeholders' perspectives on the increased adoption of EVs makes thematic analysis the best choice for this study's aims (Braun & Clarke, 2020). The following figure shows how thematic data analysis was carried out in this study.

Figure 6.1: Thematic data analysis steps



Source: (Braun & Clarke, 2012).

Figure 3.1 shows the data that the researcher must familiarize himself with the data. Data must be transcribed. Thereafter, the researcher took note of key interests and did the coding required. Thereafter, a search for themes followed, and these themes were checked, described, and called when the final analysis was done at the end.

The themes that were looked at were: policy options for increased adoption of EVs; factors necessary for increased adoption of EVs; sustainability of EVs; and government support for EVs. These themes correlate with the conceptual framework presented in Figure 2. 2. Themes 1 and 2 focused on policy options for increased adoption of EVs and factors necessary for increased adoption of EVs, respectively. These themes enable the diffusion of the new technology of EVs, and this relates to the conceptual framework presented under Chapter 2 on A (see page 34). Additionally, the study used the diffusion of innovation theory. Therefore, theme 1 of the study was based on policy options, and those policy options have an effect on how EV technology diffuses.

Themes 3 and 4 focused on the sustainability of EVs and government support for EVs. The policy analysis variables and technological requirements depicted in Figure 2.2 explain issues centered on the sustainability of EVs. In terms of technological requirements, there is a need for government support, and in Chapter 4, this is theme 4. Finally, the study also used Caiazza's general framework of public policies for innovation diffusion under the theories. Theme 4 of the study focused on government support, and this aligns with the CFPPID theory, which outlines the need for government support in addressing institutional barriers that limit technology diffusion. In short, there is coherence between these themes and the conceptual framework presented in Chapter 2 of this study.

3.8 LIMITATIONS, FEASIBILITY & POSITIONALITY

In terms of limitations, the research was limited to the South African car manufacturing sector and associated stakeholders only. Additionally, the study was based on qualitative research techniques; hence, some of the inherent limitations of this method may have been encountered. In terms of feasibility, the research was carried out at a low cost, hence secondary data was used, and the data (policy documents) are publicly available. In terms of positionality, the researcher was neutral and was guided by the literature to get insights on the issues centred on of EVs policy in South Africa. The researcher was not directly or indirectly involved in the South Africa's automotive sector and related organizations used for data collection. The researcher is not employed in the automotive sector in South Africa. Finally, the researcher embarked on this research to increase knowledge of qualitative research since he comes from an econometrics background. The researcher assumed that the data collection process was going to be very tedious, but however, it

was not very difficult as the interviewees cooperated very well. Finally, the researcher suffered from a challenge of shifting from quantitative skills to qualitative but the process was later smooth due to guidance from the research supervisor.

3.9 ETHICS

Ethics in the research field refers to the various expected standards that must be adhered to especially when one is dealing with institutions and people in a research study, (Glenna, Hesse, Hinrichs, Chiles, & Sachs, 2019). Ethical clearance was obtained from the university's faculty ethics committee. To add more, the researcher obtained permission to collect data from the organisations presented under table 1. The following ethical values were observed in this study.

3.9.1 Informed consent

Dankar, Gergely, and Dankar (2019) define informed consent as freely offered consent to participate in research. The researcher produced forms explaining the purpose and parameters of the investigation in order to get informed consent from participants for this study. The interview process was conducted only with participants who provided their consent.

3.9.2 No harm to participants

"Not to cause harm (including embarrassment, stress, discomfort, or pain) by any action or omission of the research study" is what Chiumento et al. (2020) state should be done to the subjects. Every respondent was treated equally. This was achieved by ensuring that each semi-structured interview was done at a predetermined time to minimize participant discomfort, stress, or harm, and that everyone had an equal amount of time to participate.

3.9.3 Seeking permission

According to Chimento et al. (2020), "Full information about the purpose of the study and the researcher's status and role" was disclosed. To conduct the study, permission was sought from the pertinent stakeholders specified in the sample frame.

3.9.4 Confidentiality and anonymity

All participants have a right to confidentiality and anonymity, according to El Ouazzani and El Bakkali (2018). The study's participants were not asked for any personal information like their

names or contact information. However, the researcher may know the participants names, but in the write-up, they were anonymized. In the study, the stakeholders were anonymized in terms of their organizations, but a profile was provided of their interests in the topic.

3.10 VALIDITY, RELIABILITY, DEPENDABILITY

According to Bashir, Afzal, and Azeem (2008), reliability is concerned with a study's level of consistency, whereas validity is related to the accuracy of the research. Documents related to the topic were carefully chosen in order to guarantee veracity in this investigation. The sources from which the data for this study was gathered were described in detail to assure dependability (Golafshani, 2015). Furthermore, there was openness and clarity regarding matters that could be connected to possible bias in this study. Ultimately, the research's reliability was attained through the provision of a thorough research approach.

3.11 CONCLUSION

This chapter sought to present the research methodology. From the discussion, it was established that the study took a qualitative approach. Data was collected through semi-structured interviews, and the literature on the subject matter was used as well. The target population of the research was the diverse stakeholders who deal with the South African automotive sector. The sample size totalled 10 respondents, and they were selected using purposive sampling. Interviews were administered by the researcher. All-important ethical values were observed during the data collection process. Thematic data analysis was used to analyze the data collected from the interviews. Documentary analysis was also employed in the research for the analysis of policy documents. The next chapter, which is Chapter 4, is going to be based on data analysis, presentation, and discussion.

CHAPTER 4: DATA ANALYSIS PRESENTATION

4.1 INTRODUCTION

This chapter seeks to present the data analysis and presentation. The first section will focus on the analysis of different policy documents. The second section will then focus on thematic data analysis, where data collected through interviews will be analyzed. Responses from the respondents will be used in the analysis, and they may not be presented in chronological order. The researcher combined data presentation and analysis in this chapter to ensure flow and coherence. An overall conclusion will be presented at the end.

4.2 DATA ANALYSIS: POLICY DOCUMENTS

The research was based on the analysis of six (6) policy documents, and these are listed below under Table 4.1:

Table 4. 4: List of policy documents

Title	Description of document	Author
EVs White Paper	It outlines the roadmap for EVs in South Africa**.**	South Africa's Department of Trade, Industry and Competition
Auto Green Paper on the advancement of new energy vehicles in South Africa	The document contains proposed actions on EVs in South Africa. This document was important to the study because it is the version that will lead to the development of a white paper on EVs.	South Africa's Department of Trade, Industry and Competition
Green Transport Strategy for South Africa: (2018-2050)	The document outlines the transport ministry's plan to support economic growth and create a transportation network that is secure, effective, dependable, and reasonably priced, all of which support the objectives of the National Transport Master Plan 2050. It was useful for the study because it also captures issues related to EVs in South Africa.	South Africa's Department of Transport
Automotive Production and Development Programme	The document contain information on production incentives for car	South African government

	manufacturers in South Africa. It was relevant for the study because some of the incentives outlined are also necessary for EV production.	
South Africa 2023 Automotive Export Manual	The document shows the data on exports in South African car manufacturing sector. It was relevant to the study because it contain information on proposed action plan to shift to EVs.	NAAMSA
South Africa's New energy vehicle roadmap	It is a policy document which shows what need to be captured in the white paper. It was relevant to the study because it has recommendations based from an involved stakeholder NAAMSA.	NAAMSA

Source: Researchers' Construct (2023)

4.3 KEY FINDINGS

This section presents the major findings from the literature review first and from analysis of the aforementioned policy documents. It should be noted that the interviews were conducted from July 2023- October 2023 when there was no EVs white paper. The South African EVs white paper was published in December 2023. Therefore, the responses collected may still indicate that there was no EVs and indeed it is true if we look at those time frames cited. This analysis will be based on the following themes: the current EV policy environment in South Africa.

4.3.1 Findings from the literature review

This section seeks to present the findings from the literature review. From the literature, it was established that technological adoption in the Global North and Global South varies, and the government has a role to play in supporting new technological developments. Some of the forms of government support that were observed to be useful for increased EV adoption include financial incentives, clear policy formulation and implementation, providing other regulatory and institutional frameworks, and reductions in import duty and VAT (Amankwah-Amoah, 2019; Jenny, Springel, and Gopal, 2018). Literature also proves that the key factors that determine the success of EVs are: technological infrastructure, policy frameworks, charging ports, regular power supply, and charger compatibility (Harto, 2020; Saele & Petersen, 2018).

To add more, it was also found out that some of the developing economies devote limited financial resources to the automobile sector, thereby limiting the adoption of EVs. From the literature, it was found that the adoption of EVs can be beneficial in reducing pollution; hence, it aids in the attainment of the SDG goal 13 of addressing climate change. Other benefits also include increased revenue generation from the exportation of EVs, job creation, and the development of industries that produce EV components. On the other hand, it was also established that adoption of EVs can lead to job losses unless there is reskilling and upskilling. Finally, literature review findings show that designing and implementing robust EV policies is a major factor that can help the new technology of EVs be adopted.

4.4 FINDINGS FROM POLICY DOCUMENTS

This section presents findings from 6 policy documents used in the study.

4.4.2 Current EVs policy environment

On this theme, it was realized that the current policy environment is characterized by uncertainty. This is mainly because the government drafted the Auto Green paper, and there was no white paper on EVs in South Africa from 2021 to 2023. To add more, it was established that there are challenges that can limit increased adoption of EVs in South Africa. Some of these challenges are high import duties and high VAT on EV components, irregular power supply, a lack of sufficient production and technological incentives, and a lack of purchase subsidies for EVs. This is connected to the conceptual framework presented in Chapter 2 of this study. The challenges cited above are also shown under the framework on EV determinants (E) (see page 24). Therefore, there is a positive link between the theoretical framework and this theme in the current EV policy environment.

4.3.2.1 EVs White paper

The EV White Paper (EVWP) was published in December 2023. It outlines the need for a developing electric battery value chain (Department of Trade, Industry, and Competition, 2023). However, there is no specified time frame when the electric battery industry may be set up. The EWP outlines the plans for offering consumer incentives in 2026; hence, EV production may be meant for the export market (Department of Trade, Industry, and Competition, 2023). This is because there is still low demand for EVs domestically. The plan of offering incentives aligns with the CFPPID theory used in the study under Figure 2.1, where it was explained that supply incentives help in the diffusion of technology.

On a different note, the government outlined plans to launch an EV certificate program in 2025 to improve job retention in the labor market. This action plan is commendable because it helps to reduce unemployment.

