
# FOR PROFIT OR THE ENVIRONMENT? AN ANALYSIS OF THE RELATIONSHIP BETWEEN THE MOTOR VEHICLE MANUFACTURING INDUSTRY AND THE GREEN ECONOMY IN SOUTH AFRICA.[1]

BY

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**A THESIS** submitted to the **FACULTY OF SCIENCE**, at the **UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG,** in fulfilment of the requirements for the degree of **DOCTOR OF PHILOSOPHY**.

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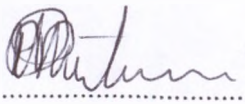
JOHANNESBURG, FEBRUARY 2018

"The support of the Global Change and Sustainability Research Institute (GCI) towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at, are those of the author and are not necessarily to be attributed to the GCI." [1]

# DECLARATION

I, Prue P.J Mutumi, declare that this thesis, including data, tables, diagrams, graphs and any other information, is my own unaided work.

The thesis is being submitted for the Degree of Doctor of Philosophy to the Faculty of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any examination to any other University.



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## ABSTRACT

Motor vehicle manufacturing plays a key role in the South African economy and in 2015 contributed 7,2% to the GDP of the country but at the same time consumes large amounts of raw materials and discharges various forms of waste into the environment (Lamprecht, 2015). The manufacturing industry, within which motor vehicle production in South Africa is located, has been identified as an industry in which sustainability principles can be pursued in spite of the adverse effects manufacturing processes generally pose for the environment. Sustainability concepts remain largely contested because of various and at times divergent interpretations of what sustainability imperatives entail or mean. However, several studies have suggested that the concept refers to the use of resources in a manner that ensures that societal needs are met on an intergenerational scale, whilst ensuring ecological conservation.

Generally, corporations have a production and profit mandate and those within vehicle manufacturing are not exempt from this mandate. Despite the variations in the understanding and application of sustainability, the environmental ills and the profit mandate, vehicle manufacturers as part of the manufacturing cohort are expected to facilitate the process of mainstreaming a *green* agenda in production under the 'Green Growth Path' that South Africa has adopted. This is largely because the vehicle manufacturing industries in South Africa yield resources and power that can facilitate a green agenda in production. In the context of this study, the interrelationships have been analysed within the setting of current debates and discussions on the "Green Economy", profitability and sustainable development with an emphasis on environmental sustainability on a global, international and local scale.

Using data collected through case studies conducted within the vehicle manufacturing industry, manufacturers' sustainability/environmental reports, in depth interviews (with managers, vehicle dealers, Departments of Environmental Affairs and Trade and Industry, oral data, observations and revealed the tensions and conundrums that exist in the manufacturing-green economy relationship. Conundrums exist in that sustainability is ill defined and global companies have redefined sustainability to suit business ultimately controlling decisions by sitting in environmental bodies and influencing decisions to favour business agendas. Contentions arise in instances where environmental considerations interfere with economic interests. The power corporations yield by virtue of their financial muscle, the interpretations of sustainability and the profitability mandate over environmental

concerns is evident in the lifecycle of a vehicle from raw material sourcing up until the end of life. Environmental preservation and manufacturing are concepts that therefore are at odds with each other particularly given what they seek to satisfy, but the current drive has been to advocate for harmonious co-existence between production and conservation.

The challenges in the relationship between manufacturing and green initiatives stem from an almost insincere or hypocritical approach towards environmental protection adopted by vehicle manufacturers as seen in sustainability reporting, supplier relations and a lack of fair platforms that can be used to address environmental concerns. This is aggravated by an overall lack of political will to address environmental concerns particularly in emerging economies. Corporations are set up with a strong profitability mandate and pursue and promote this mandate and deal aggressively with anything that hinders financial gain and this is evident in the way in which the adoption of green initiatives is explained in line with cost reductions, innovation, growth potential, potential savings, reputation protection or competitive advantage.

The suggested recommendations include reviewing the meanings attached to sustainability in relation to manufacturing to ensure preservation is not anchored on the business case for sustainability. In addition manufacturers should also focus on the total effects raw materials' extraction has on the environment and not just concentrate on the production sites. This can also feed into aspects of sustainability reporting to ensure it is not conducted solely to fulfil legal requirements or as a marketing tool but as a platform to create viable solutions. The strengthening of the political framework will also help in controlling manufacturers' capture of the greening dialogue and restructuring CSR activities to give back into the environment from which the raw materials are derived from.

Further research can be conducted to explore the sustainability-manufacturing link and the complexities that arise in setting up manufacturing as the main area for greening the economy. Building on this, more work can be conducted on teasing out the vested interests that hinder the greening process emanating from various sources such as global companies, local and host environment aspiration to cite a few. Finally, as raw materials are central in production, tracing raw materials from source together with waste generated at every value addition stage up to the production site until disposal of the manufactured component at end of life would give insights into the components that pose the most threat on the environment and these can then be used as a basis to develop less harmful and more viable alternatives.

**Keywords:** Sustainability, Environmental Sustainability, Green Economy, Profitability, Motor vehicle manufacturing, and Environmental Management Systems (EMS)

## ACKNOWLEDGEMENTS

I give glory and honour to God Almighty who strengthens me, guides me, orders my steps and is forever faithful in my life.

There are a number of people that contributed to the completion of this project that I cannot mention all by name but to whom I am greatly indebted and would like to express my deepest gratitude. I am deeply indebted to Prof. Danny Simatele, my supervisor, who in many ways (too many to mention) went beyond the call of duty and assisted me. Thank you for the opportunity you gave me to develop and sharpen my skills and not take for granted what I carry. The time you invested into my work coupled with the ideas made this journey interesting and intellectually stimulating. You were always stretching me to go beyond my capabilities. Your analysis and advice helped me refine my ideas and you always found time to listen, engage and read many different drafts of my work as well as provide timely feedback. You are a great model for what supervision entails and you have taught me to how to supervise through what you invested in me. I am also grateful to Prof. Munacinga Simatele for standing by me, holding my hand and encouraging me, I value your input immensely.

In the same vein, I would also like to thank Naome Marezana for shouldering a great number of tasks on my behalf and allowing me to write. Your help and support strengthened me and allowed me to concentrate on my work. To my PhD colleagues and colleagues at GAES-Serge Kubanza, Henry Tantoh, Londiwe Khuzwayo, Njongenhle Nyoni, Eromose Ebhuoma, Wole, Sethilana, Muneebah Kara, Frank Nkulu, Gabriel Mbambi, Regis Musavengane Emmah Mandishona, Lianda Dzikiti, Thandizwe Nsimbi, Donna Koch, Yingisani Chabalala and Khanyo Ngubo: thank you all for your support-academic, administrative and social.

I am grateful to my remarkable family, Reason, Mufaro and Atidaishe. Reason you are a source of inspiration and a great pillar of support. Thank you for the constant encouragement as I worked through the various and often difficult stages and for being there through the frustrations. I appreciate your love, selflessness, constant support, your patience and allowing me to be. Mufaro and Atidaishe I dedicate this work to you so that you will always be aware that you can be anything you desire to be-you carry it all inside of you and you are destined for greatness. You inspire me to reach great heights. I would also like to thank my spiritual parents Pastors Tich and Princisca Tanyanyiwa for investing in me. I am grateful to the rest

of my family-brothers, sisters, my parents and in laws- for all the love and support you have given me over the years and to all my brothers and sisters for the moral and practical support.

Last but not least, I would like to thank the institution that made it possible for me to complete this PhD. The GCI-Global Change Institute (under the Carnegie Grant) for providing a generous stipend and funding that supported my entire studies. Thank you for organising workshops and writing retreats-platforms from which I benefited from various experts who helped me refine my work.

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## ABBREVIATIONS

| | |
|---|---|
| APDP | Automotive Production and Development Programme |
| ASI | Aluminium Stewardship Initiative |
| BMW | Bayerische Motoren Werke or Bavarian Motor Works |
| $CO_2$ | Carbon Dioxide |
| CSI | Clean Shipping Index |
| CSR | Corporate Social Responsibility |
| DEA | Department of Environmental Affairs |
| DfE | Design for Environment |
| DTI | Department of Trade and Industry |
| ECMPRO | Environmentally Conscious Manufacturing and Product Recovery |
| EMAS | Eco-management and Audit Scheme Standards |
| EMS | Environmental Management Systems |
| EU | European Union |
| GDP | Gross Domestic Product |
| GRMC | Group Risk Management Committee |
| HC | Hydrocarbons |
| ICC | International Chamber of Commerce |
| IMDS | International Material Data Sheet |
| IMV | International Multipurpose Vehicles |
| ISO | International Organisation for Standardisation |
| KZN | KwaZulu-Natal |
| LCA | Life Cycle Analysis |
| MBSA | Mercedes Benz South Africa |
| MIDP | Motor Industry Development Plan |
| MWh | Megawatt Hours |
| NABU | Nature and Biodiversity Conservation Union |
| NCCRWP | National Climate Change Response White Paper |

| | |
|---|---|
| $NO_x$ | Nitrogen Oxides |
| OECD | Organisation for Economic Co-operation and Development |
| RDZ | Recycling and Dismantling Centre |
| SA | South Africa |
| SEED | Schools Environmental Education Development |
| SOx | Sulphur Oxide |
| SVA | Sustainable Value Added |
| SR | Sustainability Report |
| SVR | Sustainable Value Report |
| TMC | Toyota Motor Corporation |
| TSAM | Toyota South Africa Motors (PTY) LTD |
| TPS | Toyota Production System |
| UN | United Nations |
| UNEP | United Nations Environmental Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VOC | Volatile Organic Compounds |
| VW | Volkswagen |
| VWAG | Volkswagen Aktiengessellschaft |
| WCED | World Commission on Environment and Development |
| WRI | World Resource Institute |
| WBCSD | World Business Council on Sustainable Development |
| ZAR | South African Rand |

# CHAPTER ONE

# FRAMES OF REFERENCE

## 1.0 Introduction

Manufacturing in capitalist societies has always been predominantly driven by profit attainment, seeking competitive edge and outsmarting rival products (Petrella 2000). Markandya (2009) observes that capitalist societies are characterized by private ownership of wealth and a relentless quest of profit in production. Motor vehicle manufacturing industries form part of the manufacturing industries, therefore playing significant roles in exploiting resources. Manufacturing industries play a central role in the economies of most countries and have been cited as major contributors to environmental degradation (Strike, Gao, & Bansal, 2006). Strike *et al.* (2006:851) identify multinational companies as 'pollution-intensive industries' which have a tendency of vacillating between acting responsibly and irresponsibly in environmental protection initiatives. Maxi (2003) draws our attention to the fact that corporations operating in developing countries often exploit resources irresponsibly as environmental regulations therein are more lax compared to head office country regulations. This same disregard extends in some instances to using underdeveloped and developing nations as environmental dustbins in the search for profit (Maxi, 2003). Vehicle manufacturing industries are in turn located in different countries thus requiring enabling environments for their operations to flourish. This industry operates in different global environments, which are controlled by various regulatory structures and market forces (Zhu, Sarkis and Lai, 2007).

Borghesi and Vercelli (2003) are of the view that the developments of global markets aided by capitalism have led to a world-wide increase in inequality and environmental degradation. Examples of environmental degradation that have materialised and worsened as globalisation intensified include global warming, thinning of the ozone layer, loss of biodiversity, depletion of natural resources, widespread deforestation and desertification (Borghesi and Vercelli, 2003). Medovoi (2002) observes that capitalism/globalisation has facilitated exploitation of workers and the environment as corporations compete to extract the greatest possible value in a drive to increase market share and ultimately profit. Munasinghe (1999)

observes that government policies from historical times have supported economic prosperity and growth but this inevitably comes with increases in resource use and harmful emissions thereby exerting more pressure on the environment. The industrial revolution and the mechanisation that took place in this period led to an increase in the exploitation of natural resources (Borghesi and Vercelli, 2003). This exploitation, however, came with environmental pollution leading to deterioration in the quality of raw materials. The industrial revolution paved the way for economic and population growth thereby encouraging a direct increase in industrial activity which was consequently coupled with progressive environmental degradation as a direct result of higher resource exploitation and stiffer competition for resources (Borghesi and Vercelli, 2003). The industrial revolution brought in new business values that were spread all over the world by free markets, in which nature was seen as merely existent to satisfy human needs as opposed to nature having its own intrinsic and irreplaceable value (Borghesi and Vercelli, 2003). Successive technological innovations have continued to introduce new environmental problems (see Borghesi and Vercelli, 2003).

In analyzing profit-oriented production that disregards the environment Petrella (2000) identifies economic and political leaders as the major proponents of this prevailing system, which creates conducive environments for corporations' activities. Petrella (2000:67) further ascertains 'individualism, marketism and capitalism' as the three principles that form the basis of societal operations and have been in practice for over twenty-five years. Capitalism as a principle is concerned with wealth (financial) generation and places value on financial profitability. This system promotes the creation of financial capital and is markedly against anything that hinders profitability (Petrella, 2000). Medovoi (2002) draws our attention to the fact that the transformation of capitalism has awarded transnational corporations immense power over governments, people and the environment. Freund and Martin (1996) observe that the use and production of motor vehicles is tied strongly to capitalism and the way in which capitalistic influences have shaped and structured consumption. Technological developments, mass production, aggressive marketing and strong political frameworks are some of the elements that have aided vehicle production (Freund and Martin, 1996). Vehicle manufacturing under capitalism however, tends to ignore environmental problems tied to resource exploitation despite recognition of manufacturing related environmental ills from as early as the 1960s and 1970s (Freund and Martin, 1996). Vehicle production in countries of the South is expected to increase significantly over the years in order to satisfy the rising

demand for automobiles thereby leading to further resource depletion and environmental degradation (Freund and Martin, 1996).

Internationalisation of industries has led to the formation of complex links and in order to compete globally firms have now started franchises, joint ventures, licensing or subcontracting agreements (Van Veen-Groot and Nijkamp, 1999). Srivastava (2007) for example, refers to these global agreements as mega-ventures and mega-alliances due to their vastness. The motor vehicle manufacturing industry has been cited as a capital intensive industry which participates actively in this global competition (Van Veen-Groot and Nijkamp, 1999). Society has been governed around maximum exploitation of resources in an attempt to maximise on profitability (Munasinghe, 1999; Petrella ,2000). This disregard for the environment has exploited and damaged the environment with examples seen in the ecological footprint problems and environmental pollution (Van Veen-Groot and Nijkamp, 1999; Gurtu et al., 2016). The motor vehicle manufacturing industry is observed as contributing to damaging the global environment by contributing to the greenhouse effect and the depletion of the ozone layer (Van Veen-Groot and Nijkamp, 1999). Markandya (2009) argues that traditional environmental regulation focused on preventing certain modes of production that were deemed harmful to the environment, but it is apparent that more needs to be done to address the major environmental problems that have come to the fore in the capitalist system and to modify the institutions that exist therein to attain change.

Increased awareness and scientific research in environmental degradation and its link to the global climate change problem has set the pace for seeking alternative ways of production as seen by the development of Environmental Management Systems such as ISO 14000 (Schoenherr, 2012). This has raised the importance of taking into account sustainable production practices and considering environmental sustainability (Gungor and Gupta, 1999; Orsato and Wells, 2007). Munasinghe (1999) points out that there is a lesson to be learnt from the experiences of industrialised nations which experienced growth that came with increased and irreversible environmental damage. Sustainable development as an alternative to the profit seeking model, allows constant improvement to the quality of life but in a way which allows future generations an 'undiminished or even enhanced stock of natural resources' (Munasinghe, 1999:89). This increased environmental awareness has given rise to the green economy approach. Spencer *et al* (2010) highlight the need to move away from investments that are capital and resource intensive, towards the green economy approach which is also termed the low-carbon economy.

The vehicle manufacturing industry is located within this global and local context which emphasises environmental preservation in carrying out economic activities. Globally, there is increased concern on the importance of preserving the environment ultimately leading to mitigating the effects of climate change. Gungor and Gupta (1999) point out, for example, that consumers have started showing an interest in environmentally friendly products thus forcing manufacturers to design 'green products'. Environmental laws, regulations and tax implications play a part in forcing manufacturers to pay attention to environmental concerns (Gungor and Gupta 1999). Environmental preservation has gained importance through a realization that the environment is made up of both finite and infinite resources which are being exploited haphazardly thus posing a threat to the survival of future generations (Hart, 1997). South Africa as an emerging economy is not immune to developmental pressures and the activities of vehicle manufacturing industries and is therefore, likely to experience similar global pressures experienced in other countries in attempting to lessen negative effects on the environment.

## 1.1 Problem Statement

In South Africa, the manufacturing industry within which motor vehicle manufacturing is located is the biggest industry in the country contributing significantly to the GDP of the country (Du Toit, 2003; Kaggwa, 2008; Ambe and Badenhorst-Weiss, 2011). Damoense and Simon (2004) are of the view that the motor vehicle manufacturing industry is a significant subdivision of the local manufacturing sector and has become more exposed to globalisation from 1994 when South Africa attained democracy. Success within vehicle manufacturing in South Africa has been aided by favorable industrial policy (such as the Motor Industry Development Programme) that was geared towards reviving the automotive sector and vehicle manufacturing in the country has become the most successful sector as a result (Barnes and Black, 2013). The motor vehicle manufacturing industry in South Africa competes actively in the global economy with an impressive export performance (Kojima and Kaplinsky 2004, The Department of Trade and Industry, 2013). BMW has included South Africa as its base for the BMW right-hand drive 3 series model and thus prompted competitors such as VW to increase their exports (Barnes and Morris, 2008). Toyota followed this trend by exporting the Corolla and IMV models in high quantities (Barnes and Morris, 2008).

Production in the country has been aligned to parent company operations and this has afforded South African producers a global presence and a position in global value chains (Barnes and Morris, 2008; Barnes and Black, 2013). Examples of corporations that are active in the South African motor vehicle manufacturing industries include but are not limited to Toyota, BMW, Volkswagen and General Motors (Barnes and Morris, 2008). Vehicle manufacturers now manufacture globally standardized vehicles and have to adhere to specified performance targets in order to remain competitive (Barnes, Black and Duxbury, 2016). Global operations however have to take into account global concerns on the protection of the environment.

Zhu *et al.* (2007) point out that success in the vehicle manufacturing industry is, however, tied to significant environmental burdens and natural resource shortages. This massive industry actively consumes natural resources and emits harmful gases in production as well as throughout the use of manufactured vehicles (Zhu *et al.* 2007 and also Freund and Martin, 1996). This shows that vehicle manufacturing plays a great part in environmental degradation through exploiting finite resources and emitting harmful gases such as carbon dioxide into the environment (Zhu *et al.*, 2007). Manufacturing is also intricately linked with urbanisation as it provides lucrative opportunities for employment. Industries encourage development around them as infrastructure is set up to support resultant industrial activity (Njoh, 2003). As a result cities and city-regions are facing ecological resource constraints, which have interfered with the traditional way of conducting business (Swilling, 2010). African and Asian cities are expected to absorb an additional two or three billion people estimated to be living on earth by 2050 (United Nations 2005 cited in Swilling 2010). These figures have intensified the pressure on nations to come up with newer and innovative ways to sustain their economies without compromising the environment in the process.