However, the plan is subject to the South African car manufacturers as well, because they may have different plans in place as they transition to EVs. Also, there may be trust deficit issues among South African automotive stakeholders. This is so since the government failed to deliver the EV

white paper in 90 days; hence, some of these plans the state promises to deliver may not be fully taken into consideration by stakeholders due to the previous poor performance of the government in delivering the white paper on EVs. Additionally, skills development may take more time, and the EV certificate is scheduled to kick off in 2025; if South African OEMs wait for 2025, they may lose the export market.

Energy shortages affect the demand for EVs locally, and the EVWP outlines that plans are in place to increase grid capacity and charging infrastructure (Department of Trade, Industry, and Competition, 2023). However, these plans will be effective in 2027, so local demand for EVs may be low because power supply is an important factor in increased adoption of EVs. These aspects of power supply and charging infrastructure fall under B on Figure 2.2. This shows that there is a link between the theoretical framework used in the study and the findings from the EV policy document.

Furthermore, the EVWP outlines different support mechanisms, such as a reduction in import duty, tax incentives, and access to financial resources. These are good plans that enable a smooth transition to EVs, but what is important is for the government to implement these plans; otherwise, the EWP goals will not be achieved. Research and development (R&D) is very important, as the country's transition to EVs and EWP shows that the government offers a deduction of an amount equal to 150 percent of expenditure incurred in R&D (Department of Trade, Industry, and Competition, 2023). This initiative is good because it allows South African car manufacturers to engage in R&D on EVs and enjoy a deduction on tax.

The EVWP states that the South African economy will operate a dual system where it will keep pricing ICE for domestic cars and EVs (Department of Trade, Industry, and Competition, 2023). This implies that the production of EVs will be mainly for the export market. This move is commendable, as EVs are more costly relative to ICEs, and more focus should be on the export market while local demand rises gradually. The issue of the high pricing of EVs can be viewed as a barrier for consumers to adapt to the new technology, as explained under the CFPPID theory in the literature review section of this study. This therefore limits increased adoption of EVs.

Currently, the South African OEMs import different EV components, and the EWP says that funding will be available for the local manufacture of such components from 2024 (Department of Trade, Industry, and Competition, 2023). What remains questionable is that funding alone is not sufficient, and will the energy crisis have been solved to enhance the production of such components? Thus, there is a need to periodically monitor what will be implemented under the EWP and check if there are meaningful results that guarantee South Africa the ability to maintain or grow its export market of cars to the EU and other international markets.

The EWP states that there is a need for the government to purchase EVs for its fleet starting in 2027. This move aims to improve domestic demand for EVs, and this will help some of the OEMs locally in terms of sales of EVs. Overall, the EVWP outlines important factors that must be taken into consideration for a successful transition to EVs. What is required now is the full implementation of such plans and to periodically assess if the plans are yielding the much-needed results in ensuring that OEMs in South Africa do not lose the export market for cars.

4.3.2.2 Auto green Paper

The Auto Green paper outlines that the private sector should provide charging stations at commercial rates and ensure that there is technological development to support the transition to EVs (Department of Trade, Industry, and Competition, 2021). However, there is no clear policy that shows how it can be implemented; hence, the policy environment is uncertain. Furthermore, the Auto Green paper outlines the need for renewable energy production, and indeed, there are independent power producers (IPP) producing renewable energy, but the country still suffers from an energy crisis. This adversely affects the increased adoption of EVs in South Africa, and this can be viewed as a barrier. Such factors can be regarded as transfer conditions when we use the CFPPID theory as explained under Chapter 2.

It is also important to note that the Auto Green Paper cites other measures such as providing duty credits, offering production incentives, and supporting value chain investments, but this remains a pipeline dream unless implemented. These measures, which are cited in the Autogreen paper, are related to policy analysis variables (D), as shown in the theoretical framework (see page 24). Therefore, based on this analysis, an EV policy that captures these measures must be designed to ensure that there is increased adoption of EVs in South Africa. Finally, the Auto Green Paper cited

the need for work force reskilling to ensure a smooth transition to EVs. However, it's unclear how that reskilling should be done. Companies operate for profit maximization, and if it is cheaper for them to hire a new labor force, they may opt for that instead of paying for worker reskilling costs.

4.3.2.3 Automotive Production and Development Programme

The Automotive Production and Development Programme is another policy document that governs the operations of OEMs in South Africa. The policy outlines that there is a production incentive benefit to increase 25% for components (from 10% to 12.5% of value addition) (DTIC, 2023). Although this may be good for ICE production, it can be viable in the short term. In the medium to long term, there is a need for a shift to electromobility. Thus, the policy is only useful in the short term for the production of ICE for export until 2030 and 2035 for the EU and Europe.

However, this seems to be targeted towards ICE and not EVs; hence, the policy does not accommodate EVs. Thus, the current provisions in this policy document need to be blended with the policy proposal of the Auto Green Paper for the development of a white paper for EVs and this on the framework under chapter 2, this is shown under policy development (C) (see page 24).

4.3.2.4 South Africa's 2023 Automotive export manual

South Africa's 2023 automotive export manual is another policy document that was analyzed in this research. The export manual outlines the need for South African car manufacturers to tap into modern technology and produce EVs. It was also established that there is a need for South Africa's industry to produce EV batteries using the available raw materials and reskilling of workers to meet the new demands of EVs. This can be achieved through enabling policies that support different producers along the value chain. These are determinants of EV adoption, and on the conceptual framework, they fall under B and E (see page 24). These aspects are very important because technology is needed for the production of EV batteries. This is necessary to support the different global value chain stakeholders involved. According to the CFPPID theory, factors such as reskilling and industrial support for EV components fall under transfer conditions, as shown in Figure 2.1 under the literature review section.

Additionally, it can help boost revenue for the economy due to the sale of EVs; thus, increased adoption of EVs should not be tackled in isolation. The EV policy to be developed should be

comprehensive enough to enable the production of EV components such as batteries. This may lead to the creation of battery production industries and employment creation, and this will fulfill the goals of just transition as discussed under Chapter 1 of this study.

The export manual also outlined that South African consumers have limited disposable incomes due to job losses due to COVID; hence, local demand may be low. This shows that there is a need for policies that stimulate local demand and production of EVs for the export market.

4.3.2.5 The Green Transport Strategy for South Africa (GTS) (2018–2050)

The Green Transport Strategy for South Africa (GTS) (2018–2050) outlines that the incremental costs of adoption of EVs are US$513 billion from 2010 until 2050 (Department of Transport, 2023). However, it remains unclear how those costs will be paid for, given that there is no EV policy in place. This shows that the current policy environment is vague, and this limit increased adoption of EVs as investors and car manufacturers can operate efficiently when there is a clear policy framework. In the framework presented under Chapter 2, D (see page 24), it shows that there is a need for government support towards EV policy development. The government may therefore absorb such costs to stimulate the production of EVs for export and local markets.

The South African government also planned to introduce a policy to ensure that 5% of the total annual fleet requirements of EVs would be introduced and increase by 5% in 2020 (Department of Trade and Industry, 2016). This initiative is good as it will boost local demand for EVs; however, it is unknown if such targets have been met.

The GTS policy document also outlines that the South African Department of Transport will offer EV manufacturing incentives and assist in the development of local EVs (Department of Transport, 2023). On the conceptual framework presented under chapter 2, offering of incentives falls under D.

However, there is no clarity as to when these incentives will be offered to the car manufacturers in South Africa. Thus, a lack of clarity on this still limits the increased adoption of EVs. Furthermore, there is no clarity on the type of manufacturing incentives to be offered; hence, the policy environment remains vague.

Furthermore, the DST has made some strides toward promoting EVs use in South Africa through the Uyilo e-mobility program. A battery testing facility has been established at Nelson Mandela University to support the increased adoption of EVs in South Africa. The DST is collaborating with the Technology Innovation Agency (TIA) to support the development of EV components (Department of Transport, 2023). This is a good initiative towards increased adoption of EVs, but it must be complemented by a clear EV policy. This on the conceptual framework falls under B and D in that harnessing such technology through government support helps to improve the increased adoption of EVs in South Africa.

4.3.2.6 South Africa's new energy vehicle roadmap

Finally, South Africa's new energy vehicle roadmap is another policy document analyzed in this research. As per the policy document, the automotive sector has planned to invest $515 billion worldwide by 2030 to aid in the shift towards new energy vehicles. Failure to adopt EVs could result in South Africa losing up to 80% of its exports to the EU (NAAMSA, 2023). This shows that the South African automotive sector has plans to increase adoption of EVs, but the outlined financial investment can materialize if the government formulates an EV policy. Failure to have a robust EV policy will lead to a loss of exports, a loss of revenue, and possibly a loss of jobs.

The policy document also outlined the need for subsidies in order to support the transition to EVs. This policy proposal was drawn from the Chinese automobile market where the government offered to subsidies. These subsidies in the Chinese context lead to a huge sale of EVs totaling 3,4 million (NAAMSA, 2023). This shows that the subsidies worked very well in China and it can be also assumed that South Africa may record an increased production of EVs if subsidies and other factors such as energy supply, supporting policies are put in place. Offering subsidies is a key factor that was discussed also under Figure 2.2 on E under the theoretical framework. Lack of subsidies will be a barrier for increased adoption of EVs and this was explained under CFPPID theory on Figure 2.1

The first research objective of the study aimed to explore the current policy environment for increased adoption of EVs in South Africa. Findings from documentary analysis show that the current policy environment still unclear though there is EVWP and that there are a number of aspects that need to be put in place to ensure a smooth transition to electromobility. Such issues

include regular energy supply and local manufacture of EV components. The timing for implementation of actions towards the transition to EVs is also a cause for concern because any delays may lead to South Africa losing the export market in 2030.

4.5 DATA ANALYSIS : INTERVIEWS

This section presents the data analysis based on the interviews carried out. In terms of the response rate, a total of ten participants took part in the data collection exercise and this translates to 100%. In terms of gender, eight were males and two were females. The gender disparity could be because the automotive sector is male dominated.

4.5 1 Demography of Participants

This section will present the demographics of the participants. Key aspects to be discussed are the profiles of participants, qualifications, and experience.

4.5.2 Profile of participants

The participants were given pseudo-names to protect their identities as well as to maintain their privacy and confidentiality. This is presented under Table 4.2.

Table 4. 5: Assigned codes

EVs Stakeholders	**Assigned Codes**
Car manufacturers (a)	SK 1
Car Manufacturer (b)	SK 2
Trade Union	SK3
Training Authorities (SETA)	SK4
Academic Institution	SK5
Financial Institution	SK6
Civic organization	SK7
Independent energy experts (a)	SK8
Independent energy experts (b)	SK9
Government	SK10

Source: Researchers Construct (2023)

Table 4.2 shows the list of stakeholders in the left-hand column. On the right-hand column is the pseudo-name or code that is associated with each stakeholder. In terms of experience and educational qualifications, all the participants had varying years of experience. The extracts from the participants' responses are presented below.

Table 4. 6: Summary of respondent's experience and qualifications

Respondent	Experience (Years)	Qualification (degree)
SK1	5	Masters
SK2	10	Masters
SK3	34	PhD
SK4	20	PhD
SK5	8	PhD
SK6	5	Masters
SK7	4	Masters
SK8	8	Masters
SK9	5	Masters
SK10	6	Masters

Source: Researcher's Construct (2023)

All the above responses show that the respondents who took part in the data collection exercise were knowledgeable about the subject matter. Educationally, the lowest qualification recorded was a masters, and the highest was a PhD. In terms of experience the range was between 4 -34 years. This shows that the sampling methods used in this study were appropriate and allowed for high-quality data gathering from experienced respondents.

4.6 THEME EXTRACTION

This section seeks to present the different themes that were extracted from the data collected.

4.6.1 Theme Extraction Based on Interviews

The following themes were extracted from the data collected: factors necessary for increased adoption of EVs, policy options for increased adoption of EVs, sustainability of EVs, and government support for EVs. These themes are going to be discussed in detail below.

Themes 1: factors necessary for increased adoption of EVs

This was the first theme for this research. All the respondents gave different views on the necessary factors that need to be taken into consideration for increased adoption of EVs. Below is an extract of the responses from the participants.

For one of the car manufacturers:

> The key challenge is the high price premium for EVs over ICE. In Europe, North and South America, and Asia, the price differential is 12% for hybrid EVs, 43% for plug-in hybrid EVs, and 52% for battery EVs. In South Africa, we looked at the price elasticity of demand, and we noted that a 1% increase in the price of EVs reduced demand by 2%. The domestic market is not ready for EVs, and the export market must transition, provided there is a clear policy. In the medium to long run we can bring Chinese or Asian OEMs, which are relatively cheaper, to cater to the local market. SK2 – interviewed (July, 2023).

> Tax on EVs components must be reduced and we need to have regular power supply, supporting infrastructure, clear policy as well. SK7- interviewed (August, 2023).

> I think we need a clear policy from government, support and incentives from government is important. SK9-interviewed (August 2023).

> We need incentives for original equipment manufacturers (OEM) for suppliers and buyers (for example, economic zones, access to regular energy supply, reduction of import taxes. SK 10 - interviewed (July, 2023).

Implication

The above responses shows that increased adoption of EVs in South Africa can be achieved through ensuring that there is a clear policy on EVs. This will ensure good investment by different stakeholders in the car manufacturing sector. Regular energy supply is also critical to ensure that car owners can use EVs without disruptions. The aspect of energy supply was noted to be important and one of the respondents said:

> The demand for EV is low and, in our business, we can say it's less than 10%, so there is need for power availability and our country is struggling with energy issues. There is anxiety on loadshedding, charging infrastructure, so these are the key challenges we face. There is need for government funding to enable transition to EVs-SK-6 (November-2023).

In the conceptual framework, under B, regular energy supply and charging infrastructure are cited as important variables required for increased adoption of EVs in South Africa. This shows that there is convergence of ideas between the conceptual framework and the findings from the

interviews. Additionally, these findings tally with the major theory used in the study, which is the DIT theory, which states the need for an enabling environment that leads to increased adoption of new technology, and in this context, new technology refers to EVs. The need for infrastructure was also highlighted under the CFPPID theory, and therefore there is a positive link between the findings from the interviews and the theories used in the research.

To add more, reduction of import duty on EVs components was seen was a key enabler for increased adoption of EVs. The response below supports the above finding.

> In my opinion, there is a need to reduce levies or duties for EVs; we need a stable energy grid for power supply; and we need proper technical skills that can fit the new era of EVs. SK5-interviewed (August, 2023).

High import duty implies an increased final price of EVs, and this may make EVs unaffordable domestically. These research findings from interviews are at par with the Auto Green Paper proposals of offering some incentives to South African car manufactures. From the views of the respondents, it was also established that there is need for supporting infrastructure to ensure increased adoption of EVs of South Africa.

From the findings, it was established that bringing OEMs from China can be a solution as well, since they are relatively cheaper. This may be beneficial for the local market as cheaper EVs may be affordable to some consumers locally, and this can lead to increased adoption of EVs in the local market.

However, care has to be taken to ensure that such imported EVs do not destroy South African car manufacturing industries. This is so since the Chinese automobile market is well developed relative to the South African one (Chen et al., 2017). Thus, the Chinese OEMs enjoy different economies of scale in their production, which may not be enjoyed by the South African car manufacturers. Therefore, if such imports from China are not regulated, South African car manufacturers may be outcompeted because consumers may opt for cheap cars, and they may be unable to sell at cheap prices if they incur high production costs.

Skills development was also noted as an important factor necessary for increased adoption of EVs in South Africa and there is need to ensure that other policies such as BBBEE should enable skills

training by different companies. This can have an impact on the current workers in the car manufacturing sector. The aspect of skills development was also outlined under the EVWP but what is worrisome is that more time may be needed to develop such skills and 2030 is close, hence South Africa is at risk of losing the export market unless other mitigating measures are put in place.

Das & Bhat (2022) share similar sentiments with these research findings. The authors cited the importance of skills development needed for production and maintenance of EVs. The above discussion is supported by the response from the respondent shown below:

> There is need for funding to support the transition. In terms of skills, companies are less likely to train a new person. In South Africa we lack subject matter experts and we are writing to create occupation reference groups on new technology and there is need for collaboration with educational institutions. Broad-based black economic empowerment (BBBEE) is policy lever that is adversely affecting training of people to get new skills because some companies do not have the BBBEE status. SK4-interviewed (October 2023).

There may be need for reskilling to ensure that the workers possess the knowledge and skills needed in repairs and maintenance of EVs. On a similar note, this may lead to unemployment if car manufacturers opt to hire skilled workers with knowledge of EVs, thus policy to be developed should also take this into account. This finding on worker reskilling was also outlined in the Autogreen paper, though there is no clear way forward on whether the employers (South African car manufacturers) will bear the full costs alone or if the government will offer some support. This shows that the findings from the Auto green paper and the 2023 automotive export manual align with the findings from the interviews. These issues also align with the conceptual framework under (E), where skilled labor is a determinant for EV adoption. Finally, research findings depicted that South Africa may need to attract Asia or Chinese OEMS that are producing relatively cheaper EVs. This option looks good but if there is no regular energy supply, it will be difficult to attract such foreign investment.

Theme 2: policy options for increased adoption of EVs

This was the second theme of this research, and it was based on different policy options needed for increased adoption of EVs. On this theme, respondents gave different views on how taxes, subsidies, production incentives, technological incentives and import duty can be used to increase the adoption of EVs in South Africa. An extract of the responses from the participants is presented below.

> Instead of offering BBBEE rewards they can offer renewable energy points and this should be offered as an incentive. The Income tax section 11 need to be looked at as it deals with tax deductions associated with training costs and section 12 deals with incentive for innovation. So these policies should support the transition. SK4-interviewed (October, 2023).

> We can use a mix of these policy options. Subsidies can be used for market development both locally and in the export market, but these subsidies may benefit the rich people who can afford EVs, which further widens the inequality gap in South Africa. Production incentives are also necessary for EV component manufacturers and car manufacturers. SK 6 -interviewed (October, 2023).

> When we look at import taxes, they are high and must be reduced to attract more demand, but this must align with government priorities. The cost of production may be reduced for OEMs. SK8-interviewed (September 2023).

Implication

The above responses shows that policy options such as production incentives, taxes, import duty, technological incentives and subsidies can be used to increase adoption of EVs in South Africa. On this theme, all the stakeholders were in agreement with regards to the policy options needed for increased adoption of EVs. These options are discussed in detail as below.

Production and technology incentives

Car manufacturers in South Africa need increased production incentives to increase adoption of EVs. These can be in the form of investment incentives, which will increase domestic and foreign investment. The response below affirms the above assertion.

> Subsidies are necessary to increase the adoption of EVs. VAT must be reduced on EV components, and for incentives for producers, investment incentives of 20% must be increased to 50% to attract investment. SK5 –interviewed (August 2023).

The respondent cited the need to offer 50% capital payback to investors. This will stimulate the production of EVs and enable the harnessing of modern technology needed for EV production. These research findings tally with the views of Clinton and Steirnberg (2019), who said that purchase incentives play a key role in increasing EVs adoption. On the conceptual framework, production and technology incentives fall under B and E, respectively. The Autogreen paper also highlighted the importance of technological development for enhancing increased EV adoption. This shows the convergence of ideas between the policy documents and the views of the respondents.

Reduction in Value Added Tax

The respondents cited the importance of reducing value-added tax on EV components. This helps to reduce the final price of EVs if the VAT is lowered as well. The response below supports the responses from participants about the issue of VAT reduction.

> I will start with taxes. Reduce taxes on EVs. For example, Europe taxed ICE vehicles to incentivize the market to shift to EVs, so this can be used in South Africa. Subsidies are good, but the government must have enough financial resources. In 2022, we suggested: hybrid EVs: R20 000 purchase discount; plug-in hybrid EVs: R40 000; and Battery EVs: R80 000. These incentives should be removed in 2030, except for battery EVs. The projected effect will be an increase in the market share of EVs of 20% by 2025, 40% by 2030, and 60% by 2035. This will cost the government R12,4 billion by 2030 and 21.4 billion by 2035. This translates to R7–10 billion a year. Production incentives we have now are technology-neutral, but import duty is now high, and it can be reduced on components. A 50% duty rebate on EV components can help increase adoption of EVs. Technology incentive: for new investments, there should be a 50% subsidy called the Automotive Investment Scheme, in which investors get 50% of the capital on EVs but this will cost the government R68 billion up to 2035. We need OEMs that can make battery EVs cheaper in the long run. On the demand side, the government can request money from developing economies that was allocated towards the green economy to stimulate demand. SK3- interviewed (August, 2023).

However, this depends on the availability of the government to forgo the loss in revenue that comes from lowering VAT. This policy option can be effective if it is well implemented, and the lowered VAT should be for a specific period. Once production and consumption rise, the VAT can be increased again to ensure that the government earns revenue to finance other national expenditures. Wang, Tang & Pan (2019) posited that reduction in VAT on EV components helps car manufacturers to increase production of EVs as they will be incurring low costs and this also makes the cars cheaper in the market.