Multinational corporations however are still identified as contributing significantly to environmental problems, fuelled by globalisation and the incessant growth of power they yield over resource ownership and utilisation (Little and Green, 2009). Chakrabarty and Wang (2013) are of the view that corporations can play a significant role in reducing greenhouse gas emissions. This is because corporations have been cited as major contributors to a range of identified environmental problems (Christmann and Taylor, 2001; Christmann, 2004; Strike *et al.*, 2006). The sustainability debate is fraught with complexities particularly for multinational corporations within which industries such as the vehicle manufacturing sector are located and national governments which benefit from corporations' activities

(Chakrabarty and Wang, 2013). Corporations by their nature seek to realize profits and emphasize that environmentally friendly approaches kill their competitive edge (Chakrabarty and Wang, 2013). Figge and Hahn (2012) argue that business generally prioritises models that come with an improvement on the financial performance over models that solely benefit the environment or those that balance profits by taking the environment into account. Montmasson-Clair (2012) highlights that governments seek to fulfill economic growth and raise employment opportunities through the activities of corporations. A conflict of interests therefore generally exists in dealing with climate change and sustainability initiatives, as different stakeholders seek to fulfill different interests and obligations that might not necessarily be beneficial to the environment. The different levels of development in various countries also pose potential disagreements amongst nations as other parties advocate for reduction of emissions whilst others seek to protect economic interests (Banerjee, 2012). There, however, is a degree of consensus that certain industrial processes, agricultural practices and energy sources (and their use), threaten to worsen the impacts of climate change thereby directly affecting sustainability.

Beamon (1999) points out that as manufacturing industries are primarily to blame for environmental degradation it is imperative for them to change their production systems and adopt sustainable production processes. Environmental Management Systems with specific reference to the ISO 14000 series were developed with the aim of guiding and assisting organisations to move towards ecologically sustainable practices (Beamon, 1999). Schoenherr (2012) explains that aligning with initiatives such as ISO 14000- certification, reducing waste, controlling pollution or engaging in recycling of waste demonstrates a commitment to environmental sustainability. In order to achieve green supply chains, organisations need to identify inputs, outputs, by-products and resources that go into making each product, develop performance measurement systems, measure the supply chain systems, develop alternatives and establish audit and improvement procedures (see Beamon, 1999). Orsato and Wells (2007) point out that a number of manufacturers in the automotive industry have made great strides in reducing the impact production has on the environment. They, however, argue that this initiative was not directly to benefit the environment but aimed more at cutting costs and ultimately increasing productivity and profitability. An example of this type of approach is given as the Toyota Production System (TPS), which seeks to eliminate waste from all processes and activities. The TPS formed the basis for lean production and eco-factories and the essence of this practice is to attain waste elimination (see Orsato and

Wells, 2007). There still however remains a strong base to show that such innovative moves on the part of automakers such as Ford and Toyota were used to gain competitive edge in business (Orsato and Wells, 2007).

Drawing from the global debates on environmental protection, the development of International Standards of Operation (ISO) [e.g. ISO 14000 for example] and the link between vehicle manufacturing and environmental degradation, this study sought to investigate how the motor vehicle manufacturing industry in South Africa negotiates sustainability demands in the search for profit. This is in respect of their operations from the way they source their raw materials, production locations, interactions with suppliers, actual production, and movement of finished products and their negotiation of environmental regulations (regulations in South Africa as well as global environmental regulations which have a bearing on vehicle manufacturing in SA). Zhu *et al.* (2007:1042) argue that all stages of a product's life cycle from resource extraction, manufacturing, use and reuse, recycling or disposal will influence a supply chain's environmental burden. This study therefore sought to analyse how global companies such as Toyota, VW, Mercedes and BMW adopt and adapt to sustainability demands in their operations in line with adjusting to the green economy imperative.

## 1.2 Research Questions

In view of the above observations, the following questions guided the research process:

i. How has the vehicle manufacturing industry aligned its operations with the requirements of environmental management systems such as the ISO 14000 both at local and global levels?

ii. In what ways has the increased environmental awareness and the emergence of the green economy impacted upon the vehicle manufacturing industry?

iii. In what ways do multinational corporations negotiate the various regulatory environments they operate under- on a local, national (in host countries) and international level (in originating countries)?

iv. In what stages of the value chain are green practices adopted to ensure production initiatives are environmentally friendly?

v. In what ways do motor vehicle manufacturers interact with their various suppliers and how does this interaction contribute to sustainability or affect the immediate environment?

## 1.3 Aims and Objectives

In light of the contestations and global debates that exist around environmental management and the operation of corporations, this study therefore sought to understand how the motor vehicle manufacturing industry in South Africa has adapted its operations to align with requirements for sustainable production practices stipulated by the ISO 14000. This study aimed to trace how the motor vehicle manufacturing industry in South Africa has responded over time to local and international trends in adopting sustainable production methods along its value chain. Apart from seeking to understand how the industry aligns itself to the green economy imperative, the study also attempted to understand how motor vehicle manufacturers interact with suppliers as the supplier activities compound the overall impact exerted onto the environment. The study set out to understand the economic, political and social consequences of these changes for individuals and corporations and the resultant effects on the environment in South Africa.

In view of the aims identified above, the objectives of the study were as follows:

i. To establish whether the motor vehicle manufacturing industry has aligned to sustainability imperatives
ii. To assess whether corporations take the environment into consideration as they carry out their operations
iii. To examine the way in which motor vehicle manufacturing industries interact with their suppliers and the immediate environment
iv. To generate knowledge on the way the motor vehicle industry operates within South Africa in the context of a green economy

## 1.4 Research Gap and Rationale of the Study

In view of the increased environmental problems experienced globally there is a continued movement away from capital and resource intensive production towards the 'green economy', the 'Global Green New Deal', 'Green growth' approach, 'ecological civilization' or 'green development' (Swilling, 2010). In South Africa, the size of the vehicle manufacturing industry coupled with the pressure it exerts on the environment provides a suitable context within which to carry out a study analyzing how the industry is responding to sustainability demands.

Swilling (2010) illustrates that the USA has allocated US$100 billion to green investments; China has set aside 4 trillion Yuan for green technology investments. Spencer *et al.* (2010) show that the Gauteng strategy for a green economy set aside over fifty million rands to cater for research costs as well as implementation of green projects. This amount was distributed amongst the various functions in the region such as food security, energy security, and long term water supply to cite a few. All these efforts highlight that there is a general awareness that as urban populations grow rapidly, environmental protection should drive growth as opposed to confining development. Amidst such developments Swilling (2010:15) however, notes that there is a lack of a government driven initiative in 'South Africa to connect industrial policy, resource management and the protection of ecosystems'. It is in this context that this research seeks to understand how the vehicle manufacturing industry in the country is aligning to the green economy and the various ways in which the industry adjusts to the green imperative.

Brent (2005) elaborates on evaluations on environmental performance by original equipment manufacturers in the automobile sector in South Africa with specific reference to supply chain management. That study was carried out in light of the pressure on multinational vehicle manufacturing corporations to integrate sustainability into planning and management over the life cycle of a project in a drive towards preserving the environment (Brent, 2005). Brent (2005) points out that the South African automobile supply chain contributes to the environmental burden through discharge of toxic substances, greenhouse gas emissions, groundwater pollution, destruction of habitats and solid waste production. Brent's study however, focuses on the environmental performance of original equipment suppliers in the vehicle manufacturing industries. This study elaborates upon the operations of specified

multinational companies in vehicle manufacturing in South Africa, to understand whether they had adjusted to green manufacturing in the whole value chain and how they attained this.

A number of studies which have been carried out in the motor vehicle manufacturing industry in South Africa tend to focus on the Motor Industry Development Plan (MIDP) and how South African vehicle manufacturers fare in the global arena. Barnes and Morris (2004) expand on globalisation in vehicle manufacturing showing how global forces tied with government industrial policy have actively influenced the presence of German multinationals operating within South Africa. Borghesi and Vercelli (2003) state that globalisation has led to inequality within countries and the long-term correlation between the recent process of globalisation of international markets and environmental degradation is evident. This link is however not explored by Barnes and Morris in their study. A number of authors have written on the MIDP that was implemented in light of the problems that the domestic automotive industry had been facing (Flatters, 2002; Barnes and Morris, 2004; Lamprecht, 2006; Barnes and Morris, 2008; Black 2009). This was an attempt by the South African government to promote and encourage growth and development in the automobile industry. These studies in the vehicle industry in South Africa have traced historical changes in the industry and analysed the success and relevance of the MIDP and the global presence of South African vehicle manufacturers. This study however analysed the adjustment of the vehicle industry to recent developments brought about by increased environmental awareness with specific reference to the green economy. The study detailed how government policy and increased production plays a role in either preserving the environment or contributing to degradation and how corporations deal with environmental considerations in their search for profit.

Kehbila *et al.* (2009) point out that vehicle manufacturing dominates the South African economy but simultaneously contributes significantly to incorrect waste disposal, deterioration of air quality, noise pollution, degradation of land and marine environment and loss of biodiversity. Despite this realisation by Brent and Labuschagne (2003) and Labuschagne *et al.* (2005) that vehicle manufacturing contributes to environmental problems, Kehbila *et al.* (2009) highlight that vehicle manufacturing in relation to the environment in South Africa remains an under researched area. Kehbila *et al.* (2009:311) highlight that sustainable development initiatives in South Africa generally 'lack clarity and determination'. There is a dearth of information regarding how motor vehicle manufacturers in South Africa have utilised environmental management systems and the emergent results (Kehbila *et al,* 2009). The study carried out by Kehbila *et al.* (2009) seeks to understand why vehicle

manufacturers adopted EMS in their operations, the barriers to successful implementation as well as the benefits. This study elaborates further on the use of tools such as EMS to explain how the motor vehicle industry in South Africa negotiates environmental sustainability in the way the industry interacts with suppliers, the materials used in production, extraction of resources, product manufacturing, waste disposal, transportation and use of finished goods in the search for profits. This study looked at the practical application of sustainable production means in vehicle manufacturing and the way in which this has been attained in the context of the green economy in South Africa.

The South African economy is described as energy intensive and the country's dependency on coal driven energy has contributed to high carbon dioxide emissions. Carbon dioxide emissions in the country contribute more than 80% of the total greenhouse gases emitted into the atmosphere (Miranda and Larcombe, 2012)). The manufacturing industry is reliant on energy and has been identified by Miranda and Larcombe (2012) as an important source of job creation in the green economy. This study therefore, set out to understand how the motor vehicle manufacturing industries in South Africa have adapted operations to align with requirements for sustainable production practices as stipulated by the ISO 14000 and to trace how local and international trends in adopting sustainable production methods along production value chains have impacted upon the South African vehicle manufacturers.

This study explored the movement towards a green economy (or lack thereof) in the vehicle manufacturing industry in South Africa vis-a-vis local and global policy initiatives. The study will contribute experiential data on the vehicle manufacturing industry and any adjustments which have been carried out in adapting to the green economy initiatives and the consequences emergent thereof. This will be in an attempt to widen the existing body of knowledge on the green economy, with a specific focus on but not limited to the vehicle manufacturing sector and the profitability mandate. The study will therefore contribute pertinent information that can be used to influence green economy policies in the country going forward in relation to developmental goals. The sections that follow give the scope of the study, ethical consideration and an outline of the chapters detailing the organisation of the thesis.

## 1.5 Scope of the Study

The South African vehicle manufacturing sector is described as South Africa's most

important sector and is comprised of major multinationals based within the country (DTI, 2015). A wide variety of vehicles are produced within South Africa such as passenger cars and commercial vehicles (light, medium, heavy and extra heavy) as well as buses. In 2015 the industry had more than 55 brands and 2872 passenger car model derivatives for consumers to choose from (Lamprecht, 2016). The industry is located mostly within Eastern Cape and Gauteng and partly in KwaZulu-Natal. Manufacturers such as BMW, Mercedes Benz, Volkswagen, General Motors, Ford, Toyota, Fiat, Tata, Renault and Nissan have established bases within the country (DTI, 2015). In 2014, 566 131 vehicles were produced and in 2015 this figure increased to 615 658 units (Lamprecht, 2016). In 2015, the vehicle and automotive component manufacturing industries accounted for 33,5% of the country's total manufacturing output an increase of 3,3% from 30,2% in 2014 (DTI, 2015).

Vehicle manufacturers employed an average number of 29 715 people on a monthly basis in 2014; this figure increased to 31 260 in 2015 and the automotive component sector employment figures for 2014 and 2015 were 82 790 and 82 100 respectively (Lamprecht, 2016). Direct and indirect employment generated as a result of vehicle manufacturing is well above 100 000 people and if other industries that benefit from vehicle manufacturing are taken into account this figure will increase considerably. The total value of vehicle exports in 2014 amounted to ZAR 70 billion and in 2015 this amount increased to ZAR 101,9 billion (Lamprecht, 2016). In 2014 the vehicle manufacturing industry contributed 7,2% to the country's GDP compared to 5,5% in 1999 and the share contribution to the GDP has increased steadily from 5,5% in 1999 to a high of 7,5% in 2015 (DTI, 2015).

Automotive production has strong linkages to other manufacturing sectors within the country (Lamprecht, 2016). Due to the vastness of the industry and the impact it has on the overall economy, the South African Government has identified the vehicle manufacturing industry as a key growth sector. This is seen in the MIDP (Motor Industry Development Programme) which came into effect in September 1995 and has now been succeeded by the APDP (Automotive Production and Development Programme) that was launched in 2013 (DTI, 2015). The objective of the APDP is to raise the volume of cars manufactured in South Africa to 1,2 million per year by the year 2020 (Source Business Partners, 2014). This will be achieved through stable import tariffs, vehicle assembly allowance (importing percentage of components duty free), production incentives (allowance for duty free imports), automotive

investment schemes (to aid investment in technology, job creation, plant production volumes, strengthening automotive value chain) (DTI, 2015).

South Africa is home to a number of vehicle manufacturers but this research drew data from the activities of Toyota, BMW, Mercedes and VW. These specific companies were picked purposefully as they are located in different provinces in the country with Toyota located in Durban (KwaZulu-Natal), VW in Uitenhage (Eastern Cape), Mercedes in East London and BMW in Rosslyn (Gauteng) in order to give a balanced sample of the country. Gauteng houses three vehicle manufacturing companies (BMW, Nissan and Ford) and is the economic powerhouse of South Africa. KZN has the second largest economy and houses the busiest bulk port in the country (Richards Bay). Manufacturing is the largest sector in the province and automotive manufacturing plays a central role. The automotive sector in the Eastern Cape is the province's leading exporter and the province has been earmarked as a key growth area for economic development. The province is home to VW, Mercedes, GM Southern Africa and the Ford Motor Company of Southern Africa.

The choice of sites was influenced partly by location (inland and coastal) thus giving insight into environmental management in coastal and inland regions and the fact that these provinces house significant sections of the motor vehicle manufacturing industries in South Africa. The vehicle manufacturers' locations also have different effects on the environment specifically due to their locations. This helped in answering how the green economy imperative is approached in different parts of the country in trying to answer how vehicle manufacturers in the nation have responded to environmental concerns and sustainability demands. The locations of the companies were informative in determining the interconnectedness and interdependencies of places in relation to production and sourcing of raw materials. Corporations in some instances set up production sites on borders to avoid stringent environmental laws, therefore an assessment of location in this study sought to establish the reason behind the specific locations of these corporations. Interviews were conducted with managers in Toyota, VW, Mercedes and BMW. These interviews focused on management as experts as well as the fact that managers are responsible for strategic decisions and direction within companies.

The four different corporations manufacture different types of vehicles hence they are likely to derive their inputs and resources from different suppliers.VW South Africa produces the Golf model which is indigenous to South Africa and possibly derives most inputs from the

country. The plant is located closer to the coast and this has an influence on the transportation of raw materials or finished goods. BMWs are priced higher therefore the assumption is that inputs are more expensive to obtain thus presenting a different angle to production processes. BMW has won a number of sustainability awards within South Africa. Mercedes Benz produces higher priced vehicles but is located closer to a coastal area hence the transportation of raw materials, finished goods and waste disposal is likely to be handled differently to BMW's. The four manufacturers serve different markets in terms of their products and Toyota holds a market share of 19,9%, VW 15,9%, Mercedes 5,3 % and BMW 3,8% (Lamprecht, 2016). The manufacturers therefore have different economic outreaches with Toyota argued as using relatively lower priced materials hence manufacturing more affordable cars. VW states that its cars are made up of recyclable materials hence have a more developed approach to the product life cycle. BMW South Africa recently moved into the production of the fifth generation of the 3 series but had been mostly focussing on assembling vehicles prior to the recent developments. The differences inherent in these corporations served as a platform to assess their approaches to sustainability or lack thereof albeit manufacturing in a similar country.

The study therefore adopted a life cycle approach towards analysing the way in which vehicle manufacturers take the environment into consideration as they produce. This was not limited to the actual production plant but spanned across the entire life cycle of a vehicle from sourcing, transporting and the types of raw materials, the interactions with suppliers, stages in vehicle production, energy and water use, transportation of finished vehicles, use of the vehicles as well as disposal at the end of the vehicles life. All the various stages have distinct and different effects on the environment as they contribute to environmental damage. In considering all these stages the study sought to establish whether motor vehicle manufacturing industries can actually be sustainable.

## 1.6 Ethical Considerations

Ethical guidelines in research emphasise the importance of informed consent and this is obtained through explaining to participants the research purpose, harms or benefits of participating, confidentiality, use of data and their right to withdraw should they wish to do so (Flicker et al, 2007). Ethical behaviour in research is centred on protecting individuals, environments and communities within which research is conducted. Ethical behaviour guides researchers in ways that are right and virtuous and this help increase good and reduce harm

(Israel & Hay 2006). This study involved interaction with participants mainly through interviews (structured and semi structured). The corporations that were involved in this study are competitive entities which are in business for various reasons of which profitability is one. These corporations depend on their image for growing brands and expanding market share. A number of ethical considerations were taken into account in carrying out this research as it was important to conduct research in a morally acceptable manner.

In this respect when this study was carried out considerations such as confidentiality, informed consent, anonymity, access and acceptance were taken into account. The purpose of the study and methods were explained to the participants in order for them to make informed decisions about participating in the study. Consent forms were used and participants were made aware that participation was voluntary and they could withdraw from the study without any consequences to them. Participants were assured of confidentiality and anonymity and this gave them space to express their views. Creswell (2003) advises that researchers ought to respect participants and study sites and highlights the need to seek informed consent from participants. Informed consent protects the rights of participants during data collection and consent entails that participants take part voluntarily, understand the purpose of the study, and have the right to ask questions or to withdraw from the study without facing repercussions. Other ethical aspects that were taken into account included negotiating access to sites and guaranteeing confidentiality of participants (Creswell, 2003). Ethics clearance was obtained from the University of the Witwatersrand to ensure the study would be carried out in an ethical manner and the certificate is attached-(see Appendix F).

## 1.7 Structure of the Thesis

The first chapter details the frames of reference thus giving a brief theoretical background, the problem under investigation, research questions, aims and objectives. In this chapter the study is positioned, the scope of the study illustrated and ethical considerations that were taken into account for the study are outlined. The **second chapter** presents an in-depth review of literature on sustainability, profitability and environmental management within vehicle manufacturing. The **third chapter** provides a brief description of the study sites and then details the methods utilised to gather data on how global vehicle manufacturing companies adopt and adapt to sustainability demands within their operations. **Chapter four** presents empirical evidence obtained from interactions with vehicle manufacturers, their

suppliers, retailers and customers. **Chapter five** analyses and discusses the empirical evidence. The research findings are contrasted with the impact increased environmental awareness (through the emergence of the green economy) has had upon the vehicle manufacturing industry. **Chapter six** will present the overall discussion and final analysis of the debates around which this study revolves, present recommendations and possible areas for future research.