Import duty

It was established that the current 25% import duty levied on EV components is very high and discourages increased adoption of EVs in South Africa. There is a need to reduce this duty to allow a decrease in the final price of EVs; this will stimulate local and export demand. Similar research findings were also obtained by Shar, Awojobi & Soomauroo (2022) who established that economies which reduce import duty have recorded an increased adoption of EVs.

These two issues of import duty and subsidies are also outlined in the Autogreen paper, and they are also found under E in the conceptual framework presented in Chapter 2 of this study. What is

important then is to ensure that an EV policy is formulated and implemented, and that subsidies and reduced import duties are provided, which will be effective in increasing the production of EVs for the export market and the local market as well.

Subsidies

Purchase subsidies were regarded as effective for stimulating local demand for EVs. This can be achieved by the state offering purchase incentives. Purchase subsidies will make EVs relatively cheaper, and this can increase the uptake of EVs to some extent. Archsmith, Muehlegger & Rapson (2022) found similar results in their research which focused on USA.

Purchase subsidies will cost the South African government R12,4 billion by 2030 and 21.4 billion by 2035, but it will also increase the market share of EVs by 60% by 2035 (SK3, 2023). Although there is a financial cost, the long-term benefits of increasing the market share. This will also enable South African car manufacturers to maintain export markets to the EU and UK. Additionally, South Africa may be able to tap into new markets and get more foreign currency, which will cover the initial costs incurred of R12,4 billion. This is likely to happen because all economies are on a transition to adopting green technology; hence, the demand for EVs, especially for export markets in the developed world, may keep rising. The research findings from interviews are on par with the proposals under South Africa's New Energy Road Vehicle Roadmap policy and the EVWP. This implies that the EV policy to be developed should take into consideration how subsidies must be provided to enhance increased adoption of EVs in the export market and local market. Finally, the findings from both the policy document and interviews tally with the conceptual framework presented under chapter 2 on E.

Theme 3: Sustainability of EVs

Sustainability of EVs was the third theme of this research. This theme was based on the key issues that need to be taken into consideration in as far as the sustainability of EVs is concerned. Below is the response from the respondent on this theme.

> I looked at the data and found that plug-in Hybrids traditional hybrids from the past 5 years rose from 1377 in 2018 to 407 in 2019, 335 in 2019, 915 in 2021, and a significant increase of 7422 in 2022. So demand for hybrid cars may increase if they are made more affordable because they have low maintenance costs. Battery Electric Vehicles (BEVs)are very expensive, but they are good for South Africa from an environmental perspective. This issue relates to structural transformation.

> Minerals needed for battery manufacturing are available in South Africa, and we need to leverage those minerals for EV sustainability. SK1 -interviewed (September 2023).

Implication

The sustainability of EVs lies in the ability of the government and other car manufacturer stakeholders to address the energy crisis, increase technological infrastructure, for example, EV charging stations and solve structural transformation issues. Below is an extract of the response from the respondents:

> Charging ports need to be increased and this should be complemented by regular energy supply. SK 7-interviewed (September, 2023).
>
> Preferential treatment of OEMs by the grid for energy supply. We need green energy to be used across the value chain in the car manufacturing sector. These OEMs can also look at ways of producing green energy to get regular energy supplies, as Eskom is struggling. Special economic zones can be very useful as well. SK 10-interviewed (July 2023).
>
> The limiting factor is high pricing and limited choice of EVs. We need more charging stations (about 262,000) as well as regular energy supply to ensure the sustainability of EVs. So we need new technology and production incentives to ensure that we maintain our export market. SK3-interviewed (August 2023).

Without regular energy supply, the production of EVs will be adversely affected. Some respondents cited the need to support EV car manufacturers in developing their green energy solutions to alleviate the energy crisis. This can be complemented by ensuring that preferential treatment of OEMs by the grid for energy supply is provided. These research findings are at par with the views of Saele & Petersen, (2018) and who established that EVs require regular energy supply.

There is a need for improvements in human capital in TVET colleges in South Africa to ensure that technical skills are developed. The need for skilled experts was also discussed under the conceptual framework under E. These research findings from interviews are on par with the findings from the policy documents entitled South Africa's New Energy Vehicle Roadmap and EVWP. The EVWP outlined the need for the government, MERSETA, and institutions of higher learning to work together in developing the skills needed for the EV sector. Skills development will enable good production of EVs as well as improve the service needed to repair EVs; hence, increased adoption of EVs in South Africa may be achieved. Below is the response from the respondents:

> Higher educational institutions are good at developing short term learning courses, but they compete each other and they need to come to a common ground to ensure collaboration on this transition. TVET college's biggest challenges is the development of professional lecturers. There is no space to take these lecturers into new areas of knowledge and as long as we don't have a new way of curating teaching and learning through professional lecturers it is going to be difficult to create the technical skills needed. TVET lecturers need to have master's qualification in pedagogy and have technical qualifications. We have exceptionally low levels of competence on apprentices in South Africa. SK4 -interviewed (October, 2023).
>
> The demand is low and increasing, so we need to balance the local and export markets to ensure the sustainability of EVs. Incentivizing the local market is very important for South Africa, and we can also look at the African market because a lot of pre-owned cars are dumped here. We also need to look at policies that promote the production of electric buses. There is also a need for skill development to support local and export production, and educational systems must help in the development of these skills. Finally, we need sound technological infrastructure and a stable electricity supply." SK5 -interviewed (August, 2023).

These research findings are at par with the views of Brown & Papier (2023) who established that competence levels of apprentices trained in educational institutions in South Africa are very low and this must be addressed by solving the challenge of low skills of lecturers in the TVET colleges.

However, the solution of preferential treatment of OEMs is supply-side; on the demand side, EV owners also require regular energy supply for charging their cars. In terms of structural transformation, there is a need for South Africa to use the mineral resources or available raw materials to manufacture EV batteries and other components. This will help OEM manufacturers buy locally produced components and it will help ensure the sustainability of EVs in South Africa. To add to that, the development of the market for the production of EV components will create employment for different people along the value chain. These research findings from interviews on the use of minerals for the production of EV batteries are on par with the views expressed in the South African new energy vehicle roadmap.

Lastly, there is a need for skills to be developed to ensure that services are offered to EV buyers. This will help to reduce unemployment as the workers who are in the car manufacturing sector will remain active, providing the required service to the EV sector.

The second research objective was to determine how policy can be developed to enable car manufacturers and related stakeholders to have a smooth transition to the use of EVs. Based on the analysis provided above, EVs can be developed in South Africa for increased adoption by

ensuring that there is a balance in the use of policy options such as offering purchase subsidies, reducing import duty, reducing VAT, and offering production and technological incentives. This should be complemented by sufficient government support and regular energy supplies. This explanation suffices for the demands of the second research objective.

Theme 4: Government support towards EVs

This was the fourth theme of this study. The focus was on assessing government support towards increased adoption of EVs. Below are the responses from the respondents:

> The government availed financial resources in the last budget towards EVs, but more needs to be done in terms of policy and other supporting mechanisms.SK2 interviewed- (July, 2023).
>
> There is need white policy paper urgently to drive increased adoption and investment. SK3 - interviewed (August 2023).
>
> We need incentives, we need a levers of incentives and policy alone. SK4 - interviewed (October 2023).
>
> We do not have sufficient government support through different ministries and other regulators. SK5 -interviewed (August 2023).

Implication

The above responses show that there is little government support as far as increased adoption of EVs is concerned. There is a need for the government to offer more support to EV manufacturers. The form of support needed is a clear and robust EV policy that shows how the market should operate. This is important because, without a clear policy, it is difficult for investors to invest, and car manufacturers continue to suffer from high VAT and other challenges. The response from one of the participant is cited below:

> It's hard to tell without a clear policy, so support is limited to EVs. There are a few documents written by government departments, but there is no clear guidance. SK9- interviewed (August, 2023).

Therefore, the policy should be carefully developed by ensuring that equal attention is given to local and export production and consumption of EVs. Mohammadzadeh, Zegordi, Kashan & Nikbakhsh (2022) also found that government support through financial resources and policy

formulation helps to increase adoption of EVs. However, other participants gave different views with regards to government support towards EVs.

> Definitely there is support. We are coordinating a lot of efforts to accelerate the adoption of EVs, we work with Minister Patel of Trade and Industry ministry and he is on board with other stakeholders such as NAMSA, so there is some government support. SK6 –interviewed (October, 2023).

> The government is trying but the pace is slow because the process is consultative- but some financial resources have been set aside for that. SK10-interviewed (October, 2023).

The above responses show that the government is on a pathway to the development of an EV whitepaper, and there is some progress. Based on these views, it can be concluded that the respondents cited different forms of support for EVs. If we look at the development of the EV white paper, the progress was very slow since the policy document was supposed to be published 90 days after the release of the Auto Green paper in 2021. Therefore, all the respondents tackled different forms of government support in the form of policy development, financial resource mobilization, and other measures for promoting EVs. The aspect of government support was also discussed under the theoretical framework of Figure 2.2 of this study. Government support is therefore a necessary ingredient for increased adoption of EVs, and this aligns with the discussion done on the DIT theory and the CFPPID theory. All in all, there is harmony in terms of the research findings from the interviews and the theories used in the research.

4.7 CONCLUSION

This chapter sought to present the data analysis and presentation. Six policy documents were analyzed. All the different policy documents outline diverse supply-side and demand-side plans that must be implemented to ensure a smooth transition to EVs. Research findings depicted that there is still policy uncertainty and that the slow pace by the government to develop EVs from 2021–2023 adversely affected the increased uptake of EVs in South Africa. This answered the first research objective of the study. Under the thematic data analysis section, four themes were extracted, and these were: factors necessary for increased adoption of EVs, policy options for increased adoption of EVs, sustainability of EVs, and government support for EVs. On the first theme, it was established that supply-side and demand-side factors such as reskilling, charging

stations, and energy supply, among others, must be put in place to ensure a smooth transition to EVs. On theme 2 on policy options, it was also established that production incentives, reduced import duty, and subsidies can help to improve the increased adoption of EVs. On the third theme of sustainability, it was realized that there is a need for regular energy supply and setting up an EV industry that helps with the supply of EV components along the value chain. Finally, in terms of government support, which was the fourth theme, it was established that the government needs to increase its support to different stakeholders in the car manufacturing sector of South Africa to ensure increased adoption of EVs. The next chapter, which is chapter 5, is going to be based on a summary of the study and policy recommendations.