# CHAPTER TWO[2]

# THEORETICAL CONSIDERATIONS AND LITERATURE REVIEW

## 2.0 Introduction

This chapter details the contextual background and theoretical debates that have shaped and informed the sustainability debate and the relationship sustainability has with manufacturing. The chapter explores how and why the green economy imperative has emerged as well as the contestations that are tied to the sustainability debate. The second concern which is interlinked with the first question is how manufacturing which is largely driven by profitability can comfortably co-exist with the green economy which is concerned with minimal use of non-renewable resources. The argument in this chapter is that the green economy with special reference to sustainability imperatives is subject to manipulation depending on the user's needs. Placing sustainability within manufacturing where the main goal is profitability thereby inadvertently exposes and subjects sustainability to further manipulation to suit manufacturers' needs. The purpose of the chapter is to trace developments within the green economy debates and the link to 'responsible' manufacturing and how the developments have evolved over the years. By discussing the changes in the way the environment is valued the chapter relates the techniques business has adopted in dealing with environmental concerns and this helps relate (in subsequent chapters) whether sustainability and profitability can co-exist.

In this chapter key concepts are defined. A background to vehicle manufacturing in the country as well as a global overview of the developments that have occurred within vehicle manufacturing is given. A conceptual framework is developed in relation to corporate firms,

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[2] This chapter is based on a paper that has been accepted for publication in the International Journal of Sustainable Design.

Mutumi, P.P.J. and Simatele, D. (2017). Can the Motor Vehicle Manufacturing Industry be Sustainable? Exploring the relationships between Profitability, the Green Economy and Environmental Sustainability in South Africa. *International Journal of Sustainable Design*. 20, (3/4) 285-305.

sustainability and profitability whereby motor vehicle manufacturers are positioned vis-a-vis other actors in the economy. This gives insight into the sustainability debate as well as business's attitude towards sustainability and profitability. Drawing on this framework the next section within the chapter gives a contextual analysis of corporate firms' activities, their approach to sustainability and profitability specifically within South Africa. This is based on the position of vehicle manufacturers within the economy, implications on the country's GDP, green growth, energy sources and the overall policy environment prevalent in the country. Subsequently an analysis is given on the green economy drive from a global perspective as well as within South Africa. This section seeks to highlight the arguments for moving towards greening the economy, how attainable this is within vehicle manufacturing as well as illustrating what has driven vehicle manufacturers towards greening the production process.

## 2.1 Definition of Key Concepts

In order to understand sustainability in the context of vehicle manufacturing it is essential to understand concepts such as sustainable development/environmental sustainability, the green economy and profitability. These terms are used within corporates when dealing with sustainable manufacturing and vehicle manufacturing within South Africa. The use of the terms is also widespread in the role the country has adopted in dealing with multinational companies in vehicle production vis-a-vis environmental protection demands on national and international levels. Sustainable development and sustainability are terms that are cited in most political, business and strategic documents but the meanings in each of these documents is not always the same albeit comprising the same basic fundamentals (Moldan *et al.*, 2011).

### 2.1.1 Sustainable Development and Sustainability

Sustainable development and sustainability remain contested terms with various definitions accorded to try and explain the terms. Sustainable development has been defined as development that caters to the needs of current generations whilst ensuring future generations' needs are not compromised (WCED, 1987). Moldan, Janouskova and Hak (2011) highlight that sustainability can be categorized into three distinct pillars namely social, economic and environmental sustainability and all these pillars determine whether development is sustainable. Figge and Hahn (2012) clarify that for development to be

sustainable economic imperatives should not dominate above societal and environmental imperatives, even within the corporate setting.

Economic sustainability defined by Markandya and Pearce (1988) is the optimal use of current resources in a way that ensures real future incomes are not reduced thereby ensuring access to resources for each subsequent generation are met. Social sustainability is broadly defined using three components: meeting basic needs (social capital, justice, equity) on an intergenerational scale, changing human behavior to meet bio-physical environmental goals and aspects that can be sustained in social terms (preservation of socio-cultural aspects) (Vallance, Perkins and Dixon 2011). Environmental sustainability focuses on bio-geophysical aspects and deals with maintaining or improving the quality of earth's life supporting systems. Human beings however are ideally the main focus in sustainable development as they are entitled to thrive whilst at the same time living in harmony with nature on a longevity basis taking into account the fact that natural resources are finite and they have limited capacity to support life (Moldan et al., 2011).

### 2.1.2 The Green Economy

Brand (2012) likens the green economy concept to the sustainable development debate by stating that this concept groups together different contradictory concepts and interests in a bid to make them work in harmony. The green economy or green growth debate is addressed from a perspective that combines environmental sustainability and economic/industrial policies in an attempt to come up with 'win-win' solutions to the global challenges (Bina, 2013; Bailey and Caprotti, 2013). Despite integrating the economy, environment, society, different actors, expected outcomes and requisite regulatory structures, the green economy is expected to improve human well-being, social equity, and ecological well-being and reduce environmental risks (Bailey and Caprotti, 2013). Brand (2012), highlights that the green economy strives to attain a low-carbon economy, efficient resource use, technological innovation, green jobs and investments and ultimately eradicate poverty and ensure social justice. The basis for the green economy is that ambition for growth driven by investments that reduce emissions and pollutions should be supported by policy and a change in the laws (Barbier, 2012). Critiques of the green economy however highlight the fluidity of the definition and the strong economic drive behind greening the economy that can be interpreted

as a guise to support capitalistic accumulation strategies albeit in a strategic manner (Wanner, 2015; Bailey and Capriotti 2013; Brand, 2012).

### 2.1.3 Interaction and Trade-offs Among Sustainability Goals

Research into corporate sustainability highlights the predominance of economical outcomes over the environment and societal considerations as businesses focus on the return on economical capital utilised over social and environmental capital (Hahn and Figge, 2011). Profitability in corporations is defined mostly along the traditional bottom line approach, a concept that argues the role of business is to use resources in a manner that maximises on returns (Figge and Hahn, 2012; Jackson and Victor, 2011). According to sustainability principles however, business is required to take into account aspects of environmental soundness, financial success and social justice/equity in what has been termed the triple bottom line (Bryson and Lombardy, 2009). The assumption is that the three sustainability pillars can exist in harmony and they are usually given the same importance and this has shortfalls in of itself (Bryson and Lombardy, 2009). These three pillars within corporates however cannot be achieved simultaneously as trade-offs and conflicts arise amongst them as a result of the complexities surrounding sustainable development (Hahn *et al.*, 2010). Hahn and Figge (2011) point out that the economic aspect (profitability) takes priority over environmental and social aspects as it is still the driving force in businesses and the notion of corporate profitability is still deeply embedded in research carried out in corporate sustainability. Evidence from various sources of literature points out that the driving force behind corporations advocating for the environment and society is directly linked to enhancing financial outcomes and Figge and Hahn (2012) term this 'the business case for sustainability'.

## 2.2 Vehicle Manufacturing and the Environment: Globally and in South Africa

Rapid development initiatives, increased production demands and a constant movement away from agricultural societies into manufacturing oriented economies characterize the 21st century society (Swilling, 2010). Manufacturing industries play a central role in the economies of most countries but have been cited as major contributors to environmental degradation (Strike et al., 2006). This can be tied directly to the manufacturing industries'

intensive and extensive consumption of natural resources that form the basis of production. Vehicle manufacturers, for example, make use of iron ore for steel production, aluminium and petroleum for plastic, animal hides for interior linings and leather seats, copper for starter motors, wood for interior panels and rubber for tyres, all of which are resources that are directly extracted from the environment and involve the use of heavy machinery which may not be environmentally friendly (Strike et al., 2006). The South African economy is described as energy intensive in comparison to Asia and Latin America and it relies heavily on coal making the country carbon-intensive (Winkler, 2007). Strike et al., (2006) identify the motor vehicle manufacturing industry as an industry that contributes to high pollution levels and is irresponsible concerning environmental protection initiatives. It has been argued that profit oriented corporations, from as far back as the 1960s to date have been in denial of the effects resource extraction has on the physical and natural environments (Hart, 1997).

Petrella (2000), for example, is of the view that manufacturing in capitalist societies, has been predominantly driven by profit attainment, seeking competitive edge and outsmarting rival products at the expense of environmental wellbeing and sustainability. Edifying this observation, Markandya (2009) asserts that capitalist societies are now characterized by private ownership of wealth and a relentless quest for profit in production. The motor vehicle production industry forms part of the corporate world and it is part of the manufacturing cohort that plays a significant role in natural resource extraction, exploitation and utilisation. Despite the assumed resource intensity, the industry operates in diverse global environments, which are controlled by different regulatory systems, structures and market forces (Zhu *et al.*, 2007). These systems and mechanisms may have varying influences on the extent to which the industry utilises environmental resources and practices sustainability.

The process of globalisation and technological transformation has in a big way triggered the formation of complex systems, structures and links in terms of information flows and resource distribution. In order to compete globally, many firms have now begun franchises, joint ventures, and licensing, subcontracting agreements and have created boundaries of monopolies in terms of market and resource access (Van Veen-Groot and Nijkamp, 1999). Srivastava (2007) refers to these global agreements, as mega-ventures and mega-alliances and these are developed in order to capture the market or secure rights of access to specific natural resources.

Motor vehicle manufacturing industries are capital intensive, participate actively in global competitions for natural resources, and thereby contribute significantly to environmental degradation (Van Veen-Groot and Nijkamp, 1999). Technological advancements within the industry have contributed significantly in environmental dilapidation and destruction as they have afforded corporate firms with equipment, tools, means as well as huge financial resources which have made it easier to access and extract natural resources in large quantities spreading over large geographical scales. Although these developments have improved production processes significantly through computerised systems, highly mechanised robots, and a wide range of sophisticated machinery- they have had negative impacts on the environment, natural resources and ecosystems (Borghesi and Vercelli, 2003). Naturally occurring resources, as observed by Abdul-Wahad and Marikar (2012) are constantly being exploited to meet and satisfy increasing human needs and demands. In the process the intrinsic and irreplaceable value of natural resources is trivialised as the goal is to supply more natural resources in order to meet increased demand (Domosh *et al.*, 2015). Marvasti (2000) emphasises that disregarding the environment has not only resulted in the exploitation of natural resources, but in environmental degradation resulting in contemporary challenges associated with changes in the ecological footprint, climate change and environmental pollution (Van Veen-Groot and Nijkamp, 1999).

The vehicle manufacturing industry however, to a large extent draws heavily on government policies that have been developed with a view of promoting economic prosperity and growth, as well as national development. Munasinghe (1999) for example, argues that while national policies are developed to address development issues, they inevitably have negative environmental implications if managed and implemented solely from a profit perspective. The drive for profitability exhibited by multinational organisations and governments, has pushed the environmental conservation agenda to the periphery and environmental stewardship has become a rare item in policy discussions and dialogue (Medarevic, 2012). Analysing profit-oriented production, Petrella (2000) identifies economic and political leaders as the major proponents of this system, which creates conducive environments for corporate firms at the expense of the natural environment. He ascertains that 'individualism, marketism and capitalism' are the three principles that form the basis of contemporary societal organisation and operations and these systems have been in practice for over twenty-five years (Petrella, 2000).

Capitalism as a principle is concerned with profit (financial) generation and places value on financial profitability. This system promotes the creation of financial capital and is markedly against anything that hinders profitability (Petrella, 2000). The continual transformation of capitalism has afforded transnational corporations immense power over governments, people and the environment (Medovoi, 2002). The motor vehicle manufacturing industry, like most industries, operates on the principle of profit making and is thus, heavily embedded and strongly tied to capitalistic influences. These influences manifest in different ways, but one of the most viable influences, has been in increased mass-production of cars that has been accompanied by aggressive marketing, using technologically advanced advertising systems to push up both production and sales. This is done through a strong political narrative and citizenry consumptive behaviour that largely supports production as a means for both economic growth and national development as illustrated in the South African Motor Industry Development Plan (Freund and Martin, 1996). While several vehicle manufacturing companies claim to conduct their activities in a sustainable way, Freund and Martin (1996), express the opinion that environmental issues are often ignored in these companies' strategic development plans and that sustainability is often used as a guise to promote the marketability of their products (Spencer *et al.*, 2010).

Corporate social responsibility (CSR) initiatives for example have been adopted by manufacturers to cover a wide range of activities such as human resources management, environmental protection and societal well-being to cite a few (Sheikh and Beise-Zee, 2011). These initiatives emerged as a result of increased pressure on companies to act as good citizens and are designed to improve company reputations within controlled expense parameters to protect shareholders' investments whilst ensuring profits remain favorable (Sheikh and Beise-Zee, 2011). CSR is largely explained under sustainability and companies use it as a business promotion and marketing tool thereby, inadvertently shadowing the importance of environmental sustainability in the process (Du, Bhattacharya and Sen, 2010; Sheikh and Beise-Zee, 2011). It has been argued however, that CSR to some extent alleviates some of the ills on the environment, but benefits do not always accrue to the directly affected environment and communities (Sheikh and Beise-Zee; 2011). In fact Carroll and Shabana, (2010) are therefore, of the view that CSR is usually adopted as a business strategy aimed at increasing the visibility of a corporate entity and financial success, whilst ensuring the reduction of its social and political costs (Carroll and Shabana, 2010; Du et al., 2010).

In view of the above observations, this chapter thus explores the extent to which the automotive industry in South Africa positions and aligns itself with environmental sustainability principles within the contemporary regulatory structures which exist on a national, regional and global scale. South Africa as an emerging economy is not immune to developmental pressures and the subsequent global responses linked to industrial activity. Kehbila *et al.*, (2009) for example, point out that vehicle manufacturing dominates the South African economy, but simultaneously contributes significantly to incorrect waste disposal, deterioration of air quality, noise pollution, degradation of land and marine environment and loss of biodiversity. This thesis therefore, is an attempt to start and initiate dialogue and debate on the relationship between the motor vehicle industry and environmental wellbeing in South Africa. These themes have been discussed within contemporary development and policy debates and dialogues on the role of environmental management and sustainable development.

## 2.3 Corporate Firms, Sustainability and Profitability: A Conceptual Framework

Motor vehicle production is intricately linked to various production industries within the global and national economies. Vehicle production relies heavily on resources and processes that come from other sectors of the production chain: agriculture, mining, energy, and water to cite a few. Thus, the motor vehicle industry has both direct and indirect impacts on the environment. In view of this assertion, it becomes imperative for motor vehicle manufacturers to rethink their production processes and the way in which these activities can align with sustainability ideals and norms. Hughes (2011), for example, argues that the manufacturing industry, both on a global and local level, is among the industries with the potential of propagating the principles of sustainable development. This potential can be realised and ultimately achieved by setting correct examples that illustrate effective and efficient ways of utilising natural resources.

The automotive industry, like other corporate organisations, commands significant influence and power on nearly all subsectors of a country's economy, development ideologies and strategies and as such the industry is strategically positioned to articulate and implement specific production practices that would be in alignment with both global and local processes. The OECD (Martinez-Fernandez *et al.*, 2010:5), argue that,

> "the global financial crisis has stressed the need to look at our economic growth model through new lenses and a much more critical approach to our consumption and production practices. The opportunity to re-think global growth models, within the challenge of moving towards a cleaner, low-carbon economy, is mobilising intelligence and innovative thinking worldwide to identify policies, measures and strategies for future green growth".

Thus, manufacturing can play a pivotal role in this transition as it is at the centre of extensive natural resource extraction and utilisation.

Given the complexities surrounding resource sourcing, it has been argued that the fight against resource exploitation moving towards sustainable futures must begin, among others, with the manufacturing industry (Bowen and Kuralbayeva, 2015; Bird and Lawton, 2009). The drive towards preserving the environment and the resources therein, must therefore, be accompanied by the development, adoption, and implementation of strategies and policies that ensure efficient resource use, in ways that promote social-economic and ecological wellbeing on an intergenerational scale. With contemporary contestations surrounding the sustainability concept, it becomes imperative to explore whether vehicle production can be considered a sustainable industry, contributing towards the transition to green jobs and economies.

Sustainability as a concept still holds contested definitions despite the Brundtland Commission's elaborate definition: "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (see United Nations World Commission on Environment, 1987:8). Although this definition has been criticised in relation to its practicability in adopting economic growth models, and its heavy dependency on non-renewable resources, it is generally accepted as a framework through which to rethink current development paradigms and approaches, as well as re-define the human-environment interactions on a longevity basis (Ahi and Searcy, 2013). It has been argued that the heavy reliance and the extensive nature of non-renewable resource exploitation by manufacturing industries have directly compromised the ability of present generations to meet their needs. High poverty levels, increased food insecurities, climate change and environmental degradation, have subjected the poor in deprived regions to untold levels of misery. In the context of these trends it becomes difficult to imagine what sustainability really is or what it should entail.

Despite shortcomings in the sustainability discourse, development as a process of change has been identified as a pertinent process that should consider how the natural environment overarches social and economic processes (Blewit, 2008; Elliott, 2011). The assumption is that social and economic processes are dependent on the nature and quality of the environment (Elliot, 2011). While the foregone assertion forms the normative basis for imagining and thinking about sustainability, contemporary and misguided enlightenment ideals have tended to promote the notion of dominancy over nature in the name of promoting human progress and development (Gray, 2010). The emphasis on the use of Environmental Management Systems with specific reference to ISO 14000, the emergence of green growth and green economy ideals is a clear indication that environmental sustainability has not been properly addressed. Adopting such initiatives is an attempt to outpace the current environmentally damaging development initiatives (Borel-Saladin and Turok, 2013).

Powerful corporations as major actors in environmental exploitation have in most instances twisted the meaning of sustainability. Gray (2010) points out that sustainability at corporate levels is explained loosely as social responsibility or corporate social responsibility. The effect of this definition is that sustainability or sustainable development is trivialised or misrepresented (Milne *et al.*, 2009). In fact, the use of terms such as corporate sustainability or corporate reporting, as observed by Bassen *et al.*, (2005) show how corporates use a range of terms to persuade the public that they operate in harmony with the environment and that business embraces sustainability. Gray (2010), however, argues that this state of affairs is generally misleading as the focus is taken away from how sustainability is actually attained and how business reporting aids sustainability.

Ahi and Searcy, (2013) observe that the danger in the current frames used to view sustainable development lie in that business ignores the essence of sustainability and has created a dominant discourse of what sustainability entails to suit certain business parameters. This has been done in ways that tend to ignore developments surrounding the businesses such as scientific evidence from research or development literature (Gray; 2010; Hopwood 2009). Most of what is reported as sustainability by business is either not sustainability or holds very little significance to sustainability (Gray 2010). Tregidga and Milne (2006) are of the view that the ways in which sustainability reports are generated by businesses potentially constrain ideas on dealing with sustainable development. The sustainable development concept appeals to the business world in that it paints a more optimistic picture than economic growth at the expense of the environment. The open definition of sustainability also affords business the

opportunity to interpret sustainability for business benefit (Tregidga and Milne, 2006). Bruno and Karliner (2004) as cited by Tregidga and Milne (2006) for example, argue that the Earth Summit in Rio de Janeiro distorted the essence of sustainable development. The follow up summit that was held in Johannesburg in 2002 was also set up for failure as the corporate voice emerged as strongly as it did in the first summit.

Other attempts have been made in trying to represent sustainability in ways that business understands. Financial accounts, as well as non-financial accounts have been used to show the sustainability position of a company (Gray, 2010). Some of these approaches include: *sustainable costs* of an organisation's activity whereby the sustainable costs highlight the amount of money an organisation would have spent had it been sustainable; *remediation*, which entails the amount of money it would cost for the organisation to reverse any damages caused on the environment; *sustainability gap* whereby the organisation analyses its current activities against sustainable activities and the difference is used to calculate the costs needed to bridge the gap; *sustainable value added* (SVA) takes into account the efficiency and effectiveness of resource use, and finally, *sustainability assessment model* which analyses projects and gives an idea of how the project impacts on the economic, social and environmental resources throughout its duration and data helps in identifying the pros and cons of projects and possibly develop strategies to correct negative impacts (Gray, 2010; Jones, 2010; Lamberton, 2005).

Non-financial accounts that have been utilised to represent sustainability include inventory of fauna and flora and the use of ecological footprints (Bebbington *et al.*, 2014; Jones, 2010). Financial approaches have been criticised in that placing monetary values on the environment and social damage is still widely contested (Bebbington *et al.*, 2014). The practical application of the financial approach is severely limited as a result (Figge and Hahn 2004). Both the financial and non-financial accounts are generally not attractive in business as they either threaten profit margins, the existence of the business itself or bring out the organisational flaws and point out to unsustainable practices adopted by the business instead (Gray, 2010).

Given such a background it is inevitable that sustainability at corporate level might be difficult to realise. This is because sustainability as a concept spans across ecological and societal spaces and has a broad definition that can be manipulated to suit specific contexts or to underplay the relevance and importance particularly that of environmental sustainability

(Bebbington and Larrinaga, 2014). Sustainability is likely to be achieved through an interaction of many different players such as organisations, individuals and states contributing to specific sustainable requirements (Gray, 2009). It is of paramount importance therefore to critique the feasibility of translating sustainability meaningfully at corporate level. Therefore a relationship consisting of the nature of environment (ecological, societal spaces) and contestations around what sustainability entails and how it is defined, pose further challenges to an already complex and contested discourse- the feasibility of attaining sustainability within manufacturing.

## 2.4 Corporate Firms, Sustainability and Profitability in South Africa: A Contextual Analysis

The vehicle manufacturing industry in South Africa competes actively globally with exports forming a significant share in European and US imports. A total of 276 873 units were exported in 2014, yielding a total value of R70 billion for the year (Lamprecht, 2015). Vehicle exports contributed 11, 7% of the total goods exported and within the country the contribution was 7, 2% towards the country's GDP as part of the broader automotive industry (Lamprecht, 2015). Barnes and Morris (2008) attest that the automotive manufacturing sector in South Africa has been the most successful sector in the country. South Africa actively encouraged, promoted and revived the motor vehicle industry through the Motor Industry Development Plan (MIDP) (Barnes and Morris, 2004, 2008; Black 2009; Flatters, 2002; Lamprecht, 2006). Global forces tied with the MIDP's government driven industrial policy actively influenced the presence of German multinationals operating within South Africa (Barnes and Morris, 2004).

The automotive industry is large and its impact spans across various sectors such as business and the environment. Vehicle manufacturing and utilization however contributes significantly to the deterioration of the environment (Orsato and Wells 2007). The availability of raw materials and labour supply in the South African economy also adds to the attractiveness of setting manufacturing plants for cars to sell to both the local and global market. Orsato and Wells (2007:989) point out a number of economic challenges that the automotive industry is faced with such as 'capital intensity and problems with achieving adequate profitability'. This in turn highlights the profit-oriented mandate tied to corporates and the possible complexity

sustainability brings into the process. The manufacturing industries in South Africa have been cited as one of the industries that have potential to realize the initiatives of a green economy (Swilling, 2010). This study will attempt to answer how this profit orientation and movement towards sustainability thus play out in a practical way and whether profitability and sustainability can coexist.

Kehbila (2013) emphasises that success in the vehicle manufacturing industry is, however, tied to environmental degradation and natural resource shortages. These massive industries actively consume natural/finite resources and emit harmful gases such as carbon dioxide in production and throughout the use of manufactured vehicles (Kehbila *et al.*, 2010 and Winkler, 2009). Brent and Visser (2005) argue that all stages of a product's life cycle from resource extraction, manufacturing, use and reuse, recycling or disposal will influence a supply chain's environmental burden. The South African automobile supply chain contributes to the environmental burden through discharge of toxic substances, greenhouse gas emissions, groundwater pollution, destruction of habitats and solid waste production (Brent, 2005).

The green economy debate reflects the sustainability debate in that it is open to various interpretations. Some players in the green economy advocate for a transition towards an ecologically sustainable future whilst others view it as a tool towards starting economic growth and innovation. Death (2014) describes four types of approaches that can be adopted in the green economy initiative as green revolution, transformation, growth and resilience. *Green revolution* involves a radical transformation of economic activities along with capitalism and state systems to align with natural limits and ecological virtues (Goodman and Salleh, 2013). In *green transformation* economic growth remains the main progress driver with the environment seen as a resource for development -state systems are used to regulate processes to ensure social justice, equity and redistribution inter-generationally (WCED, 1987).

*Green growth* perceives green markets as economic opportunities offering new markets, sources of wealth and areas for innovation (Death, 2014). Green strategies in this system present green niches globally and coupled with increasing population present viable markets that offer future growth, profits and jobs (Foresight, 2011). Focus is not on limits/scarcity of resources but on new markets, services and type of consumption. *Green resilience* strives to maintain the status quo albeit in a cautious way and seeks to utilise alternative sources for

survival such as climate sensitive agriculture and technological innovations (Foresight, 2011; Death, 2014). South Africa is pursuing green growth within manufacturing therefore according to Death (2014) this translates loosely into the country seeking new markets and profits without necessarily caring for the environment thereby indirectly propagating the profit-seeking mandate of corporations.

South Africa, the dominant economic producer in Southern Africa is characterized by rapid development initiatives. Swilling (2010) elaborate that the new constitution in South Africa makes reference to the right of all South Africans to have an environment that is protected for the benefit of all. Swilling (2010) elaborate further that the constitution calls for all stakeholders in public and private sectors to engage in ecologically sustainable development. This call is reflected in the vision and mission statements of vehicle manufacturing companies such as VW, BMW, Toyota and Mercedes. These statements uphold the importance of sustainability and the generation of sustainability reports. The green economy in South Africa is presented as viable and relevant to addressing various challenges that the country is currently facing (Musango *et al.*, 2014). Musvoto *et al.* (2015) demonstrate that the New Growth Path (2010) proposes to drive growth through a greener economy and ultimately promote social equity and improve human wellbeing. Agreements such as the Green Economy Accord (2011) were signed in which Government, business community, trade unions and civil society committed to supporting the green economy and creating green jobs within the country (Musvoto *et al.*, 2015). This is all being done in an attempt to preserve and protect the environment and attain sustainable development. Death (2014) maintains that commitment to the green economy in South Africa is neither deep rooted, sustained nor coherent. Cock (2012:23) emphasises that there is 'corporate capture' of the green economy in South Africa as the corporate world is in the forefront of defining what greening the economy entails. Corporations make use of manipulative advertising in what Cock (2012:25) terms 'green-wash' but the definitive goal remains profitability.

Mining and manufacturing in South Africa relies heavily on coal-powered energy and the South African economy is described as energy intensive deriving above three quarters of its energy demands from coal-powered energy (Cock, 2012; Death, 2014). The Medupi and Kusile coal plants in the country are the third and fourth largest in the world with the Sasol Secunda plant hailed the largest $CO_2$ emitter in the world (Death, 2014). The manufacturing industry is heavily reliant on coal-generated energy but has been identified in the Miranda and Larcombe (2012) report as a source of green job creation in the green economy. Death

(2014) is of the view that South Africa currently falls short of the United Nations Environment Programme (UNEP) green economy definition that encompasses low carbon emissions, efficient resource use and an equitable socially inclusive environment. South Africa depends heavily on coal and in 2010 South Africa emitted 9.2 tons of $CO_2$ emissions ($tCO_2e$) per capita, compared to 1.7 $tCO_2e$ in India, 2.2 $tCO_2e$ in Brazil and 6.2 $tCO_2e$ in China (World Bank 2013 cited in Death, 2014). This casts doubt on how manufacturing can supply green jobs, produce sustainably and play a role in decarbonising the economy towards achieving sustainable development.

Brent and Labuschagne (2003), and Labuschagne *et al.*, (2005) make reference to the fact that regardless of the country's active involvement in green economy initiatives, vehicle manufacturing still contributes to environmental problems. Kehbila *et al.*, (2009:311) highlight that sustainable development initiatives in South Africa generally 'lack clarity and determination'. Cock (2012) explains that sustainability has been incorporated into practices such as corporate social responsibility thus avoiding requisite transformative change. Policy documents in the country reflect a commitment to shift towards greening the economy but the real economy remains carbon intensive without clear legislation on carbon reduction (Cock, 2012). This evident lack of political will and poorly enforced legislation thus brings into question the sustainability of the vehicle manufacturing industry. Musvoto *et al.*, (2015) assert that the information and policies required to support the green economy drive are not fully developed in the country. There is significant contradiction in government actions as seen through the expansion of coal and nuclear powered energy through a $3,75 billion loans from the World Bank (Cock, 2012).

A number of initiatives have been embarked on globally in an attempt to address environmental problems experienced worldwide. Aichele and Felbermayr (2013) observe that climate change takes priority as the major environmental problem of our time and a number of climate change conventions have been held over the years to address environmental concerns. South Africa is a signatory to international conventions on climate change and therefore participates and contributes actively in these conventions. The United Nations Framework Convention on Climate Change (UNFCCC) that was negotiated at the Rio Earth Summit in 1992 is an example of some of the attempts that have been made to address environmental crises (Birnik, 2013). Further international climate change negotiations and debates, adaptation policies and strategies continue as witnessed by

meetings in Doha (2012), Durban (2011), Cancun (2010), and Copenhagen (2009) thus showing the extent of the climate change dialogue (Birnik 2013).

Measures such as the Kyoto Protocol serve to show the efforts that are going into dealing with climate change (Chakrabarty and Wang 2013). The Kyoto Protocol is an undertaking by industrialised nations and the European Union to bring down greenhouse gas emissions 'by an average of 94,8 % of their 1990 levels by the period 2008-2012' (Aichele and Felbermayr 2013:737). Banerjee (2012) points out that the Kyoto Protocol was the first world meeting that managed to set binding agreements on the reduction of the greenhouse gases by industrialised nations. The United States however refused to ratify the Kyoto Protocol together with Australia even though Australia eventually ratified the agreement in 2007 the overall effectiveness of the Protocol was reduced from 5,2% to 2% (Liverman 2009:292). India and China were in opposition to legally binding emission targets as set out by the Kyoto Protocol (Banerjee, 2012). Banerjee (2012) is of the view that the annual meetings have failed to establish global agreements mainly due to disagreements between industrialised and developing nations. The Copenhagen and Cancun conferences are noted as outright failures whilst the Durban conference is described as tainted and complicated by the emergence of India, China and Brazil as global players thus resulting in unclear positions in dealing with climate change (Banerjee, 2012).

## 2.5 The Rise of the Green Economy and Arguments for Adopting this Approach: A Global Perspective

The green economy initiative is a relatively recent development that seeks to move away from capital and resource intensive development (Halle, 2011). This has come to the fore, as there is an increased awareness globally of the importance of preserving the environment. Hart (1997) explains that corporations in the 1960s and 1970s were generally in denial of the effect their activities had on the environment. This culminated into the introduction of stricter regulations as ecological problems continuously came to the fore. Currently companies and nations have decided to adopt 'green' production or chosen 'green' growth strategies in an attempt to reduce resource and capital consumption (Halle, 2011). Hart (1997) argues that for sustainability to be effective it needs to be done on a global scale as the negative effects from different parts of the world have a bearing on every part of the world. Carfi and Schiliro (2012) attribute the rapid population growth and economic development in emerging

economies as some of the major contributors to unsustainable practices as these have a direct bearing on the way natural resources are used.

A green economy has been described as one that seeks to grow mainly by reducing resource consumption (Swilling, 2010). According to UNEP (2009), a green economy is characterized by business processes that deliver better returns on investments (economic capital, natural and human) yet at the same time reducing greenhouse gas emissions, using fewer natural resources and creating less waste. Vazquez-Brust and Sarkis (2012) explain that green growth is more than balancing economic growth with the protection of the environment. Green growth seeks to reduce carbon emissions and use energy efficiently through clean technology, natural resources and innovative marketing for produced goods and services. Investing in the environment should be the driving or central force for economic growth. Shin (2009) cited in Vazquez-Brust and Sarkis (2012) observes that it is important to use green growth to break the usual cycle whereby the environment deteriorates and poverty levels increase without attaining the desired sustainable economic growth.

Hart (1997) argues that the driving force behind companies going green has mostly been economic gain and not necessarily for the benefit of the environment. The green imperative has been attached to cost cutting or risk reduction and not necessarily strategy or technological development. Hart (1997) explains that the global economy is made up of interdependent and interconnected economies. These are broken down into the market economy, survival economy and nature's economy. The market economy is comprised of developed and emerging economies. About one sixth of the world's population lives in the developed nations yet consume more than 75% of the resources and energy (Jackson and Senker, 2011). Hart (1997) argues that pollution reduction and greening in the developed world has been achieved by strict environmental regulations, greening the industry and transferring industries that cause the most pollution (such as heavy manufacturing) to emerging economies. Industrialisation and economic growth in the emerging economies thus brings about urbanization which poses threats on the environment. Predictions show that by 2025 two out of 3 people will be dwelling in urban centres. The overall effect this will have on the environment is increased energy consumption and higher levels of greenhouse gas emissions. (Hart, 1997)

Hart (1997) suggests a strong technological overhaul in business coupled with a movement away from greening towards an external and more strategic focus on sustainable development. Environmental Management Systems such as the ISO 14000 incentivize companies to move away from pollution reduction to adopt pollution prevention strategies. Pollution prevention encourages incessant efforts to reduce waste production and energy use. Products can also be designed with the environment in mind, in what Hart (1997:71) terms 'product stewardship' whereby there is a focus on minimizing pollution and considering the impact of the entire product lifecycle on the environment. Design for the Environment-DFE (Toyota, 2014) encompasses concepts in which any products that are designed are easily reused, recycled or recovered. In DFE all possible impacts a product is likely to pose on the environment are examined from the design phase through to use and disposal (BMW, 2013). This process involves not only the Production Company but technical experts, environmentalists and customers thus presenting a holistic approach to production in an attempt to safe guard the environment. A radical shift is required to replace the existing technology bases in most companies with more sustainable technologies.

## 2.6 Towards a Green Economy and Sustainable Future in South Africa

The motor vehicle industry, as part of the manufacturing industry holds great potential towards contributing to the creation of a green economy due to its size, influence and overall impact on the economy (Musango *et al.*, 2014). Although the green economy initiative is a relatively recent development, it seeks to move away from capital / resource intensive development systems to eco-friendly forms of production and resource use (Musango et al., 2014). Business processes in the green economy as argued by UNEP (2009) deliver better returns on investments (economic capital, natural and human) whilst contributing to the reduction in greenhouse gas emissions, use of fewer natural resources and creation of less waste. The green economy concept emanated from increased global awareness on the importance of preserving the environment and seeks to grow mainly by reducing resource consumption (Swilling, 2010). In view of the increased environmental problems there is an increased movement away from capital and resource intensive production towards the 'green economy', the 'Global Green New Deal', the 'Green growth' approach, or 'green development' (Swilling, 2010).

According to Vazquez-Brust and Sarkis (2012) green growth is more than balancing economic growth with environmental protection. Green growth seeks to reduce carbon

emissions, use energy efficiently through clean technology and market goods and services innovatively. Shin (2009) cited by Vazquez-Brust and Sarkis (2012) observes that it is important to use green growth to attain desirable sustainable growth whilst protecting the environment. Hart (1997), and Ersty and Winston (2009) however, are of the view that the driving force behind companies going green has mostly been economic gain. They further observe that the green imperative has been attached to cost cutting or risk reduction and not for the benefit of the environment.

Edifying this observation, Orsato and Wells (2007) and Monden (2011) express the opinion that although a number of manufacturers in the automotive industry have made great strides in reducing the impact on the environment, the initiatives have not been developed to benefit the environment, but are aimed at cutting costs and ultimately increasing profitability. An example of this type of approach is identified as the Toyota Production System (TPS), which seeks to eliminate waste from all processes and activities (Monden, 2011; Aguado *et al.*, 2013). The TPS has come to characterise the basis for lean production and eco-factories and the essence of this practice is to attain some level of waste reduction and eventual elimination in the production chain (see Orsato and Wells 2007; Balakrishnan, 2015). Despite the development of such initiatives, there are still strong arguments and debates that question the credibility of such innovative moves in contributing towards environmental sustainability. Moreira et al., (2010) argue that these initiatives have been developed by automakers such as Ford and Toyota to increase and gain competitive edge in business.

In some cases, developed countries have achieved green production through transferring pollution intense industries (such as heavy manufacturing) to emerging economies such as China and India (Gurtu *et al.*, 2016). This gives a false attainment of greening production as carbon emissions and environmental degradation are consequently captured as environmental ills occurring in the emerging economies (Gurtu *et al.*, 2016). Emerging economies face challenges in that environmental regulations are not properly enforced, therefore increased industrial activity and economic growth in emerging economies poses extensive environmental threats therein (Blackman *et al.*, 2010). The energy produced in most emerging economies is usually coal powered thus driving the manufacturing industry on this energy will ultimately result in higher levels of greenhouse gas emissions (Hart, 1997). A transfer of the heavy manufacturing industries to emerging economies despite their nature of energy generation therefore shows the hypocritical nature of business and its incessant drive

to attain profits at all costs without addressing practical sustainability concerns (Dauvergne and Lister, 2013).

The value of a finished vehicle potentially contains up to 80% of various materials and components from suppliers in different industries, therefore purchasing departments in the vehicle manufacturing industries have become highly sophisticated in order to compete for favourable prices from suppliers (Closs *et al.*, 2011; Orsato and Wells, 2007). This in a way shows the power that the automobile industry exerts in its interactions with the other constituents in the 'organisational field' (Orsato and Wells, 2007: 990). Given such a scenario where components are derived from various sub-sectors, it becomes problematic to assert that sustainability and green jobs or green growth can be attained comfortably within the automotive industry.

Attempts have been made to come up with alternative systems to ensure that manufacturing activities have less negative impacts on the environment. The most common of the alternative Environmental Management Systems (EMS) include the ISO 14000. These global systems were created in an attempt to standardise environmental management criteria across the globe (Melnyk *et al.*, 2003). EMSs focus on those processes that contribute to the creation, management and elimination of pollution, as reduction of waste translates into reduction of manufacturing costs (Melnyk *et al.*, 2003). Companies are thus incentivized to move away from pollution reduction towards adopting pollution prevention strategies (Khanna *et al.*, 2009). A radical shift is therefore required to replace the existing technology bases in most companies, namely the production companies and their spheres of influence with more sustainable technologies.