CHAPTER 5: SUMMARY OF STUDY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 INTRODUCTION

This section presents the summary of the study, conclusion and policy recommendations. These policy recommendations will be based on the research findings from the interviews as well as policy documents.

5.2 SUMMARY OF STUDY

This section presents the summary of the study and all the findings. The first theme focused on the factors necessary for increased adoption of EVs. Primary research findings suggest that South Africa's current EV policy environment is unclear and that there are several aspects that need to be put in place to ensure a smooth transition to electromobility. Some of these aspects are crafting and implementing EV policies, regular energy supply, reduction of import duty on EV components, skill development, offering purchase subsidies, and production and technology incentives. Primary research findings also indicated that there is a need to segment the production of EVs. The first segment should focus on the production of EVs for the export market, and the second segment should be devoted to EV production for domestic consumption. This segment is based on the notion that the research findings proved that there is still low demand for EVs in South Africa, but there is high demand for EVs in the EU, UK, and other markets. All these research findings answered the first research objective of the study that aimed to explore the current policy environment for increased adoption of EVs in South Africa.

The second theme focused on policy options for increased adoption of EVs. Primary research findings depicted that production and technology incentives, subsidies, reduced VAT, and reduced import duty are key policy levers that should be taken into consideration when developing policies for increased adoption of EVs in South Africa. These research findings from interviews are on par with the findings from policy documents such as South Africa's new energy vehicle roadmap, the EWVP, the Autogreen paper, South Africa's 2023 automotive export manual, and the Green Transport Strategy for South Africa. These policy options have a bearing on the development of EV policies, and if implemented, they can enhance increased adoption of EVs in South Africa. The findings from interviews and the policy documents satisfied the demands of the second

research objective, which aimed to determine how policies can be developed to enable car manufacturers and related stakeholders to have a smooth transition to the use of EVs.

The third theme focused on EVs sustainability. According to research findings, the sustainability of EVs depends on the government and other stakeholders in the auto industry's ability to address the energy crisis, develop skills, expand the technological infrastructure—such as EV charging stations and resolve structural transformation issues. These study results from interviews are comparable to those from the policy documents called the EVWP and the South African New Energy Vehicle Roadmap.

The focus of the fourth theme was on assessing government support for increased adoption of EVs. It was also established that there is a need for more government support for EVs in South Africa. This support should be in the form of financial and non-financial resources. These research findings are on par with the findings from policy documents such as the Auto Green Paper and the EWVP.

Finally, theoretical literature has established that certain government support measures, such as financial incentives, well-defined policy formulation and implementation, provision of additional institutional and regulatory frameworks, and lower import duties and VAT, have been observed to be beneficial for the addition of electric vehicles. It was also determined that the shift to EVs is advantageous for the creation of jobs, the growth of EV component manufacturing businesses, and money generation from the export of EVs. Every finding from the interviews aligned with the conclusions drawn from the examination of the policy papers. In summary, it was determined that there were considerable uncertainties in the current EV policy environment and that full implementation of the EVWP is necessary to encourage the adoption of EVs in South Africa. Every one of the study's research goals was satisfactorily addressed. The research gap of this study was successfully closed as the researcher unearthed the necessary requirements that must be put in place to ensure increased adoption of EVs in South Africa.

5..3 POLICY RECOMMENDATIONS

This section seeks to present the policy recommendations. These policy recommendations to be discussed are implementing and evaluating EVs policy, producing battery EVs, government support, skills development and research and development.

5.3.1 implementing and evaluating EVs policy

The South African government and the relevant stakeholders need to work collaboratively to ensure that an EV policy is implemented timeously. Timeous implementation of the EV policy will help to ensure that the economy does not lose the export market.

5.3.2 Producing battery EVs

It can be recommended that South African car manufacturers may opt to produce low cost Battery Electric Vehicles that can be affordable for the domestic market. This will help to stimulate demand and increase adoption of EVs in South Africa. This will also enable more revenue to be earned through exportation of Battery Electric Vehicles

5.3.3 Government support

There is need for government support in terms of financial and non-financial incentives. Financially, the government should consider providing technological and production incentives, purchase subsidies as discussed prior. This will aid in improving the adoption of EVs in South Africa.

5.3.4 Research and development

The government and the car manufacturers in South Africa need to work collaboratively in terms of research and development. This will help the automotive sector navigate through the journey of EVs using findings from research, and this will be useful for policy formulation as well. Such collaboration will help in the transition process from ICE to EVs.

5.3.5 Skills Development

Educational institutions in South Africa need to improve on the quality of the human capital needed for delivering educational services. This is essential because when the lecturers especially in TVET colleges are not fully equipped they are unable to improve the competence levels of the students they teach.

6.1 CONCLUSION

Chapter one sought to present the introduction and the background of the study. The study used a policy analysis technique and focused on increased adoption of EV in South Africa. As was evident in Chapter 1, there are several obstacles affecting the growing acceptance of EVs in South Africa,

including a deficiency of consistent electricity supply, a shortage of charging stations among others. Furthermore, it was shown that EV adoption can be increased if South Africa is to keep its export market share from the EU and the UK. From the discussion, it was realized that the policy environment has a bearing on the increased adoption of EVs in South Africa.

Chapter 2 presented the literature review and a brief description of the diverse types of EVS was presented. A number of automotive policies that were introduced in South Africa were discussed and it was concluded that there is policy uncertainty on the transition to EVs. Under the empirical literature review, it was established that high rates of technology adoption in the Global South and Global North are dependent on government support, the availability of financial resources, and supportive institutional frameworks.

The third chapter of this study was based on the research methodology. From the discussion, it was established that the study took a qualitative approach and data was collected through semi-structured interviews, and the literature on the subject matter was used as well. The sample size totalled 10 respondents, and they were selected using purposive sampling from the target population that was made up of diverse stakeholders in the automotive sector in South Africa. Interviews were administered by the researcher and all-important ethical values were observed during the data collection process. Thematic data analysis was used to analyze the data collected from the interviews. Documentary analysis was also employed in the research for the analysis of policy documents.

Chapter 4 of this study sought to present the data analysis and presentation. Six policy documents were analyzed. All the different policy documents outline diverse supply-side and demand-side plans that must be implemented to ensure a smooth transition to EVs. The major themes that were discussed were: factors necessary for increased adoption of EVs, policy options for increased adoption of EVs, sustainability of EVs, and government support for EVs.

Research findings depicted that there is still policy uncertainty and that the slow pace by the government to develop EVs from 2021–2023 adversely affected the increased uptake of EVs in South Africa.

Chapter 5 presented the summary of the study, conclusion and policy recommendations. In short, research findings proved that there is no clear EV policy in South Africa, and this must be

addressed timeously. Government support, research and development, production of BEVs, and crafting an EVs policy were suggested as important policy recommendations.

REFERENCE LIST

Aacharya, H. (2022). Content Analysis. Retrieved from: https://www.researchgate.net/publication/360186791_content_analysis/link/63a3f7d1e598500876c39618/download

Acikgoz, F., Elwalda, A., & De Oliveira, M. J. (2023). Curiosity on Cutting-Edge Technology via Theory of Planned Behavior and Diffusion of Innovation Theory. *International Journal of Information Management Data Insights*, *3*(1). https://doi.org/10.1016/j.jjimei.2022.100152

African Development Bank (2022). Transport: Toward a more inclusive, safer and cleaner mobility in African Cities. Retrieved from: https://www.afdb.org/sites/default/files/2023/01/18/transport-toward_a_more_inclusive_safer_and_cleaner_mobility_in_african_cities_-_sudap_paper_-_addb_umdf_-_2022.pdf

Ahman, M. (2006). Government policy and the development of electric vehicles in Japan. *Volume 34, Issue 4, March 2006, Pages 433-443.*Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0301421504001855

Alonge, O., Agrawal, P., Talab, A., Rahman, Q. S., Rahman, A. F., Arifeen, S. El, & Hyder, A. A. (2017). Fatal and non-fatal injury outcomes: results from a purposively sampled census of seven rural subdistricts in Bangladesh. *The Lancet Global Health*, *5*(8), e818–e827. https://doi.org/10.1016/S2214-109X(17)30244-9

Amankwah-Amoah, J. (2019). Technological revolution, sustainability, and development in Africa: Overview, emerging issues, and challenges. *Volume27, Issue5 September/October 2019, Pages 910-922.* Retrieved from: https://onlinelibrary.wiley.com/doi/epdf/10.1002/sd.1950

Ayetor, G. K., Mbonigaba, I., Ampofo, J., & Sunnu, A. (2021). Investigating the state of road vehicle emissions in Africa: A case study of Ghana and Rwanda. *Transportation Research Interdisciplinary Perspectives*, *11*(February), 100409. Pages 1-14. https://doi.org/10.1016/j.trip.2021.100409

Archsmith, J. Muehlegger, E. & Rapson, D. (2022). Future Paths of Electric Vehicle Adoption in the United States: Predictable Determinants, Obstacles, and Opportunities. *Environmental and Energy Policy and the Economy Volume 3. pages 71-110.* Retrieved from: https://www.journals.uchicago.edu/doi/abs/10.1086/717219

Barnes, J., & Black, A. (2014). *The Motor Industry Development Programme 1995-2012: What have we learned?* https://www.researchgate.net/publication/281237290

Bashir, M., Afzal, M. T., & Azeem, M. (2008). Reliability and Validity of Qualitative and Operational Research Paradigm. *Pakistan Journal of Statistics and Operation Research, 4(1), 35*. https://doi.org/10.18187/pjsor.v4i1.59

Belotto, M.J. (2018). Data Analysis Methods for Qualitative Research: Managing the Challenges of Coding, Interrater Reliability, and Thematic Analysis. Retrieved from: https://nsuworks.nova.edu/tqr/vol23/iss11/2/

Bazen, A., Barg, F. K., & Takeshita, J. (2021). Research Techniques Made Simple: An Introduction to Qualitative Research. *Journal of Investigative Dermatology*, *141*(2), 241-247.e1. https://doi.org/10.1016/j.jid.2020.11.029

Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. *NursingPlus Open*, *2*, 8–14. https://doi.org/10.1016/j.npls.20

Bienvenido-Huertas, D., Sánchez-García, D., Rubio-Bellido, D., & Marín-García,C. (2021). Analysing energy poverty in warm climate zones in Spain through artificial intelligence. *Journal of Building Engineering, Volume 68,2023.* Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S2352710223002954

Biyase, M. (2023). Challenges facing the South African Automotive Industry in its Transition to Electric Vehicles. Retrieved from: https://www.researchgate.net/publication/367207542_Challenges_facing_the_South_African_Automotive_Industry_in_its_Transition_to_Electric_Vehicles

Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper (Ed.), APA handbook of research methods in psychology. *Vol 2: Research designs (Vol. 2, pp. 57–71). American Psychological Association*. https://doi.org/10.1037/13620-004

Bronkhorst, E., Steyn, J., & Stiglingh, M. (2013). The automotive production and development programme: An analysis of the opinions of South African stakeholders. *Journal of Applied Business Research*, *29*(5), 1281–1300. https://doi.org/10.19030/jabr.v29i5.8013

Brönner, M., Ampofo, J., Fries, D., & Lienkamp, M. (2020). Configuration Parameters within Electric Vehicle Production Strategies in Sub-Saharan Africa - The aCar mobility Case. *Procedia CIRP*, *86*, 288–293. https://doi.org/10.1016/j.procir.2020.01.025

Brous, P., Janssen, M. and Herder, P. (2020). The dual effects of the Internet of Things (IoT): A systematic review of the benefits and risks of IoT adoption by organizations*," International Journal of Information Management. Elsevier, 51(May 2019), p. 101952.* doi: 10.1016/j.ijinfomgt.2019.0

Brown, H. & Papier, Y. (2023). Beyond the trade test: Using the COMET Model to build occupational competence. *Journal of Vocational, Adult and Continuing Education and Training. JOVACET vol.6 n.1*. Retrieved from: https://www.scielo.org.za/scielo.php?pid=S2663-36472023000100001&script=sci_arttext

Burch, I., and Gilchrist, J. (2018). Survey of global activity to phase out internal combustion engine vehicles. The climate center. https://theclimatecenter.org/wp-content/uploads/2020/03/Survey-onGlobal-Activities-to-Phase-Out-ICE-Vehicles-update-3.18.20-1.pdf

Buchanan, M. E. (2016). Methods of data collection. *AORN Journal, 33(1).* https://doi.org/10.1016/S0001-2092(07)69400-9

Caboz, J. (2019). South Africa exported more than 30,000 cars and 67 massive trucks in a single month – here's what foreigners are buying. Retrieved from: https://www.news24.com/news24/bi-archive/south-africa-exported-more-than-30000-cars-and-67-massive-trucks-in-a-single-month-heres-where-they-are-going-2019-1-2

Caiazza, R. 2015. A cross-national analysis of policies affecting innovation diffusion. *Journal of Technology Transfer*, 41(6), 1406–1419. Available: http://dx.doi.org/10.1007/s10961-015-9439-2

Capuder, T., Sprcic, D., Pandzirc, H. & Zoricic, D. (2020). Review of challenges and assessment of electric vehicles integration policy goals: Integrated risk analysis approach. *International*

Journal of Electrical Power & Energy Systems,Volume 119, 2020,105894. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0142061519318174

Castleberry, and A. Noleen, A. (2023). Thematic analysis of qualitative research data: Is it as easy as it sounds? *Currents in Pharmacy Teaching and Learning, Volume 10, Issue 6,2018, Pages 807-815.* Retrieved from: https://www.researchgate.net/publication/235356393_Using_thematic_analysis_in_psychology https://www.sciencedirect.com/science/article/abs/pii/S1877129717300606

Chachdi, A., Rahmouni, B., & Aniba, G. (2017). Socio-economic Analysis of Electric Vehicles in Morocco. *Energy Procedia*, *141*, 644–653. https://doi.org/10.1016/j.egypro.2017.11.087

Chen, Y., Cynthia Lin Lawell, C., Muehlegger, E. J., Wilen, J. E., Wang, Y., Bushnell, J., Canes, M., Fan, Y., Fulton, L., Ghoddusi, H., Kheiravar, K., Li, S., McCarthy, P., Ogden, J., Qiu, Y., Ryan, S., Rust, J., Sallee, J., Sen, A., … Sweeney, J. (2017). *Modeling Supply and Demand in the Chinese Automobile Industry 1*.

Chege, W.W. (2021). Electric vehicles market intelligence report (Report No. EV MIR 2021 31 3 21).

Christianson, D. (2022). South African policy needs to catch up with electric vehicles. Retrieved from: https://www.tralac.org/blog/article/15521-south-african-policy-needs-to-catch-up-with-electric-vehicles.html

Clinton, B. & Steirnberg, D. (2019). Providing the Spark: Impact of financial incentives on battery electric vehicle adoption. *Journal of Environmental Economics and Management, Volume 98, 2019, 102255.* Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0095069618303115

Chiumento, A., Rahman, A., & Frith, L. (2020). Writing to template: Researchers' negotiation of procedural research ethics. *Social Science and Medicine*, *255*. https://doi.org/10.1016/j.socscimed.2020.112980

Collett, K. A., Hirmer, S. A., Dalkmann, H., Crozier, C., Mulugetta, Y., & McCulloch, M. D. (2021). Can electric vehicles be good for Sub-Saharan Africa*? Energy Strategy Reviews, 38(September), 100722.* https://doi.org/10.1016/j.esr.2021.100722

Connoly, K. (2022). 5 Lessons from South Africa's Just Transition Journey. Retrieved from: https://www.wri.org/technical-perspectives/5-lessons-south-africas-just-transition-journey

Creswell, J. W. (2014). The Selection of a Research Approach. *Research Design*, 3–23. https://doi.org/45593:01

Dankar, F. K., Gergely, M., and Dankar, S. K. (2019). Informed Consent in Biomedical Research. *Computational and Structural Biotechnology Journal, 17, 463–474.* https://doi.org/10.1016/j.csbj.2019.03.010

Das, P. & Bhat, M. (2022). Global electric vehicle adoption: implementation and policy implications for India. Retrieved from: https://link.springer.com/article/10.1007/s11356-021-18211-w

Dearing, J. W., & Cox, J. G. (2018). Diffusion of innovations theory, principles, and practice. *Health Affairs*, *37*(2), 183–190. https://doi.org/10.1377/hlthaff.2017.1104

Department of Transport (2023). Green Transport Strategy for South Africa: (2018-2050). Retrieved from: https://www.transport.gov.za/documents/11623/89294/Green_Transport_Strategy_2018_2050_onlineversion.pdf/71e19f1d-259e-4c55-9b27-30db418f105a

Department of Trade, Industry and Competition (2023). Electric Vehicle White paper. Retrieved from: https://www.thedtic.gov.za/wp-content/uploads/EV-White-Paper.pdf

Department of Trade, Industry and Competition, (2021). Auto Green Paper. On The Advancement of new energy vehicles in South Africa. Retrieved from: http://www.thedtic.gov.za/government-releases-auto-green-paper-on-the-advancement-of-new-energy-vehicles-in-south-africa/

Doyle, L., Brady, A. M., & Byrne, G. (2009). An overview of mixed methods research. *Journal of Research in Nursing*, *14*(2), 175–185. https://doi.org/10.1177/1744987108093962

Downs, F. S. (2017). Handbook of Research Methodology. *Dimensions Of Critical Care Nursing*, *9*(1), 60. https://doi.org/10.1097/00003465-199001000-00018

Eberhard, M. & Tarpenning, M. (2006). The 21st century electric car. Tesla Motors. Retrieved from: https://c2e2.unepccc.org/kms_object/the-21st-century-electric-car/

Ejiaku, S. A. (2014).Technology Adoption: Issues and Challenges in Information Technology Adoption in Emerging Economies." *Journal of International Technology and Information Management, 23(2).* Retrieved from: https://scholarworks.lib.csusb.edu/jitim/vol23/iss2/5/

Electric Vehicle Industry Association (2016). EVIA, Unity in sustainable mobility - roadmap towards building a unified electro mobility industry in South Africa.

El Ouazzani, Z. and El Bakkali, H. (2018). A new technique ensuring privacy in big data: K - anonymity without prior value of the threshold k.

European Commission (2023). Incentives and Legislation. Retrieved from: https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/norway/incentives-legislations#:~:text=The%20subsidy%20is%20a%20maximum,Oslo%20City%20Council%2C%202021.

Fahad, & Shahid, M. (2022). Exploring the determinants of adoption of Unified Payment Interface (UPI) in India: A study based on diffusion of innovation theory. *Digital Business*, *2*(2), 100040. https://doi.org/10.1016/j.digbus.2022.100040

Fadeyi, O. A., Ariyawardana, A. and Aziz, A. A. (2022).Factors influencing technology adoption among smallholder farmers: a systematic review in Africa. *Journal of Agriculture and Rural Development in the Tropics and Subtropics, 123(1), pp. 13–30.* Retrived from: https://www.jarts.info/index.php/jarts/article/view/202201195569

Furlonger, D. (2022). Illegal car imports cost the taxman as much as R8bn. Retrieved From: https://www.businesslive.co.za/bd/economy/2022-10-26-illegal-car-imports-cost-the-taxman-as-much-as-r8bn/ Date of Acess: 21 January 2023.

García-Avilés, J.A. (2020). Diffusion of Innovation. Retrieved from: https://www.researchgate.net/publication/344338279_Diffusion_of_Innovation

Galazzi, A., Bruno, M., Binda, F., Caddeo, G., Chierichetti, M., Roselli, P., … Laquintana, D. (2023). Thematic analysis of intensive care unit diaries kept by staff: insights for caring. *Intensive and Critical Care Nursing*, *76*(January), 103392. https://doi.org/10.1016/j.iccn.2023.103392

Gellar, L., Druker, S., Osganian, S. K., Gapinski, M. A., LaPelle, N., & Pbert, L. (2012). Exploratory research to design a school nurse-delivered intervention to treat adolescent overweight and obesity. *Journal of Nutrition Education and Behavior*, *44*(1), 46–54. https://doi.org/10.1016/j.jneb.2011.02.009

Golafshani, N. (2015). Understanding Reliability and Validity in Qualitative Research. The Qualitative Report, (December 2003). https://doi.org/10.46743/2160-3715/2003.1870

Glenna, L., Hesse, A., Hinrichs, C., Chiles, R., & Sachs, C. (2019). Qualitative Research Ethics in the Big-Data Era. American Behavioral Scientist, 63(5), 555–559. https://doi.org/10.1177/0002764219826282

Harto, C. (2020). Electric Vehicle Ownership Costs: Chapter 2—Maintenance. Retrieved from: https://advocacy.consumerreports.org/wp-content/uploads/2020/09/Maintenance-Cost-White-Paper-9.24.20-1.pdf

Hanto, J., Schroth, A., Krawielicki, L., Oei, P. & Burton, J. (2022). South Africa's energy transition – Unraveling its political economy. Retrieved from: https://www.sciencedirect.com/science/article/pii/S0973082622000928

Hartzeberg, T. & Muradzikwa, S. (2002). Transfer of Technology for Successful Integration into the Global Economy A case study of the South African automotive industry. Retrieved from: https://unctad.org/system/files/official-document/iteipcmisc21_en.pdf

Hertzke, P., Muller, N., Schenk, S. & Wu, T. (2018). The Global Electric-Vehicle Market Is Amped Up And On The Rise. Retrieved from: https://www.mckinsey.com/~/media/McKinsey/Industries/Automotive%20and%20Assembly/Our%20Insights/The%20global%20electric%20vehicle%20market%20is%20amped%20up%20and%20on%20the%20rise/The-global-electric-vehicle-market-is-amped-up-and-on-the-rise-web-final.pdf

Hidayatno, A., Natalia, Y., & Rahman, I. (2020). Conceptual Model for Understanding the Policy Challenges of Electric Vehicle Adoption in Indonesia. Retrieved from: https://dl.acm.org/doi/abs/10.1145/3429551.3429557

Hudson, B., Hunter, D., & Peckham, S. (2018). Policy failure and the policy-implementation gap: can policy support programs help? Retrieved from: https://www.tandfonline.com/doi/full/10.1080/25741292.2018.154037

Huitema, J. (2023). EU ban on the sale of new petrol and diesel cars from 2035 explained.