Sustainable technologies in this regard are essential as the environment contains limited resources and disposal spaces (Gupta and Gungor, 1999). In an attempt to preserve the environment for future generations' it becomes essential to identify and correct current environmental problems. Gungor and Gupta (1999) elaborate on Environmentally Conscious Manufacturing and Product Recovery (ECMPRO) which has been prompted by government regulation and customer environmental awareness. ECMPRO involves integrating environmental thinking into new product development including design, material selection, manufacturing processes and delivery of the product to the consumers, plus the end-of-life management of the product after its useful life. Societal demands in high technology have resulted in production of different types of products which end up in landfills once they are

discarded (Gungor and Gupta, 1999). ECMPRO takes into account reduction of the raw materials and an increase in different forms of waste thus suggesting green products and a development of methods that deal with product recovery and waste management. The development of green products relies on understanding the full product life cycle (Gungor and Gupta, 1999).

The planetary boundary approach expands on the idea of limited resources in the environment by highlighting that development of human societies ought to be carried out within safe operating zones, based on our understanding of the interconnectedness of the earth's systems (Steffen *et al.*, 2015). Increased industrial activity and the resultant population growth have led to a dramatic destabilization of the environment thus threatening the very essence of human survival. Planetary boundary frameworks in this regard aim to prescribe safe operating spaces within which human society can continue to thrive and develop (Steffen *et al.*, 2015). Planetary boundaries are placed well before biophysical thresholds are reached in order to allow society time to attend to early signs that movement is towards unwanted change (Steffen *et al.*, 2015).

## 2.7 Conclusion

The power and influence that is wielded by corporations contributes towards working against sustainable imperatives (Shiva, 1993). This is because corporations emerge as the dominant voice and are able to influence sustainability initiatives in ways that make business sense as opposed to sustainable sense. The corporation was birthed out of capitalism and has a strong profit-seeking mandate (Petrella, 2000). This profit seeking behaviour occurs at the expense of the environment and workers. State and civil society attempts at holding corporations to account have been rendered useless by the power financial access has afforded corporations (Gray, 2010). Shiva (1993) explains that a number of the major environmental threats have been caused by corporations as they have wider access and control of resources spanning across continents. Application of sustainability initiatives at corporate level tends to be complicated as these initiatives threaten the profitability mandate that forms the essence of manufacturing. Corporates would have to restructure the way natural resources are harnessed, transported, utilised in production, and the way in which waste is disposed of to cite a few aspects if they are to contribute meaningfully to sustainability.

Sustainability is still open to various contested definitions with the corporate voice in the forefront, defining what sustainability entails. The green economy initiative in many ways tends to display the same poorly defined parameters such as those evident in sustainability debates. Environmental regulations particularly within South Africa are not well enforced or policed thus weakening the sustainability mandate within the country. Corporations especially in vehicle manufacturing have the financial power to dictate to suppliers and government thereby further weakening any efforts that may speak to decarbonising the economy and protecting the environment for future generations. Vehicle manufacturers in South Africa are largely protected by Government regulations that favour economic development, as well as a lack of clear and defined environmental regulatory structures. The green growth position currently adopted by the country adds further complexities to the sustainability initiatives. Manufacturing within the country still needs to address aspects such as energy harnessing, what sustainability entails, green growth and manufacturing as well as corporations' activities.

# CHAPTER THREE

# METHODOLOGICAL CONSIDERATIONS

## 3.0 Introduction

The aim of this chapter is to present the methods and data collection tools that were used in this research. The study adopted a qualitative approach. This chapter gives a description of the corporations under investigation as well as their geographical locations. It outlines the researcher's positionality as well as the data collection techniques that were applied throughout the study, sampling procedures, samples of questions asked, data analysis, and limitations of the study as well as ethical considerations. The study was also based on an extensive review of literature on sustainability, manufacturing and the vehicle manufacturing industry within South Africa as well as globally. Data was collected through interviews with key informants within vehicle manufacturing, suppliers to manufacturers, former vehicle manufacturing employees and employees working in VW, Mercedes, Toyota and BMW dealerships. Interviews were also conducted with key people within the Departments of Environmental Affairs and Trade and Industry. Secondary data sources utilised in the study were obtained from vehicle manufacturers' sustainability and environmental management reports. The questions asked in the interviews covered key topics pertaining to sustainability, raw material sourcing, and manufacturers' relationships with their suppliers, production processes, waste disposal, the regulatory environment within which production occurs, environmental reporting structures and consumer behaviour.

## 3.1 Research Methodology

Research can be conducted using quantitative or qualitative methods. The differences inherent in both methods are from ontological (set of assumptions concerning reality under investigation), epistemological (knowledge of the reality) and methodological paradigms (ways of knowing the reality) (Sale, Lohfeld and Brazil, 2002; Eriksson and Kovalainen, 2015). The quantitative approach according to Carr (1994) is described as a formal, objective and systematic process that uses data in numerical format to measure phenomena and produce findings and is based on positivism. This method tests theories and deduces from existing knowledge thereby developing relationships and proposed outcomes for study

(Eriksson and Kovalainen, 2015). Quantitative methods derive from scientific methods and use large sample sizes as well as a detached approach as the objective is to view and understand phenomena independent of human perceptions (Sale *et al*, 2002). The research process adopted is descriptive, experimental/quasi-experimental, counts occurrences, estimates prevalence frequency and magnitude, has prediction over time and generally dismisses the experiences of the individual (Curry, Nembhard and Bradley, 2009; Eriksson and Kovalainen, 2015). The ontological position is that there is only one truth and epistemologically the researched and researcher are independent of each other meaning there is no transference of influence in any way (Sale *et al*, 2002) and the data presented is normally numerical and ordered (Carr, 1994).

Qualitative research on the other hand is guided by ideas, perspectives or hunches and it studies the world from the perspectives of the subjects under study to uncover beliefs, values and motivations and not the perspectives of the researcher (Carr, 1994; Curry *et al*., 2009). This method is used to make sense of complex social processes and understand humans and their interactions amongst themselves as well as their surroundings (Eriksson and Kovalainen, 2015). Qualitative methods derive from history, philosophy, anthropology, sociology and psychology and the samples used are smaller in comparison to those used in quantitative researches (Carr, 1994). This is mainly because qualitative research is more selective due to the in depth study undertaken as well as the level of data analysis required (Eriksson and Kovalainen 2015). The researcher undertaking the study interacts extensively with the subjects and there is first-hand experience to data collection (Curry *et al*., 2009). This ultimately allows for flexibility and a deeper understanding of the subjects under study in that the subjects can raise other issues thus adding quality to the data collected (Eriksson and Kovalainen, 2015). The ontological paradigm therefore in this method attests to the fact that there are numerous realities based on the way one constructs reality and epistemologically there is extensive interaction to the extent that findings are mutually created in the contexts the studies occur (Sale *et al*., 2002).

This study was informed by the qualitative constructivist/interpretivist school of thought. Creswell (2003:18) observes that qualitative approaches make claims based on constructivist perspectives (multiple meanings or experiences socially or historically constructed) in an attempt to develop a theory or pattern. Qualitative research involves exploring concepts or social phenomena and takes place in the natural setting where phenomena occur. This type of research is interactive and humanistic thus enabling active participation by contributors.

Qualitative research offers researchers an interpretation platform and allows social occurrences to be viewed holistically (Creswell, 2003). Qualitative research therefore seeks answers through examining different social settings and the people within them in an attempt to understand how humans organise themselves and make sense of their surroundings and settings (Berg, 1995). Interpretivist/constructivist approaches to research focus on the complex humanistic way of making sense of situations as they emerge and this sense making approach is ultimately shaped by life experiences that shape people and influence perceptions (Curry *et al.*, 2009). The constructivist approach thus enables participants to relate their experiences and a close collaboration develops between researcher and participant (Baxter and Jack, 2008).

## 3.2 Researcher Positionality

Takacs (2002:175) defines positionality as 'the multiple unique experiences that situate individuals in relation to each other'. Researchers need to understand their positions in relation to others and they particularly need to be aware of the power dynamics that potentially exist between them and the researched (Takacs, 2002; Bourke, 2014). Other aspects that have a bearing on research positions are the identities of both the researchers and participants as these tend to impact the research process ultimately resulting in perceptions and biases feeding into and shaping the entire process (Bourke, 2014). The resultant meanings and interpretations of the results emanating from the research are thus formulated taking into account the various aspects constituting identities such as race, gender, nationality or religion (Sanghera and Thapar-Bkorkert, 2008). Identities thereby mark researcher's relational positions, and knowledge becomes valid when researchers acknowledge their positions within the given contexts (Maher and Tetreault, 1993). According to Maher & Tetreault (1993), context and relational factors define identities and knowledge in given situations. The act of analysing or scrutinising self during the research process helps the researcher to inspect relationships with respondents closely and the positions the researcher takes are subject to change depending on the context within which the research occurs (Bourke, 2014). Positionality in qualitative research ultimately means that the researcher's personal attributes affect the research process starting from the questions asked, aspects of data collection and the reporting of the findings (Carling, Erdal, and Ezzati, 2013).

In researching the motor vehicle manufacturing industry in South Africa the researcher was aware of her outsider-insider position (Sanghera and Thapar-Bkorkert, 2008). As an outsider

and not affiliated to the vehicle manufacturing industry, being foreign to the country, black and feminine meant the researcher had to negotiate power dynamics in trying to gain access into this industry. The researcher often had to deal with identity questions in line with who she was working for and whether she had any links to the media industry, thus she was positioned as having questionable motives for requesting access. As an insider the researcher has lived in the country for 8 years and has to some extent an appreciation of the country's history and the importance of vehicle manufacturing particularly contributions to South Africa's GDP. There was a constant shifting of positions as the researcher had to negotiate the outsider-insider relations throughout the research process.

During the research the researcher encountered gate keepers but had been made aware of the potential and possibility of gate keepers. This is mainly because vehicle manufacturers are protective of their operations as there are a number of aspects at stake such as their reputations, trade secrets or brand protection measures. According to Sanghera and Thapar-Bkorkert (2008), researchers might have to negotiate access through various gate keepers to gain access to participants. Gatekeepers are those people with power to deny researchers' access to people or situations for purposes of research (Sanghera and Thapar-Bkorkert, 2008). In this instance the gatekeepers included the security guards manning the plant entrances as well as the customer service agents as they form the first port of call for access. The researcher negotiated access using limited Zulu/Tswana and this usually put the guards at ease as using English (being black but not native to SA and feminine) speaking to mostly men would have been viewed as disrespectful. Access to key personnel through customer care agents was granted by asking for alternative means to which the plants could be opened to the public particularly in instances where access to environmental managers had been denied outright.

The researcher was interested in finding deeper meanings and making sense of situations and their practical application particularly in the natural settings within which they occur. To this end the researcher was cognisant of the projected views on the corporation and how in most instances corporations are viewed with scepticism in their commitment to environmental management. Corporations are portrayed in media as responsible for various forms of environmental ills as they are deemed to hold immense power over governments, people and resources as the goal within corporations is to profit. Regardless of this profit mandate, South Africa has identified manufacturing as the industry that can drive the green agenda (growth

and jobs). With this position in mind the researcher went out to research on the deeper meanings and tried to make sense of the corporations and greening conundrum.

## 3.3 Recapping Research Aims and Objectives

The methods detailed in this chapter were utilized to fulfill the aim of this study that sought to understand how the motor vehicle manufacturing industry in South Africa has adapted its operations to align with requirements for sustainable production within the context of the green economy. This is in line with developments in local and international trends in adopting sustainable production along the value chain and this sheds light on how motor vehicle manufacturers interact with suppliers as supplier activities contribute to the overall impact exerted onto the environment. Thus, the economic, political and social consequences of the vehicle manufacturer's activities on individuals, corporations and the resultant effects on the environment in South Africa were taken into account. The objectives of the study were to establish whether vehicle manufacturers have aligned to sustainability initiatives, consider the environment as they produce, to examine manufacturer's interaction with their suppliers and the environment as well as to generate knowledge on how vehicle manufacturers in South Africa operate within the context of a green economy.

## 3.4 Research Design

The research design that was adopted in this study was a case study approach researching the relationships amongst the profit-seeking nature of vehicle manufacturing industries, sustainability initiatives such as ISO 14000 and the environment in South Africa in the context of a green economy. A case study approach permits in depth exploration of the topic at hand and collection of detailed information over a period of time. Case studies are concerned mostly with investigating then interpreting characteristics, attributes and behavioural patterns (see for example, Behr 1983:104). This study entailed collecting information from motor vehicle manufacturing companies on how they have adapted and adopted sustainability requirements in their operations and ultimately interpreting the data collected. An interpretive approach to the study helped in understanding how the motor vehicle manufacturing industry in South Africa has responded over time to local and international trends in adopting sustainable production methods along its value chain. This approach assisted in explaining how motor vehicle manufacturers in South Africa align to

sustainability demands, adopt ISO 14000 requirements in their production and ultimately balance the search for profit against environmental concerns.

Baxter and Jack (2008) highlight that case studies afford researchers opportunities to study complex topics within the contexts in which the phenomena occur. This is done using a range of data sources. Yin (2003) and Curry *et al.*, (2009) propose that case studies are ideal when answering 'how', 'what' and 'why' questions, when researcher cannot manipulate participant behaviour, to cover contextual conditions relevant to the study and where there are unclear boundaries between the occurrences and the contexts shaping them. The aim of this study was to establish 'how' vehicle manufacturers in South Africa adapt to and adopt sustainable practices in production such as stipulated by the ISO 14000. A case study approach also enables use of multiple data sources and this strengthens the integrity of the data (Yin, 2003). Understanding sustainability within vehicle manufacturing in this study was aided by data collected from various sources then connected together in the analysis process.

### 3.4.1 Description of Data Materials and Data Sources

The data used to inform this study was collected from Mercedes-Benz SA, VW SA, Toyota SA and BMW SA. Figure 3.1 shows the locations of the four manufacturers within the country.

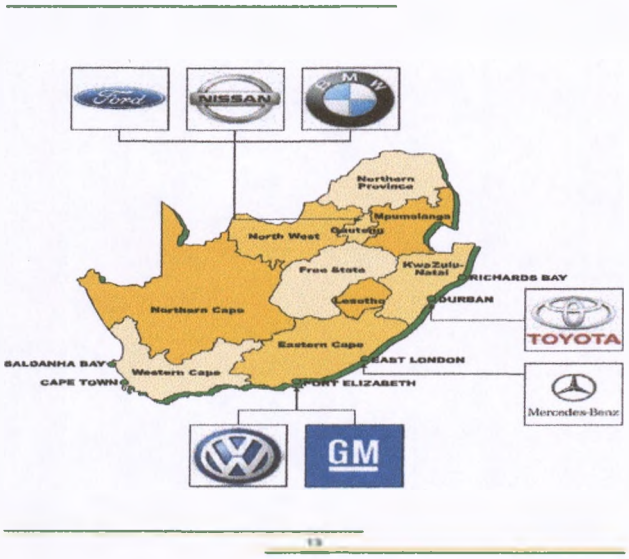


**FIGURE 3.1:** LOCATION OF VEHICLE MANUFACTURERS (VW, BMW, TOYOTA AND MERCEDES) IN SOUTH AFRICA SOURCE: DTI, 2015

**Volkswagen Group South Africa**

The Volkswagen Group South Africa is a wholly owned subsidiary of the Volkswagen Aktiengessellschaft (VWAG) in Wolfsburg, Germany and it was established in 1946. VW SA is located in Uitenhage, an industrial town in the Eastern Cape located 35 km from Port Elizabeth. VW SA is part of the 120 production plants that VW AG owns and about 43,000 cars are produced on a daily basis at these plants. The Uitenhage plant is the largest German investment in SA and it contributes extensively to foreign investment, world class technology transfer and skills/knowledge development. VW SA employees receive training at various VW plants and this company employs nearly 6,000 people directly. Figure 3.2 shows the VW plant in South Africa.


FIGURE 3.2: VW SOUTH AFRICA (UITENHAGE) PLANT, SOURCE: VW, 2016

**Toyota South Africa Motors (Pty) Ltd. (TSAM)**

Toyota South Africa Motors (Pty) Ltd. (TSAM) was established in 1962 and is a wholly owned subsidiary of the Toyota Motor Corporation (TMC) in Tokyo, Japan. The TSAM manufacturing plant is located in Prospecton to the south of Durban and covers 79ha. This plant employs well over 8,000 people directly and most of the employees work on a shift basis in the vehicle production lines in KwaZulu-Natal. Toyota has a set of values, beliefs, principles and business methods it broadly terms *The Toyota Way* and these are based on respect for people and continuous improvement. Toyota South Africa Motors (TSAM) is one of the country's largest exporters. TMC has invested over 9 billion to modernise the TSAM plant over the years and it now has latest world class automotive manufacturing technologies. The Prospecton plant now has the annual capacity to build 140,000 Toyota Hilux cars amongst other models. Figure 3.3 shows an aerial view of the Toyota Prospecton plant.

FIGURE 3.3: TOYOTA SOUTH AFRICA (PROSPECTON) AN AERIAL VIEW, SOURCE: NGAGE PUBLIC RELATIONS, 2016

**BMW South Africa**

BMW South Africa was established in 1975 when the BMW Group acquired full shareholding in Praetor Monteerders. The BMW SA Rosslyn plant is located near Pretoria and was the BMW Group's first foreign location. By 2011, BMW employed 1,700 people and manufactured over 53,000 units of the BMW 3 Series Sedan. Most of the vehicles manufactured at this plant are for export across the world. A third shift has now been added into the work schedule and it has resulted in an increased number of cars produced at the Rosslyn plant. Averages of 75,000 BMW 3 Series sedans are produced yearly. The production of the BMW's 3 series has created 36,000 jobs within BMW's South African supplier network. Figure 3.4 shows an aerial view of the BMW Rossyln plant in South Africa.

FIGURE 3.4: BMW SOUTH AFRICA (ROSSYLN) AERIAL VIEW, SOURCE: SA KNOWLEDGE, 2011

**Daimler AG, Mercedes-Benz South Africa**

The company was established in South Africa in 1958 and it currently employs 3 300 people directly with an annual production of between 100,000-200,000 cars. In 1958 Car Distributors Assembly Ltd began producing Mercedes-Benz vehicles under contract. In 1984 Daimler-Benz acquired a 50.1% share in United Cars and Diesel Distributors and since then the company has been registered as Mercedes Benz South Africa (MBSA). MBSA is a wholly-owned subsidiary of Daimler AG. The company has a manufacturing plant in East London where Mercedes-Benz C-class cars are manufactured (right hand drives for the local market and left hand drives for export). Production is not limited to the C-classes only but extends to Mercedes-Benz commercial vehicles, buses, FUSO trucks and also the assembly of Freightliner trucks. Figure 3.5 shows the Mercedes Benz East London plant as well as an aerial view.