Retrieved from : https://www.europarl.europa.eu/pdfs/news/expert/2022/11/story/20221019STO44572/20221019STO44572_en.pdf

International Energy Agency (2016). *Global EV Outlook 2017: Beyond one million electric cars.* Paris: IEA ***Available:*** https://www.iea.org/reports/global-ev-outlook-2016

IRENA. 2017. *Electric vehicles: Technology brief*. Abu Dhabi, IRENA. Retrieved from: https://www.irena.org/-/media/Files/IRENA/Agency/Articles/2017/Jul/Bonn-Uni-Lecture--Innovation-driving-the-energy-sector-transformation.pdf?la=en&hash=9001E83BDA3C59461575D1801B20EB891D141D0D

Jenny, A., Springel, K., & Gopal, A. (2018). Effectiveness of electric vehicle incentives in the United States. Retrieved from: https://econpapers.repec.org/article/eeeenepol/v_3a119_3ay_3a2018_3ai_3ac_3ap_3a349-356.htm

Lachvajderová, L., & Kádárová, J. (2020). Emissions In Life Cycle Of Electric Vehicle. Perner's Contacts, 15(2). https://doi.org/10.46585/pc.2020.2.1626

Lamprecht, N., Rudansky-kloppers, S., & Strydom, J.W. (2011). South African Automotive Policy Intervention (1924-2008): The Case Of An Intelligently Designed Automotive Support Structure.

Le Roux, L. (2023). The shape of the Electric Vehicle revolution in SA and the possible impact thereof on the Eskom grid. Retrieved from: https://drive.google.com/file/d/1-sEAf69H5bZryt9lc5UFDhbX8tP5xGdu/view

Liu, L., Kong, F., Liu, X., Peng, Y., & Wang, Q. (2015). A review on electric vehicles interacting with renewable energy in smart grid. *Renewable and Sustainable Energy Reviews, 51, 648-661*. Article 4574. https://doi.org/10.1016/j.rser.2015.06.036

Luken, R.A. (2019). Green Industrialisation in Sub-Saran Africa. Retrieved from: https://view.ckcest.cn/AllFiles/ZKBG/Pages/31/6cfc5e9b5222054644f2358636eae665cb8c3385.pdf

Malinga, S., (2022). Skills pivotal to transition towards electric mobility [Online] Available at: https://www.itweb.co.za/content/mYZRX79gJZJqOgA8

Mangipinto, A., Lombardi, F., Sanvito, F. D., Pavičević, M., Quoilin, S., & Colombo, E. (2022). Impact of mass-scale deployment of electric vehicles and benefits of smart charging across all European countries. *Applied Energy*, *312*(October 2021), 118676. https://doi.org/10.1016/j.apenergy.2022.118676

Marella, D., and Pfeffermann, D. (2019). Matching information from two independent informative samples. *Journal of Statistical Planning and Inference, 203, 70–81*. https://doi.org/10.1016/j.jspi.2019.0

Marume, S., Mutongi, C., Jubenkanda, R. Chikasha, A. (2016). Public Policy Analysis Models. Retrieved from: file:///C:/Users/freemanm/OneDrive%20-%20University%20of%20Johannesburg/Downloads/tijhss,+47.+HS1603-115.pdf

Martins, H., Henriques, C. O., Figueira, J. R., Silva, C. S., & Costa, A. S. (2023). Assessingpolicy interventions to stimulate the transition of electric vehicle technology in the European Union. *Socio-Economic Planning Sciences*, (December 2022), 101505. https://doi.org/10.1016/j.seps.2022.101505

Mashilo, A.M. (2019). Auto Production In South Africa And Components Manufacturing In Gauteng Province. Retrieved from: https://global-labour-university.org/wp-content/uploads/fileadmin/GLU_Working_Papers/GLU_WP_No.58.pdf

Menzli, L. J., Smirani, L. K., Boulahia, J. A., & Hadjouni, M. (2022). Investigation of open educational resources adoption in higher education using Rogers' diffusion of innovation theory. *Heliyon*, *8*(7), e09885. https://doi.org/10.1016/j.heliyon.2022.e09885

Mohubedu, S. (2021). Developing A Framework To Promote The Adoption Of Electric Vehicles In South Africa.

Mohammadzadeh, N., Zegordi, S., Kashan, A., & Nikbakhsh, E. (2022). Optimal government policymaking for the electric vehicle adoption using the total cost of ownership under the budget constraint. *Sustainable Production and Consumption. Volume 33, 2022, Pages 477-507.* Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S2352550922001890

Mohubedu, S. (2021). Developing A Framework To Promote The Adoption Of Electric Vehicles In South Africa. Retrieved from: https://openscholar.dut.ac.za/handle/10321/4717

Momoh, O. D. & Omoigui, M. O. 2009. An overview of hybrid electric vehicle technology, IEEE Vehicle Power and Propulsion Conference, 1286–1292. Available: https://ieeexplore.ieee.org/abstract/document/5289703

NAAMSA (2023). Fueling the economy. Retrieved from: https://naamsa.net/fueling-the-economy-2021/#:~:text=AUTOMOTIVE%20INDUSTRY%20GP%20CONTRIBUTION&text=The%20Original%20Equipment%20Manufacturers%20building,component%20manufacturing%20to%20vehicle%20assembly%5D.

Nel, J. & Inglesi-Lotz, R. (2022). Electric Vehicles Market and Policy Conditions: Identifying South African Policy"Potholes". Retrieved from: https://www.up.ac.za/media/shared/61/WP/wp_2022_57.zp228500.pdf

Odeh, (2010). A Comparative Analysis Of Global North And Global South Economies. Retrieved from: https://jsd-africa.com/Jsda/V12No3_Summer2010_A/PDF/A%20Comparative%20Analysis%20of%20Global%20North%20and%20Global%20South%20Economies%20(Odeh).pdf

Patton, C., Sawicki, D. & Clarke, J. (2017). Basic Methods of Policy Anal(2017nd Planning. Retrieved from: http://surjonopwkub.lecture.ub.ac.id/files/2019/01/Basic_Methods_of_Policy_Analysis_and_Planing.pdf

Palmer, Kate & Tate, James E. & Wadud, Zia & Nellthorp, John, (2018). "Total cost of ownership and market share for hybrid and electric vehicles in the UK, US and Japan," Applied Energy, Elsevier, vol. 209(C), pages 108-119.

Posada, F. (2017). South Africa's New Passenger Vehicle Co2 Emissions Baseline Analysis. Retrieved from: https://www.globalfueleconomy.org/media/461030/africa_icct-sa-fe-baseline-report_final.pdf

Presidential Climate Commission (2023). Just Energy Transition. Retrieved from: https://www.climatecommission.org.za/just-energy-transition

Razi & Dincer, (2022). A review of the current state, challenges, opportunities and future directions for implementation of sustainable electric vehicle infrastructure in Canada. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S2352152X22020369

Remme, D., & Jackson, J. (2023). Green mission creep: The unintended consequences of circular economy strategies for electric vehicles. *Journal of Cleaner Production*, *394*(February), 136346. https://doi.org/10.1016/j.jclepro.2023.136346

Rezvani, A. (2022). Auto companies are racing to meet an electric future, and transforming the workforce. Retrieved from: https://www.npr.org/2022/10/01/1126079120/auto-companies-are-racing-to-meet-an-electric-future-and-transforming-the-workfo

Rogers, E.M. (1962). Diffusion of Innovation Theory. Retrieved from: http://www.lamolina.edu.pe/postgrado/pmdas/cursos/innovacion/lecturas/Obligatoria/17%20-%20Rogers%201995%20cap%206.pdf

Rudansky-Kloppers, S. (2011). South African Automotive Policy Intervention (1924-2008): The Case Of An Intelligently Designed Automotive Support Structure. (National Association of Automobile Manufacturers of South Africa). In Journal of Contemporary Management DoE (Vol. 8).

Saele, H. and I. Petersen, P. (2018). "Electric vehicles in Norway and the potential for demand response," 2018 53rd International Universities Power Engineering Conference (UPEC), Glasgow, UK, 2018, pp. 1-6. Retrived from: https://www.researchgate.net/publication/329648941_Prototype_for_estimation_and_forecasting_of_the_future_demand_and_generation_from_households_in_selected_European_countries

Schober, M. (2017). Policy Analysis. Retrieved from: https://link.springer.com/chapter/10.1007/978-3-319-48526-3_7

Sebastaian, G. (2021). In The Driver's Seat: China's Electric Vehicle Makers Target Europe. Key

developments and challenges to European governments and companies. Retrieved from: https://merics.org/sites/default/files/2021-09/MericsChinaMonitorAutomotiveindustry%2071_final2_1.pdf

Shar, K., Awojobi, M. & Soomauroo, Z. (2022). Electric vehicle adoption in small island economies: Review from a technology transition perspective. Retrieved from: https://wires.onlinelibrary.wiley.com/doi/full/10.1002/wene.432?casa_token=BHsq5hdJ1gUAAAAA%3A5Vi6lTkXkHcOKWSFiav9JiuVWyka-_vspS-ejKYBojMcsBE5Pc65V26QhaMYI5Dx6twdIvNh6iE

Sherk, J. & Sarget, J. (2023). Research Report: Proposed EV Mandate Would Eliminate 117,000 Auto manufacturing job. Retrieved from: https://americafirstpolicy.com/latest/research-report-proposed-ev-mandate-would-eliminate-117000-auto-manufacturing-jobs#:~:text=If%20EV%20sales%20rose%20to,be%20in%20final%20assembly%20positions.