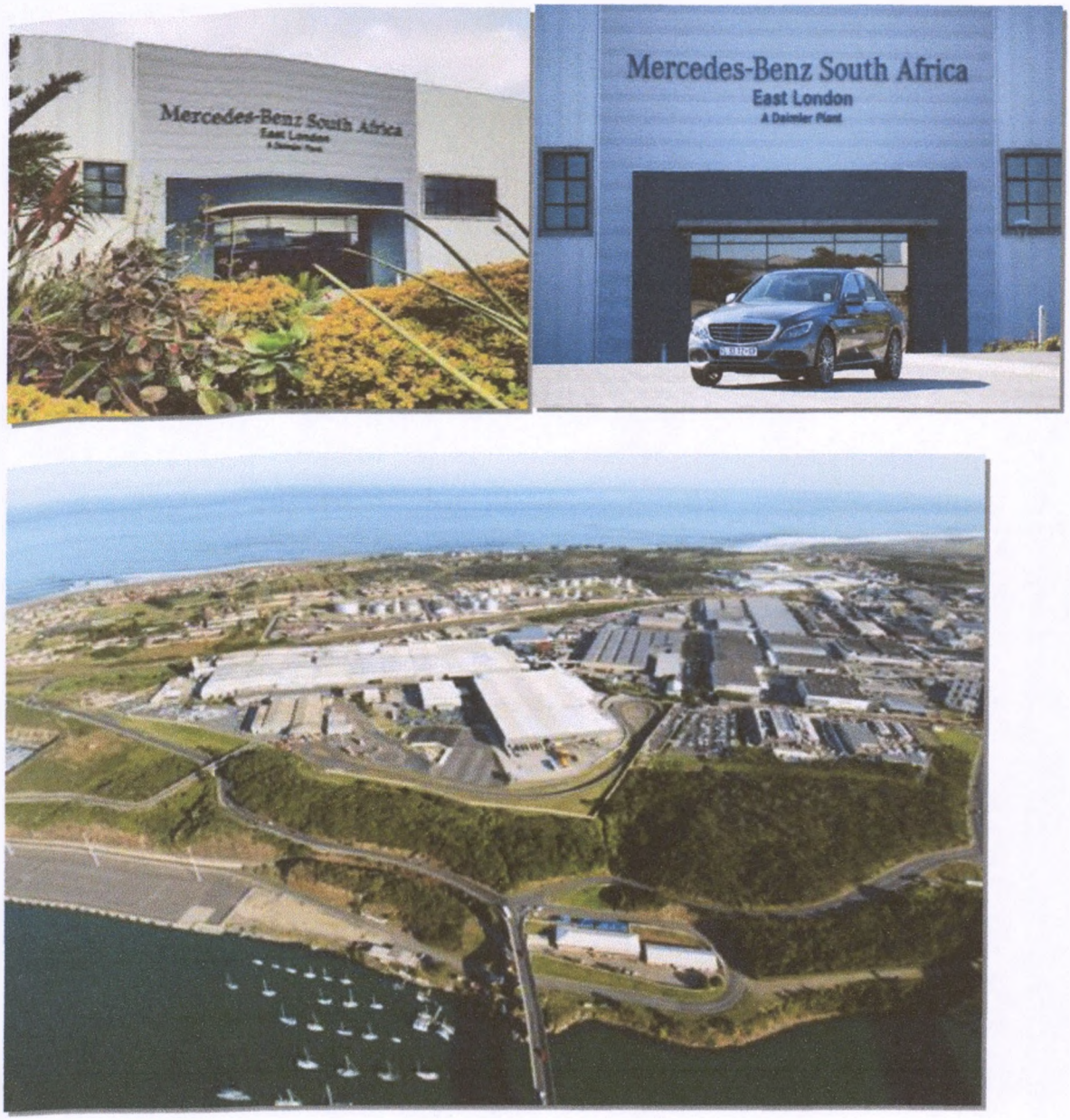


FIGURE 3.5: MERCEDES BENZ SA (EAST LONDON) PLANT SOURCE DE VOS, 2016 AND AN AERIAL VIEW, SOURCE: WHEELS 24, 2012

### 3.4.2 Study Population and Sampling Procedure

The sample comprised of four vehicle manufacturing companies and within each company two managers dealing with environmental management and sustainability were selected as respondents. These managers were responsible for aspects such as energy, water and the environment. Another set of managers that were considered consisted of purchasing managers as this group of managers is directly linked to and deals with suppliers. The vehicle manufacturers in this study were selected using purposive sampling as the idea was to get an

understanding of environmental concerns unique to each location. Managers in this regard were also selected purposively as the goal was to interview experts working within the environmental/sustainability and purchasing departments within the companies. Purposive sampling in both cases enabled the researcher to group participants according to the highlighted criteria and this brought relevance to the research questions set out to guide the study.

Twelve dealerships were selected within South Africa and these were made up of three dealerships each for each specific vehicle manufacturer. From these dealerships two respondents (dealers) were selected and in total 24 participants were interviewed. The sample of dealerships was drawn mainly from the three provinces within which the four vehicle manufacturers are based in KwaZulu-Natal, Eastern Cape and Gauteng-but the rest of the provinces were included to obtain views from other parts of the country. Out of the total number of three dealerships selected, at least two dealers were from the province housing the specific vehicle manufacturer whilst the remaining ones were selected from the remaining provinces. Care was taken to ensure that dealers were drawn from all the provinces to glean views on vehicle manufacturing across the country.

Semi-structured interviews were used with dealers, as the aim was to get specific information pertaining to materials used in the manufacturing of specific vehicles. Dealers also provided information on consumer behaviour/perceptions with regard to green production in vehicle manufacturing. Some information on suppliers was obtained from retailers as most dealers sell car parts and accessories thus having access to suppliers used by specific vehicle manufacturers. Through the semi-structured interviews the researcher managed to get an idea of where raw materials are sourced and the general reasons behind car purchasing behaviours that is whether green practices by vehicle manufacturers are an important consideration to consumers when they purchase cars.

Table 3.1 illustrates the study population and sample size that was used to inform the study.

**Table 3.1: Basic Information on the selected sample**[3]

| | Vehicle Manufacturers | | | |
|---|---|---|---|---|
| | Mercedes | BMW | VW | Toyota |
| Environmental Managers | 2 | 2 | 2 | 2 |
| Purchasing Managers | 1 | 1 | 1 | 1 |
| Dealerships | 3 | 3 | 3 | 3 |
| Dealers | 2 | 2 | 2 | 2 |
| Total Participants per Company (Dealers & Managers combined) | 9 | 9 | 9 | 9 |
| **Total Number of Participants Interviewed (Dealers and Managers)** | | | | **36** |

Within the dealerships and in the government departments chain sampling/snowball sampling was used to identify participants as this facilitated ease of access to key informants. The researcher was initially referred to one individual in DEA and a former VW dealer who were instrumental in setting up progressive interviews. Participants with whom contact had been established thereafter referred the researcher to relevant people who could potentially contribute meaningfully to the study. From this interaction the researcher interviewed a total number of 5 participants. This helped the researcher in that a number of the people who took part in this study would have been difficult to access without help from colleagues within the same industry. Chain sampling also helped put a number of participants at ease as they were assured of the purpose of the study by colleagues prior to meeting with the researcher. Access to most of the dealers was facilitated by the detailed company websites that provide email addresses as well as phone numbers to vehicle dealers across the country. The researcher made extensive use of tools such as the 'Find a dealer' option and 'Dealer locator' interactive maps on the vehicle manufacturers' websites as well as Mercedes 'locate a dealership' option. Contact with dealers was through email, telephonically and through the use of a survey designed in Survey Monkey.

[3] Please note that this study engaged with specialised research participants because of the nature of the study itself.

### 3.4.3 Data Collection Tools

The research employed mostly qualitative methods. A range of data collection techniques were adopted such as a pilot study, documentary analysis, in-depth interviews, semi-structured interviews and participant observation. Triangulation in this study helped to validate the data and the research as the same information was cross-verified against different sources (Bowen 2009, Patton and Cochran, 2002). Data source triangulation in this research was through the use of evidence from different types of data sources such as primary and secondary research. Patton and Cochran (2002) elaborate that as more sources of information are employed more insight is gained into the topic under study. Methodology triangulation involved combining a number of methods to gather data such as documents, interviews and observations as the primary research was conducted at different times and different places- that is within the different provinces that house the vehicle manufacturing industries. The advantage of this approach is that the inadequacies that are potentially in one data source or method are ultimately reduced, multiple sources verify and complement similar data, extensive data is derived from various sources and if there are any inconsistencies that are present these are then easily picked up (Patton and Cochran, 2002).

**a) Pilot Study**

Primary data was collected through a pilot study involving two vehicle manufacturers. The study was conducted between September 2015 and November 2015 and the data collection process informed the researcher on what to anticipate in the field. Adjustments were then made to the research approach and the questions that were going to guide the research process. The selection of the two vehicle manufacturing industries was done through the use of a lottery system in which all vehicle manufacturers operating in South Africa were allocated a unique number and placed in a box. It was decided to randomly draw two numbers and these yielded BMW and VW. Initial contact was established with the vehicle manufacturing industries through their respective public relations offices and the snowball technique was then applied to identify the relevant research participants. Using this technique, six managers and environmental experts drawn from the two organisations and working within their respective environmental management departments were identified and included in the study. Furthermore, using a purpose sampling approach, an additional two officials from the Department of Environmental Affairs (DEA) and two officials from the

Department of Trade and Industry (DTI) were identified, selected and included in the study. In total ten expert research participants were selected and included in the pilot study and this contact provided part of the information on which this thesis is based. The pilot study also helped the researcher to anticipate potential challenges and to improve on the data collection procedure before carrying out more extensive fieldwork. Through this pilot study the researcher decided to utilise extensive documentary analysis to gather more results as VW declined to participate from the onset. The negative response from VW also helped the researcher to seek alternative respondents and information from people who had previously worked for vehicle manufacturers as they gave useful insights on the automotive industry

**b) Documentary Analysis**

Documentary analysis is applicable to qualitative case studies as it produces rich descriptions of events within an organisation (Yin 1994, Bowen 2009). Document analysis is an organised way of scrutinising documents from a range of places, that is, information from the internet or from printed sources and this process requires data to be examined to understand phenomena thereby developing knowledge (Corbin and Strauss 2008, Bowen 2009). Reports and internal correspondence act as a source of empirical data from the context within which the participants operate (Mills, Bonner, and Francis, 2006). Documents therefore help the researcher to uncover relevant information that answers the problem statement (Bowen 2009). In this study the documents analysed included organisational and institutional reports, advertisements, brochures and company website pages. Analysis included looking for the relevant documents then selecting, reviewing and combining quotations, passages and excerpts. These were then organised into relevant major groupings, themes and topics. Yin (1994) proposes that document analysis should be used in combination with other qualitative research methods as a means of triangulation and this study made use of interviews and participant observation detailed in forthcoming sections in the chapter. According to Bowen (2009) documents are useful in providing background and context to the aspect under investigation, formulating additional questions, providing supplementary data, tracking change and development, and verifying findings.

**i) South African Legislative Environment**

The study analysed some aspects of the South African environmental policies such as The National Environmental Act, provincial green policies such as the Gauteng, Tshwane and Durban green policies with regards to the vehicle manufacturing industry and also examined the overall green policy position the country has adopted. These policies were chosen as they influence the operations of vehicle manufacturers as their activities span across these specific provinces in South Africa. National and provincial policies also showed the policy position adopted by the country and how the country translates and breaks down overall global policies to speak specifically to the country. The study examined the global policies that exist in order to establish the position South Africa has taken in regards to the green economy imperative.

**ii) Company Sustainability and Environmental Reports (VW, Toyota, Daimler and BMW) 2010-2015**

The researcher also examined company sustainability reports from VW, Toyota, Daimler and BMW between the years 2010-2015 in order to establish how production has been influenced by green initiatives over time and whether this is reflected in the company documents in any way. Through this, the study aimed to find out the way in which companies report on sustainability and any initiatives they possibly undertake to ensure the greening of the production process. Company reports were also used to access sustainability information specifically for companies such as VW who blocked any form of interaction with and access to the researcher. The company reports were also utilised to try and establish the role the state and vehicle manufacturers have adopted and encouraged a movement towards green production as well as the level of support (if any) the state offers to the vehicle manufacturing industry. In addition to the company reports the researcher accessed information pertaining to the sustainability initiatives undertaken by the companies from the company websites. In most instances this information takes the form of advertisements as the companies use the websites and brochures as communication platforms with potential clients and investors likewise. Company reports in some instances provided insight into the time frames that are set by vehicle manufacturers concerning attainment of sustainability.

In utilising documents the researcher was aware that documents must be used cautiously and viewed with a critical eye. Aspects that were taken into account in using documents in this study included credibility, authenticity, accuracy and representativeness of the documents chosen (Patton and Cochran, 2002). Documents were then evaluated against other sources of information. For purposes of this study the researcher treated the documents as authentic as they consisted of pieces of legislation and signed off audited company reports that are produced in compliance to the law and archived under the vehicle manufacturers company records. Table 3.2 lists the documents that were selected and the data that was analysed. Data was analysed together with that from interviews and observations to establish themes that were emerging across all data sets.

**Table 3.2: Sample of Documents Selected and Data Analysed**

| Documents Selected | Data Analysed |
|---|---|
| VW Sustainability Reports 2010-2015 | Company's approach to sustainability and changes over the years, Sustainability strategy for progressive years and response to legislative environment. |
| Daimler Sustainability Reports 2010-2015 | Company's approach to sustainability and changes over the years, Sustainability strategy for progressive years and response to legislative environment |
| Toyota Sustainability Reports 2010-2015 | Company's approach to sustainability and changes over the years, Sustainability strategy for progressive years and response to legislative environment |
| BMW Sustainable Value Reports 2010-2015 | Company's approach to sustainability and changes over the years, Sustainability strategy for progressive years and response to legislative environment |
| Green growth path | Strategic green decisions the country is working on and the newly adopted ADP that is a replacement of the MDIP |

| | |
|---|---|
| South African Constitution | Rights of citizens pertaining to environmental preservation as the constitution is the overarching legal structure upon which all Acts are founded |
| Environmental Act | South African governments' position on overall environmental management expectations |
| Environmental Brochures | Environmental management approach as given out to the public |
| Independent Assurance Reports (Attached at the end of each sustainability report) | Evaluations conducted on the reliability and relevance of information given by manufacturing companies from independent assessors, attached mostly to sustainability reports. |

**e) Key Informant Interviews**[4]

The most commonly used method of data collection in qualitative studies is interviews (Minhat, 2015). Gill, Stewart, Treasure and Chadwick (2008) propose that interviews are useful in exploring sensitive topics, instances where is it inappropriate to talk about experiences in a group setting as well as when detailed insights are required from individual participants. In this study detailed answers were required and some of the questions adopted for the study required information that might have been regarded as confidential hence respondents were engaged individually. Interviews in this instance were useful in exploring experiences, perceptions and beliefs formulated by the various institutions' attitudes towards the environment and such aspects would not have been adequately revealed by answering questions in a structured questionnaire. Interviews therefore afforded the researcher an opportunity to explore in depth the participants' viewpoints and ultimately obtain detailed information (Minhat, 2015). The researcher took field notes to capture all the information that was given as the companies under investigation have strict policies on the use of gadgets of any nature on their premises.

[4] Table 3.1 shows the sample of participants that were selected purposively as the nature of the study required expert input. Within vehicle manufacturing a total number of 36 participants were interviewed and an additional 5 participants were included in the study through snowballing.

### i) Interviews with managers in vehicle manufacturing and DEA, DTI

The researcher conducted in-depth interviews with managers and key decision makers who focus on environmental concerns within manufacturing in the vehicle manufacturing industry. In-depth interviews were also conducted with key people in provincial green strategy development initiatives and experts in the green economy field. In interviewing management the goal was to understand the strategic decisions adopted by specific corporations in trying to adopt green strategies in manufacturing. These interviews extended to the purchasing department in tracing where all the parts used in production come from, how they are transported (by rail, road or water) and how eventually waste is disposed of. In-depth interviews were used as the goal was to get companies' personal perspectives and experiences in the green economy debate as this has both direct and indirect effects on the overall activities. This type of interview was adopted as the topic under consideration involved company information. Interviews with provincial officials assisted in evaluating policy positions adopted within the country and the extent to which policy is implemented thereby achieving what it is expected to achieve. The information given helped in critiquing the system in place and it gave a view that was different to that of the vehicle manufacturers'. At the government level key informants targeted were those in the Department of Environmental Affairs and Tourism and the Department of Trade and Industry. This was to solicit information on green economy policies and the intricate interrelationships that tie the departments together thus influencing policy positions.

### ii) In depth interviews with employees in VW, BMW, Mercedes and Toyota Dealerships

In consolidating the information that was obtained from the interviews with vehicle manufacturers, the researcher interviewed some workers within the BMW, Toyota, VW and Mercedes dealerships. These interviews helped gain insight into the specific materials used to manufacture vehicles and where these materials are derived from. Interviews with dealerships also helped to establish the driving force behind consumers purchasing specific vehicles over others. This gave partial insight into the motivation behind car purchases.

**f) Participant Observation**

Participant observation is used mostly in collecting data on behaviours as they occur in their usual set up. Data obtained from observation helps to cover the gap between what people say and their actual actions thus helping the researcher to unveil behaviors the participants themselves may not be consciously aware of (Patton and Cochran, 2002). In order to collect data on the vehicle production process the researcher participated in a BMW plant tour in June 2015. BMW offers plant tours to the public (morning and afternoon sessions daily) and interested parties are requested to sign up for tours on the BMW SA websites. The researcher followed this process and participated in an arranged tour with a group of other participants. Participation thereby enabled the researcher to access information on the raw materials that go into the BMW production as well as an insight into the company's environmental ethic and production space. The researcher also managed to identify behaviours surrounding and informing sustainability during the participative tour.

**g) Oral Data**

The researcher managed to have informal conversations with two former VW employees, one engineer in Toyota and one employee working in a company that is a supplier to VW. These conversations reinforced insights into VW operations as the initial attempted contact with VW had not been very fruitful. Patton and Cochran (2002) highlight that informal talk is an ideal way of understanding different settings because as people talk they communicate certain pertinent information that is not ordinarily said in specific controlled environments. These informal conversations helped the researcher glean data that was very informative as the researcher was included in the talks and thereby accessed what was important to these people and what they thought about sustainability in relation to their workspaces/ former workplaces.

### 3.4.4 Data Analysis

In analysing documents the researcher used elements of content and thematic analysis in combination. Content analysis involves organising information into categories that are related to the central questions of the research and relevant meaningful data is extracted (Bowen, 2009). Thematic analysis involves recognising patterns that develop from the data then using these as categories for analysis and this process is more focused and requires repetitive reading and reviewing of data which is then coded and categorised to reveal the themes

pertinent to a phenomenon (Patton and Cochran, 2002). Predetermined codes may be used specially in instances where documentary analysis is used to supplement other research methods employed for the study (Bowen, 2009).

Thematic analysis of data involves reviewing all data gathered in order to identify common threads that recur and identify main themes that cover all views that have been collected (Bowen, 2009). The key stages that are involved are reading and interpreting data, identifying themes, developing a coding scheme and coding the data (Patton and Cochran 2002). In reading and interpreting the data the researcher made initial observations in trying to establish the trends in the data gathered. Themes relating to sustainability, environmental management, interaction with suppliers and alignment with green initiatives were identified and the researcher made sense of these themes and made notes. From all the themes that were emerging a coding scheme was developed where broad codes were developed and multiple sub codes derived from them. Unique numbers identifying each code were selected and assigned accordingly. The initial analysis helped shape progressive data collection as this helped the researcher to refine in some instances and to broaden the range of questions asked. The codes were then applied to the rest of the data by applying the unique number for each code to the broad themes and sub themes.

Once all the data was coded the researcher then extracted data from original contexts and combined it with other examples of data on the same topic and started establishing the patterns across the data. For example the data on vehicle manufacturers' relationships with their suppliers and sub codes pertaining to areas and locations where raw materials are sourced was grouped together. Patterns such as relative location of suppliers, types of material supplied, and effects of raw material sourcing on the environment were thus established. The patterns that were found and that were specific to each theme became the basis for the progressive chapters on empirical evidence, discussion and analysis as well as the final chapter on the overall discussion, analysis and conclusion.

## 3.5 Methodological Reflections

In order to carry out the research I had to establish links with the motor vehicle manufacturers in the country. I managed to connect with the chosen manufacturers despite not having links within the industry as I used their customer services as well as opportunities that arose for site

visits. A number of managers in the chosen corporations were ready to help either directly or through availing sustainability reports, but in instances such as VW where access was denied outright, I resorted to using official sustainability reports to gain insights into the way in which they approach environmental sustainability. This proved useful and I used the reports from all the other corporations to support the information I had gathered from the interviews I had managed to conduct. In addition to this I approached vehicle dealers as they have immense product knowledge and this helped substantiate the data I had collected. The research was time consuming and lengthy as I constantly had to follow up on the participants. The nature of the participants was such that they were never in one place at any given time and they would travel for meetings and I constantly had to reschedule appointments. In most of the manufacturing plants, I constantly had to assure the participants that I was not a journalist or environmental activist as they were a bit sceptical of where my interests lay. I overcame this by carrying my student card as well as detailed information on my study as reflected in the participant information sheets, informed consent forms and ethics clearance certificate. In a number of the sites the managers would refer me back to the Group reports for detailed information.

## 3.6 Limitations of the Study

This study focused on the motor vehicle manufacturing industry in South Africa in the context of the green economy. The respondents were picked from sites relatively dispersed from each other and dealing in different products and markets. The relative distance between the sites made the field work cumbersome. A lack of willingness from participants to take part in the study was a limiting factor in the data collection process. Most of the vehicle manufacturing companies constantly referred the researcher to the parent companies' websites to access official records or to the Public Relations Departments. This limited the study in that most of the information given out was rehearsed thereby to some extent lacking the lived experiences of the people working within the environmental departments in the chosen manufacturing companies. This also meant that the information given out from the parent company and the Public Relations Departments was not only specific to the South African context but covered all the subsidiaries under the parent company. Going through the voluminous copies of reports to gain insights into the South African context specifically became very laborious and time consuming.

The researcher then reviewed company environmental and sustainability reports to overcome the barriers that went up in trying to access information through interviews as these yielded data that was not very rich. VW declined to participate in the study from the onset by highlighting they did not give out confidential information to the public. Companies in South Africa are however bound by the Promotion of Access to Information Act 2 of 2000. This Act encourages accountability and transparency in both public and private sectors. The other technique used by the researcher in light of the barriers was to trace the use of raw materials that go into vehicle production through the various dealers that sell VW, Mercedes, and Toyota and BMW cars in the country. This offered insight into the level of environmental exploitation that occurs in order to facilitate the manufacturing process.

In carrying out the fieldwork the researcher was constantly mistaken for a journalist and this made accessing information somewhat difficult as the respondents might have given guarded and calculated answers. In some instances the researcher was identified as seeking information to sell to competitors. This meant that respondents were particularly careful of the level of information they made available. Gadgets with camera functions were strictly prohibited within the manufacturing plants and this meant no pictures or recordings could be taken to give an insight of the various aspects that characterize the manufacturing plants. Pictorial evidence would have enriched the study as it would have highlighted the various aspects that go into vehicle production, distribution and division of work, the mechanisation level and the level at which tasks are organised in the plants to cite a few aspects.

# CHAPTER FOUR

# EMPIRICAL EVIDENCE

## 4.0 Introduction

This chapter presents the empirical evidence that was gathered between September 2015 and August 2016 to address the research questions used in this research. The aim of this chapter is to highlight what the research sought to investigate and the findings obtained thereof. The data was categorized in relation to the research questions and relevant data was extracted from the content. To ensure data that was relevant to the central questions was picked all patterns that were established in the data were put into categories. These categories were established through repetitive reading and reviewing of the content. Through this process themes responding to the research questions were drawn out and utilised to establish an overall understanding of the way in which motor vehicle manufacturers adapt their operations to align with environmental sustainability demands in their search for profit. The data drawn from this process is presented in a number of ways, through excerpts from interviews and documents, excerpts from electronic mail communication as well as graphs and tables where relevant.

The initial response from the vehicle manufacturers is presented first followed by the different vehicle manufacturers' approaches to sustainability. The next subsection illustrates the raw material compositions found in different cars by make, model and produced in South Africa. This section details the advances that have been made in the adoption of the various materials and to some extent the justification behind the adoption and utilisation of the various components in specific instances. Vehicle manufacturing is governed by international standards of operation that can be adopted and under this section the adoption of EMS such as the ISOs by vehicle manufacturers is presented. The next section presents data on the impact environmental awareness and emergence of the green economy has on vehicle production and the ways in which manufacturers have responded to the changing operational environment. Almost similar to EMS adoption are the ways in which vehicle manufacturers

operate within different global and national regulatory environments. This extends to the ways they negotiate the variations and the relationship with laws and this is explored under the regulatory environment section. The section after regulation deals with the stages in the value chain where green practices are adopted and this is followed by the vehicle manufacturers' interaction with their suppliers as the last section. The overall findings are highlighted at the end of the chapter.

## 4.1 Initial Response from Contact with Manufacturers

Vehicle manufacturers in South Africa seemed very cautious and guarded in the way in which they deal with the public in spite of the seemingly open values communicated on their websites. An analysis of the four websites showed that most of the companies value customers and potential customers and they have customer interaction platforms for the public such as: http://www.toyota.co.za/contact-us; http://www.mercedes-benzsa.co.za/contact-us, https://www.bmw.co.za/en/integration/contact-us. However, in soliciting information pertaining to environmental sustainability and the way in which specific manufacturers interact with the environment in the manufacturing process from such platforms the typical responses that the researcher received through the communication channels is illustrated below:

> ***Dear Miss Mutumi,***
>
> *Many thanks for your e-mail and your interest in the BMW Group.*
>
> *Unfortunately, we cannot provide you with the detailed material that you requested. General information on our company and its products is available at www.bmwgroup.com.We hope that this information will be of some help to you.*
>
> *Kind Regards, BMW Group*
>
> *Corporate Communications* (Email. Com a, 2016)

Similar communication was received from the VW SA group highlighting that the company does not disclose confidential information. The difference in the two responses was that BMW directed the researcher back to the company website as a way of responding to the questions raised whilst VW was forthright in saying that releasing this information would violate their company policy and this is shown in the communication sent through electronic mail.

*Memo*

*To: Miss Prue Mutumi*

*Email: 500948@STUDENTS.WITS.AC.ZA*

*Assignment letter*

***Dear Miss Mutumi***

*X 1735290000/CIC Customer Interaction Centre 0860 434 737 041 394 5170 support@vwconnect.co.za*

*Volkswagen of South Africa (Pty) Ltd. (Reg No 1946/023458/07) Registered Address: 103 Algoa Road*

*Uitenhage, 6229 Tel: +27 – 41 – 994 4111 Fax: +27 – 41 – 994 5437*

*Website: www.vw.co.za Chairman: T Ulbrich**

*Managing Director: T Schäfer* Directors: Ms P Hoffmann* (Sales & Marketing) C Klingler** S Macozoma*

*Ms NH Maliza (Corporate and Government Affairs)*

*C Stapel* (Finance) PJ Smith (Human Resources) A Pinto*** (Production)*

*German* Austrian ** Portuguese ****

*Thank you for your e-mail and for selecting Volkswagen of South Africa as your organisation of choice.We maintain a strict confidentiality policy regarding sensitive/confidential information. Any communication of such information to the general public would go against this policy.*

*We wish you all the best.*

*Best regards*

*X*

*Specialist: Customer Interaction Centre Public (Email. Com b, 2015)*

In as much as the vehicle manufacturers responded as highlighted above, they still communicate that they produce sustainably. The four manufacturers define sustainability on a

broad spectrum and their company policies differ in a number of areas as each company seeks to position itself favourably with customers, stakeholders and in society. The various approaches and definitions to sustainability as presented in the various sustainability reports are captured in section 4.2 below

## 4.2 Sustainability Defined by Vehicle Manufacturers

Vehicle manufacturers define sustainability in many different ways despite functioning in the same industry. The sections below elaborate on these differences by looking at the way BMW, VW, Mercedes and Toyota define sustainability in relation to manufacturing.

### 4.2.1 BMW Group

BMW defines sustainability as resource management and these resources include finances, people, raw materials and energy use as well as the impact these exert on the environment. This is illustrated in the diagram below that demonstrates that the central aim in vehicle manufacturing in BMW is value creation attained through the use of all the resources illustrated in the outer segments of the chart shown in figure 4.1.

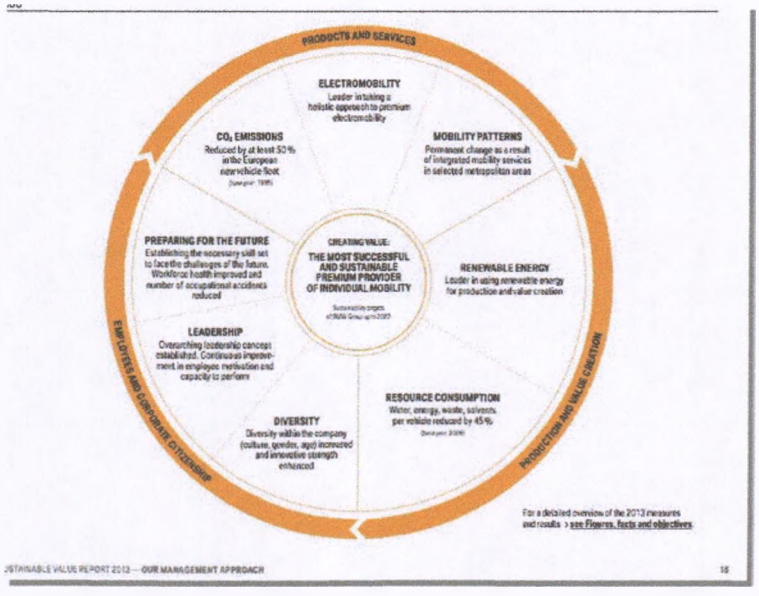


FIGURE 4.1: SUSTAINABILITY DEFINED BY BMW, SOURCE: BMW, 2013.

BMW's corporate policy as shown in Figure 4.1 focuses on the three aspects of sustainability namely economic, environmental and social. This three-pronged focus is linked to the long

term viability of the company, particularly economic success. A high percentage of managers interviewed (82%) by D. Little Consulting were of the view that sustainable growth plays a central role in increasing the economic value of the company (BMW, 2001). In an interview published in the Sustainable Value Report in 2001, Manfred Schoch (Chairman of the EURO Committee and National Works Council, Deputy-Chairman of the BMW Group Supervisory Board) highlighted that in as much as the work of BMW needs to be aligned to the requirements of environmental protection the goal is to attain economic success and to pay attention to social issues. The belief that comes through strongly in the BMW sustainable value reporting is that resource consumption has a bearing on the economic viability of the company, but harmony can be attained between economic efficiency and environmental sustainability.

Sustainable resource utilisation/sustainability is deemed to bring about frequent cost reductions (in sales, service operations and production), aid in increasing productivity, enhance the company's reputation or corporate image, act as an indispensable aspect of quality management and ultimately enhance the company's future economic viability and value. This value that is created then becomes the basis upon which companies can practise environmental responsibility. BMW classifies sustainable operations as an investment into the future and highlights that there is a strong business case towards adopting sustainable practices as illustrated below:

> *Sustainable operations are an investment in our future success and one of the main drivers of our business. We are already demonstrating how sustainability measures have led to cost savings or generated revenue – thus validating the business case for sustainability. For us, sustainability means: making decisions weighing up the environmental, economic and social aspects of our actions. For us, sustainable operations constitute a long-term business case: sustainability means making a lasting positive contribution to the company's economic success. For us, constant integration of sustainability into our business model is an investment in our future. By acting sustainably, we leverage new business opportunities, minimise risk and seek to overcome social and business challenges such as scarcity of resources, climate change and demographics at an early stage* (BMW, 2014; 2015).

In line with the above, BMW points out that between 2006-2012 the entire group reduced energy, water, waste and volatile organic compounds emissions by 36% per vehicle leading

to cost savings of around €100 million (BMW, 2012). In the same year the company had a profit of over €7.8 billion and 2012 was deemed the most successful financial year in the company's history. In 2013 and 2015 the group attained cost savings of €6.8 million and € 8.2 million respectively. In addition, BMW was named the most sustainable carmaker in the Dow Jones Sustainability Index for the eighth consecutive year in 2012. All sustainable activities are examined on the basis of their profitability and the results are seen on the company's balance sheets thereby making the group attractive to investors. This is due to the fact that investors are focusing on sustainability performance as an investment criterion.

Sustainability in the BMW Group has also been made the core principle and an integral part of the four strategy pillars that make up the company's Strategy Number One. This is highlighted in the excerpt below that details how the company seeks to achieve its vision:

> *As we strive to achieve our vision, we will focus consistently on growth, profitability, working actively to shape the future, and on access to new technologies and customers. These core areas of action form the four pillars of Strategy Number One. Sustainability is one of the BMW Group's core principles and an integral part of each of the four strategy pillars* (BMW, 2014).

Sustainability is ingrained in each of the four focus areas and the objectives are: to ensure that products and services lead the way and tap into new markets and customer groups, the BMW group is a leader in innovation in the area of individual mobility and leverages potential efficiencies along the entire value chain and that new technologies enable customers to experience the company as well as its products and services. Strategy Number One thus contributes towards the competitive advantage of the company and this is illustrated in Figure 4.2.

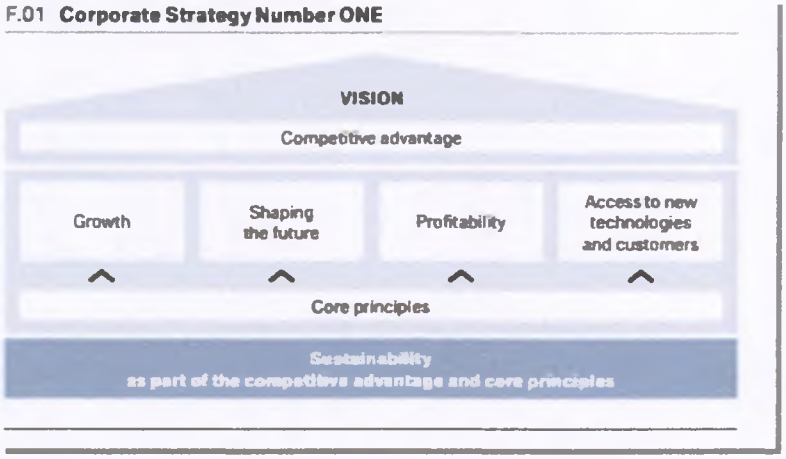


FIGURE 4.2: BMW'S STRATEGY NUMBER ONE, SOURCE: BMW, 2013

Success within the group is measured not only through the financial indicators but also through the integration of the company into society thereby taking into account social and environmental responsibility and using these to build a good corporate image. To this end all projects are measured in terms of sustainability as a corporate objective as highlighted below:

> *This means that every project must be measurable in terms of "Sustainability" as a corporate objective, ensuring that, in addition to economic factors, environmental and social aspects are also accounted for in the decision-making process – because we know that today, the value of a company is not measured solely by direct financial indicators but also by so-called non-financial performance indicators. By setting the right course in the early stages of a project, the company saves resources and any necessary corrective measures down the line, which often entails much higher costs. In addition, sustainability as a corporate objective cascades down to personal target agreements for managers and is thus part of their performance-based remuneration* (BMW, 2013).

The development of the Dow Jones World Composite Sustainability Index is one measure that business has adopted to measure the sustainability levels of investments and it was developed in line with the Dow Jones World Stock Index that was compiled along conventional economic criteria. The sustainability index thus shows the advantages for sustainability-oriented investors against using unsuitable materials for production as this results in losses. In 2013, the BMW group was recognised as a leader in terms of its

innovation management and commitment to reducing negative environmental impacts along the value chain.

### 4.2.2 VW Group

VW brings together concepts of sustainability and responsibility particularly based on the urgency to conserve resources, protect the earth in changing climatic conditions as well as to ensure generational equity. The justification of this approach lies in that the group believes growth is intertwined with responsibility, environmental protection and social protection to the point where all four become value drivers. VW believes operating sustainably means taking responsibility especially since the company has a global reach and ultimately profits from global growth as illustrated in the following statement:

> *As we understand it, sustainable development means taking equal account of economic, environmental and social interests and maintaining an appropriate balance between them. Ensuring stability and profitability therefore constitutes a core action area of the Volkswagen Group – providing a basis for sustainable growth and investment in the future* (VW, 2013).

Managing and improving conditions for sustainable growth as well as developing new growth opportunities become paramount for future survival. VW highlights that sustainability entails balancing economic, environmental and social objectives and this is reflected in the way CSR is valued in the group. Volkswagen views corporate social responsibility (CSR) as its contribution to sustainable development and this ensures that the manner in which the company conducts business and consumes resources guarantees opportunities for future generations. CSR entails considering the impact on society and on the environment. Ecological, economic and social goals are pursued in the same measure and are viewed as essential components in the creation of a sustainable global economy. Sustainability principles are integrated along the company's value chain and this safeguards the company's long-term viability. Three core areas play a part in VW's sustainability management and these are the political level, customers and financial market participants. The political level influences corporate sustainability reporting as transparency and quality are regarded as imperative in the production process. Customers (key account or fleet customers) are seen to be demanding compliance to sustainability criteria. Financial market participants on the other hand are seen to be basing their recommendations on CSR and sustainability profiles.

The above considerations and approaches to sustainability management have driven VW particularly towards putting a holistic and strategic sustainability concept in place. The company views CSR as the company's responsibility for its impacts on society. VW highlights that it is better suited to combine modern understandings of responsibility and sustainability with the more traditional approaches that valued entrepreneurial activity. This means integrating the view of CSR as charity with a better model of responsibility and sustainability thereby addressing the challenges currently faced in society such as resource conservation and climate protection on an intra-and intergenerational scale.

This preceding view is expressed in the excerpt below:

> *The modern view of CSR sees responsibility and sustainability as two sides of the same coin, because sustainability calls precisely for an equitable ultimate balance between the economic, ecological and social dimensions* (VW, 2011).

Figures 4.3 and 4.4 below give examples of the company CSR budgets from BMW and Toyota that are allocated towards environmental management as part of CSR and the distribution of environmental activities respectively. In 2012 BMW Group gave a total of 8% of donations and scholarships towards science technology and environmental related donations and sponsorships with the highest donation allocated to charity/community as well as art and culture at 34%. Between 2000 and 2014, Toyota has supported 19 bio-diversity conservation and other projects as well as six global warming related and other projects in Africa with the highest number of projects based in Japan.