Showkat, N., & Parveen, H. (2017). Non-Probability and Probability Sampling. Retrieved from:https://www.researchgate.net/publication/319066480_Non-Probability_and_Probability_Sampling

Simon, M. & Damoense, A. (2004). An analysis of the impact of the first phase of South Africa's motor industry development programme (MIDP), 1995-2000. Retrieved from: (PDF) An analysis of the impact of the first phase of South Africa's motor industry development programme (MIDP), 1995-2000.

Söderberg, C., Tillmar, A., Johansson, A., Wernvik, E., Jönsson, A. K., and Druid, H. (2020). The importance of sample size with regard to the robustness of postmortem reference values. *Forensic Science International, 311*. https://doi.org/10.1016/j.forsciint.2020.110292

Smith, J. D., & Hasan, M. (2020). Quantitative approaches for the evaluation of implementationresearch studies. *Psychiatry Research*, *283*(August 2019), 112521. https://doi.org/10.1016/j.psychres.2019.112521

Statistisches Bundesamt (2023). Road transport: EU-wide carbon dioxide emissions have increased by 21% since 1990. Retrieved from: https://www.destatis.de/Europa/EN/Topic/Environment-

energy/CarbonDioxideRoadTransport.html#:~:text=Around%20740%20million%20tonnes%20of,trucks%20for%20a%20further%2010%25.

Sousa, J., Lagarto, J., Carvalho, E., & Martins, A. (2023). SWHORD simulator: A platform to evaluate energy transition targets in future energy systems with increasing renewable generation, electric vehicles, storage technologies, and hydrogen systems. *Energy, 271*. https://doi.org/10.1016/j.energy.2023.126977

Sovacool, B. K. (2023). Expanding carbon removal to the Global South: Thematic concerns on systems, justice, and climate governance. *Energy and Climate Change*, *4*. https://doi.org/10.1016/j.egycc.2023.100103

Suryananda, T. D., & Yudhawati, R. (2021). Association of serum KL-6 levels on COVID-19 severity: A cross-sectional study design with purposive sampling. *Annals of Medicine and Surgery*, *69*(6), 102673. https://doi.org/10.1016/j.amsu.2021.102673

Talbi, J. (2021). Innovation in the long run: Perspectives on technological transitions in Sweden 1908–2016. Retrieved from: https://pdf.sciencedirectassets.com/270502/1-s2.0

Tanç, B., Arat, H.T., Baltacıoğlu, E., Aydın, K. (2019). Overview of the next quarter century vision of hydrogen fuel cell electric vehicles. International Journal of Hydrogen Energy, 44 (20), pp. 10120-10128. https://doi.org/10.1016/j.ijhydene.2018.10.112

TC Global (2023). Electric Vehicle Industry And Jobs of Tomorrow. Retrieved from: https://tcglobal.com/electric-vehicle-industry-jobs-of-tomorrow/

The presidency Republic of South Africa (2023). South Africa's Just energy transition investment plan. Retrieved from: https://www.thepresidency.gov.za/download/file/fid/2649

Tiseo, I. (2023). Road transportation carbon dioxide emissions worldwide 2018, by region. Retrieved from: https://www.statista.com/statistics/1201116/road-transport-sector-co2-emissions-worldwide-by-region/#:~:text=The%20Asia%2DPacific%20region%20emitted,transportation%20sector%20CO2%20emissions%20worldwide.

Tongwane, M. I., & Moeletsi, M. E. (2021). Status of electric vehicles in South Africa and their carbon mitigation potential. *Scientific African*, *14*, e00999.

https://doi.org/10.1016/j.sciaf.2021.e00999

Tossun J. & Treib, O. (2018). Linking Policy Design and Implementation Styles. Retrieved from: https://www.researchgate.net/publication/325060241_Linking_Policy_Design_and_Implementation_Styles.

United States of America, DoE. 2014. *The history of the electric car*. US Department of Energy. Available: https://www.energy.gov/articles/history-electric-car

United Nations, (2023). Sustainable Development Goals. Retrived from: https://education.nationalgeographic.org/resource/sustainable-development-goals/

Van Barlingen, W. & Simpson, J. (2021). The history of electric cars. Retrieved from: https://blog.evbox.com/electric-cars-history

Ward, M. M., and Guthrie, L. C. (2019). Validity of health transition questions is supported by larger clinical improvements in purposive samples enriched for improvers. *Journal of Clinical Epidemiology, 116, 138–139.* https://doi.org/10.1016/j.jclinepi.2019.05.038

Wang, N., Tang, L., & Pan, H. (2019). A global comparison and assessment of incentive policy on electric vehicle promotion. *Sustainable Cities and Society, volume 44,2019, Pages 597-603.* Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S2210670717305577

Winkler, H., Tyler, E., Keen, S., & Marquard, A. (2023). Just transition transaction in South Africa: an innovative way to finance accelerated phase out of coal and fund social justice. Journal of Sustainable Finance and Investment, 13(3), 1228–1251. https://doi.org/10.1080/20430795.2021.1972678

World Bank (2022). Technology Adoption by Firms in Developing Countries. Retrieved from: https://www.worldbank.org/en/topic/competitiveness/publication/technology-adoption-by-firms-in-developing-countries

Yan, S. (2018). The economic and environmental impacts of tax incentives for battery electric vehicles in Europe. *Energy Policy, Volume 123, 2018, Pages 53-63*. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0301421518305597

LIST OF APPENDICES

APPENDIX A: INTERVIEW GUIDE

I am Freeman M Mateko, a student studying towards a Master of Management (Governance) in the department of Wits School of Governance at the University of Witwatersrand, am conducting a study on research entitled: **Policy challenges affecting the electric vehicle manufacturing sector in South Africa** under the supervision of Mr Murray Cairns

All information is for academic purpose only. Thank You!!

Time: Approximately 15 -20 minutes

Name of field worker: Freeman M Mateko Contacts: 0848933286

Section A: Biographical information.

(1) Age ..... years

(2) Gender Male Female

(3) Position at work ……..

(4) Years of experience……..

(b) Qualification: Diploma Honours Masters PhD Other (clarify)

SECTION B: Overview of Electric Vehicles in South Africa (EVs)

(3) How should the introduction **of Electric Vehicles (EVs)** in the South African Market be properly implemented?

Section C: Policy Alternatives for EVs

(4) In your view can you please **explain** how any of the following policy **options can** enhance increased adoption of EVs.

(a) Taxes (b) Subsidies (c) production Incentives to EVs manufacturers (d) reducing import duty on EV components (e) technological incentives.

(4b) In your opinion how **effective** are the above **policy alternatives**? **Justify.**

SECTION D: Sustainability of EVs

(5) In your view is there **sufficient demand for EVs** in South Africa? Justify your opinion.

(6) Briefly explain **the status and importance of modern technological infrastructure** needed to produce EVs and give reference **to how this affects you** as a stakeholder in the car manufacturing industry of South Africa.

(7) Outline **the role of the government in supporting EVs adoption** in South Africa. Explain if there is **sufficient support** and justify.

(8) is there **sufficient institutional framework (laws, regulations, procedures**) to support the adoption of EVs in South Africa. Explain your answer.

(9) What can be done to **improve EVs policy development for increased adoption of EVs** in South Africa?

THE END. THANK YOU!!!!!!!

APPENDIX B: ETHICAL CLEARANCE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCHOOL OF GOVERNANCE ETHICS COMMITTEE

CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE: **WSG-2023-88**

PROJECT TITLE: **Policy challenges affecting the electric vehicle manufacturing sector in South Africa**

INVESTIGATOR	Freeman Mmateko
SCHOOL/DEPARTMENT OF INVESTIGATOR	School of Governance
DATE CONSIDERED	23 August 2023
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	Minimal Risk
EXPIRY DATE	Date of submission of the Research Report

ISSUE DATE OF CERTIFICATE 05 September 2023 **CHAIRPERSON** Rekgotsofetse Chikane
Rekgotsofetse Chikane

cc: Supervisor:

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am are authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

FMM
Signature

05 / 09 / 2023
Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

APPENDIX C: CONSENT LETTER

Dear participant

I, Freeman M Mateko, a student studying towards a Master of Management (Governance) in the department of Wits School of Governance at the University of Witwatersrand , am conducting a study on research entitled: **Policy challenges affecting the electric vehicle manufacturing sector in South Africa** under the supervision of Mr Murray Cairns who can be contacted at Murray.Cairns@wits.ac.za. I am pursuing data collection to meet the objectives of my study and complete my qualification.

Please accept my sincere offer to participate willingly in a fifteen-minute interview with the researcher (Freeman M. Mateko). Your participation in the study is completely voluntary, and you are free to end it at any time for any reason. I would like to formally state that any information you choose to share with me will be held in strict confidence and used only for research. Your name will also be kept anonymous in the study's findings to preserve the confidentiality agreement. In accordance with best practices, the data acquired for this study will be kept for three years in an encrypted file.

Yours sincerely,

Freeman M Mateko

…….

Cell: +27848933286

E-mail address: **2636446@students.wits.ac.za**

I ……..consent to be part of this study :

Sign ----------

Date ----------

APPENDIX D: PERMISSION LETTER

Letter of Permission to Conduct the Study

Attention:

Re: **Request for permission to conduct research in your organisation**

To Whom It May Concern

I, Freeman M Mateko, a student studying towards a Master of Management (Governance) in the department of Wits School of Governance at the University of Witwatersrand , am conducting a study on research entitled: **Policy challenges affecting the electric vehicle manufacturing sector in South Africa** under the supervision of Mr Murray Cairns who can be contacted at Murray.Cairns@wits.ac.za. I am pursuing data collection to meet the objectives of my study and complete my qualification.

The main aim of the study is to explore policy environment for increased adoption of EVs in South Africa. I thus request your consent to allow the staff to take part in this research project for only academic reasons. Virtual interviews will be utilized to gather information that will be used for academic research. It is ensured that both the department and potential participants will remain anonymous. The research findings are also of such a character that it is almost impossible to hurt the department or potential participants, and strict confidentiality will be always maintained.

I endeavour upon completion to provide an executive summary of the findings and recommendations from the study. You are welcome to contact my supervisor, Mr Cairns on telephone number: 011717 3689 or email address Murray.Cairns@wits.ac.za, for clarification or further information.

Thanking you in advance for your co-operation.

Yours Sincerely

_____

Freeman M Mateko

2636446@students.wits.ac.za