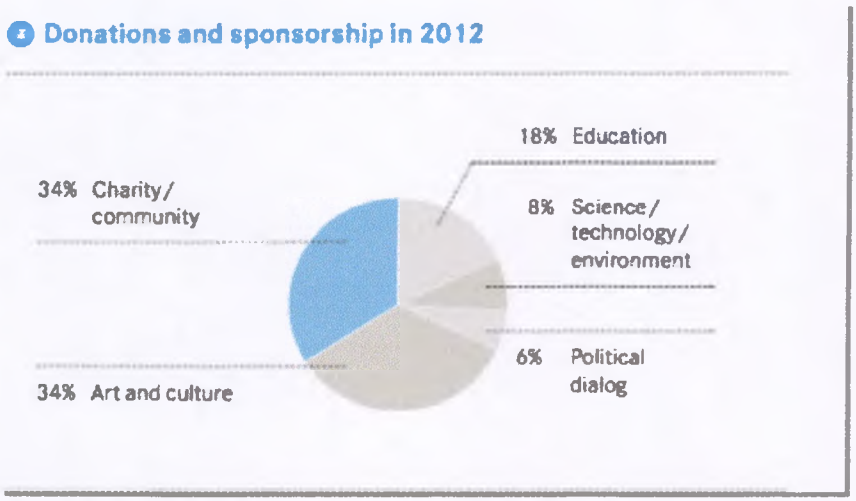


FIGURE 4.3: BMW DONATIONS AND SPONSORSHIP, SOURCE: BMW, 2013

implementing the sustainable practices at all levels, in all stages of the value chain with numerous brands, across over 118 production locations and with numerous suppliers.

Figure 4.5 details the company's approach to sustainability in relation to the targets set for 2018 and shows the interrelationship amongst the people, economy and the environment in the attainment of the company's goals:

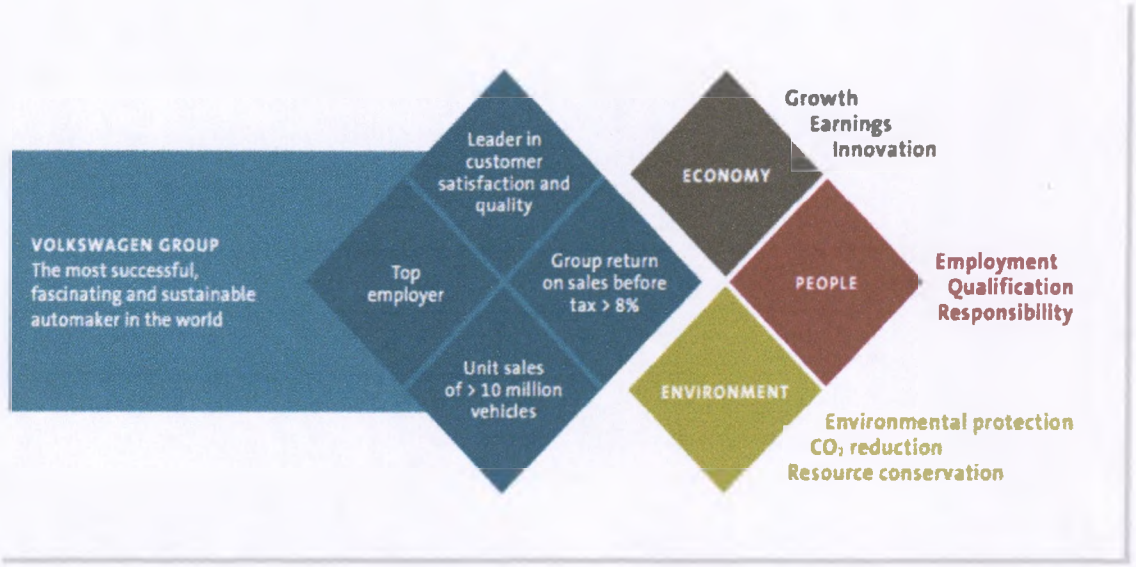


FIGURE 4.5: VW GROUP STRATEGY 2018, SOURCE: VW, 2013

In support of the above, VW's 'Think Blue' concept has gained prominence and has been broadened since late 2011 to include production operations. The aim is to reduce impact on the environment for each vehicle and component produced by 25% using 2010 as the base year and this is to be achieved by 2018. Five key environmental factors that are considered in the company are energy, water, waste, $CO_2$ and solvent emissions. In 2013, out of the 43 VW plants spread across four continents, 27 were taking part in the environmental programme such that they had identified a resource saving potential of €114.3 million. These targets are captured in the statement highlighted below that also illustrates how VW defines sustainability:

> *The Volkswagen Group has a clear goal: by 2018 we aim to be the world's most successful, fascinating and sustainable automobile manufacturer. For us, sustainable means a form of responsible long-term economic activity that benefits everyone –*

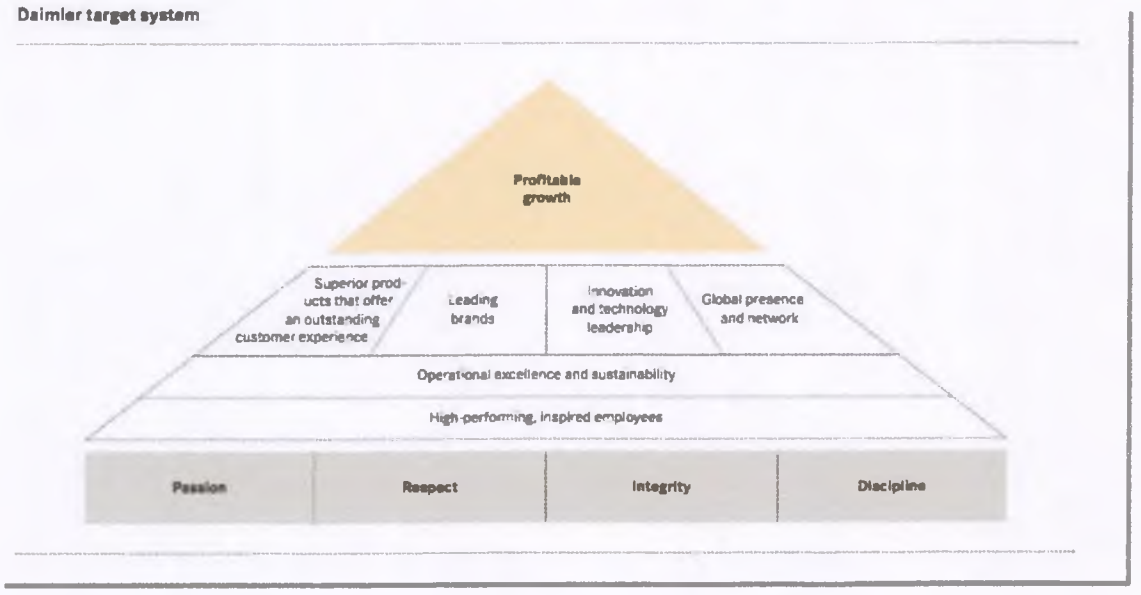


FIGURE 4.6: DAIMLER SUSTAINABILITY TARGET SYSTEM, SOURCE: DAIMLER, 2011

Sustainability management within the group seeks to control the economic, environmental and social consequences of the business activities by minimising negative effects and maintaining positive effects that benefit the company and society. The commitment to adhere to sustainability demands as well as the levels to which the group is committed is highlighted below:

> *In 2010 we incorporated sustainability as an objective into our system of strategic targets. In this way we're emphasizing the fact that economic, environmental, and social responsibility are all interconnected at Daimler. We have also tried to more clearly show how our sustainability strategy is derived from the issues that are particularly crucial to us and how this strategy is incorporated into our business strategy. The strategy and the supporting management systems help us implement our Group-wide sustainability program, for which we already set ambitious goals in 2010. Given that the program runs from 2010 to 2020, we can plan measures for a longer term and manage our activities with greater foresight. Because it stipulates targets and also defines the target horizon and the degree of goal achievement, the program is worded in a much more binding manner than was the case in the past* (Daimler, 2011).

The Daimler group highlights that being competitive in the global markets and making profits

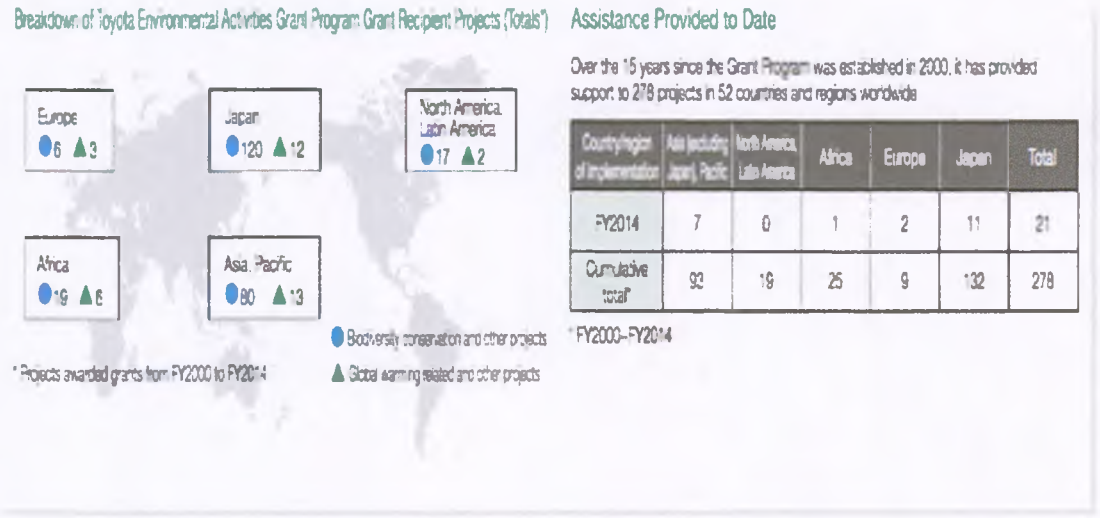


FIGURE 4.4: TOYOTA ENVIRONMENTAL ACTIVITIES GRANT PROGRAM, SOURCE: TOYOTA, 2015

CSR ensures that at every stage in the value chain the company avoids risk, identifies development opportunities and continues to build its reputation thus securing the company's future and raising its value in the long term. The excerpt below encapsulates the way in which VW explains sustainability:

> *For the Volkswagen Group, sustainability means that we conduct our business activities on a responsible and long-term basis and do not seek short-term success at the expense of others. Our intention is that everyone should profit from our growth – our customers and investors, society and, of course, our employees. In this way, good jobs and careful treatment of resources and the environment form the basis for generating lasting values* (VW, 2014).

Vehicle production has both positive and negative effects such as job creation, regional prosperity, emissions as well as resource consumption and this is why VW has structured sustainability objectives and activities under three umbrella terms: economy, people and environment. Under environment, the group deals with aspects such as climate and environmental protection, resource conservation across the lifecycle, intelligent mobility, vehicle safety, environmentally friendly products and vehicle electrification. VW accedes that in as much as it has made a commitment to sustainable practices, the challenge lies in

*employees, customers, investors, environment and society. This calls for appropriate endeavors by all brands in all regions where they operate, and along the entire value chain* (VW, 2013).

The 'Think Blue' concept encapsulates the sustainability philosophy of the VW Group that aims to balance mobility needs with environmental needs. This is attained through inspired and motivated employees, customers, the general public as well as environmental organisations around the world. Components of the 'Think Blue' philosophy include Engineering, Factories, Dealers and Mobility. 'Think Blue Engineering' seeks to improve the environmental performance of new models whilst 'Think Blue Factory' aims to reduce consumption of energy and water, the volume of waste for disposal, solvent emissions and $CO_2$ emissions per unit made by 25% worldwide. 'Think Blue Dealer' seeks to address energy utilization outside of production and in this instance dealers will be advised on energy related aspects. VW aims to provide information on electric mobility (efficient powertrains-main component generating power, efficient technologies and clean cars to cite a few) thereby making a meaningful contribution to global sustainable mobility and this is achieved through 'Think Blue Mobility'.

VW is aware that analysts and potential investors use CSR and sustainability performance as indicators for future oriented corporate leadership. The group affirms that sustainability ratings capture the environmental, social and economic performance of a company and high scores are attractive to both stakeholders and potential employees. In 2011 for example, VW scored highly in environmental management and this is captured in the excerpt below:

*Volkswagen is one of only three automobile companies listed in the Dow Jones Sustainability World Index. In the assessment by Swiss asset management company SAM on behalf of Dow Jones, Volkswagen scored top marks especially for environmental management and employment growth, as well as for risk management, social commitment and stakeholder relations. As of December 31, 2011, Volkswagen was represented in the following sustainability indices: Advanced Sustainability Performance Index (ASPI), Carbon Disclosure Leadership Index (CDLI), Dow Jones Sustainability World Index, ECPI Ethical Index Europe, ECPI Ethical Index EMU, ECPI Ethical Index Global, Ethel Sustainability Index (ESI), FTSE4Good and STOXX ESG Leaders Indices* (VW, 2011).

Sustainability indices play a critical role in image building for the VW Group and these have a bearing on the customer base of the group. Customers are central and are regarded a top priority within VW. In terms of sustainability in the group, customer satisfaction is deemed a top indicator of the level to which product development and model facelifts cater to stakeholder needs.

### 4.2.3 Daimler AG, Mercedes- Benz SA

Daimler defines sustainability as responsible corporate behaviour that results in long term business success whilst in harmony with the society and the environment. Sustainability is integrated in all operations and all employees are required to take ownership for sustainable operations. Business partners are also required to participate in sustainable operations and stakeholders are engaged in continuous dialogue. Management structures, processes and systems are all aligned to sustainability and all approaches are anchored along integrity and legal practices. In order to maintain a leading position in sustainability, measurable targets have been set for the Daimler Sustainability Programme 2010-2020 and areas included are sustainability management, products, environmental protection, human resources and social responsibility. The corporate culture is founded on the UN Global Compact's (world's largest multinational sustainability initiative) ten principles. The overarching goals in the group are to attain profitable growth and increase the company's value in a sustainable manner.

In order to achieve these goals the group has come up with four values that are put into practice in the entire group and these are passion, respect, integrity and discipline and these are illustrated in Figure 4.6. The use of technology is central to the development of environmentally sensitive vehicles, systems and safety features. The drive behind sustainability is to ensure the group safeguards its position in established markets and strengthens its position in new ones. This is done through inspired employees and a Board of Management that deals with sustainability issues as it is the central sustainability monitoring body. All corporate decisions are made through the board as it combines management processes and areas of responsibility that are relevant to sustainability. A closer look at Figure 4.6 however shows a lack of explicit focus on the environment given that the company claims a movement towards environmental sustainability.

is part of social responsibility and this contributes to value creation. Other aspects such as environmental protection and compliance with social standards are closely related to competitiveness and profit making and serve as opportunities (when managed well) or as risks (when mismanaged) ultimately impacting on the economic performance. Sustainability is used in advertising; for instance in 2012 various advertisements were flighted and examples are given below:

> *Efficiency and sustainability played a prominent role in the advertising campaigns for the M- and B-Class. Efficiency was also the dominant topic of an ad printed as part of the C-Class advertising campaign. The "Efficiency Pays" trade marketing campaign and the "Staying Alive" TV commercial about the fuel consumption- reducing ECO START-STOP function* (Daimler, 2013).

Vehicle manufacturers view value creation holistically and ultimately group together economic, environmental and social responsibility to ensure long term viability. Sustainability efforts tend to be concentrated in areas that are significant for stakeholders and the company, with an emphasis on stakeholders as they are crucial to value creation. The excerpt below captures Daimler's approach to sustainability:

> *Therefore, our conviction is that only those who deliberate on and consider the effects their actions have on the environment and society will be successful in the long term. On the other hand, we as a company can do very little for the environment or society if we are not competitive in business. In essence, then, we must bring our economical, ecological and social goals in harmony. In doing so, we are guided by the ten principles of the UN Global Compact, as they relate to human rights, labour standards, environmental protection and the fight against corruption* (Daimler, 2013).

Figure 4.7 gives the principles and guidelines for sustainability management used by Daimler. It shows the international and national principles that form the basis of the binding frames of reference the group's companies operate by. Drawing from these reference points the figure then shows Daimler's most important principles and guidelines such as environmental and energy guidelines. The entire set of regulations is accessible to all employees through a central employee portal.

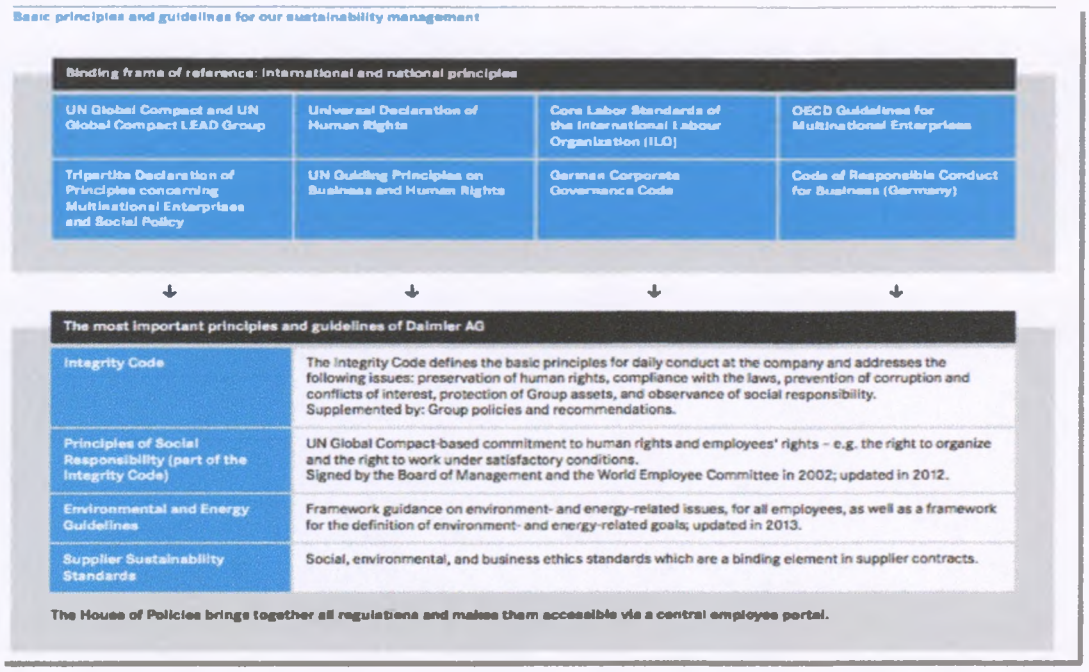


FIGURE 4.7: PRINCIPLES AND GUIDELINES IN SUSTAINABILITY MANAGEMENT, SOURCE: DAIMLER, 2013.

### 4.2.4 Toyota

Toyota's vision shown in Figure 4.8 entails making better cars that exceed expectations and this is done in a way that enriches community lives using values such as the Guiding Principles at Toyota, Toyota Earth Charter and The Toyota Way. This ensures the company has satisfied customers leading to a stable business base and through all of this the company can achieve sustainable growth and contribute to sustainable development. In providing better cars the focus is on customer satisfaction through a product that can be considered safe and high in quality. The goal in enriching communities is to contribute towards the economic development of communities. This is achieved through drawing suppliers and dealers to Toyota with a focus on encouraging local purchasing. In terms of the environment, Toyota seeks to reduce environmental burdens throughout the vehicle lifecycle by developing eco-friendly vehicles that are fuel-efficient and produce minimal emissions.

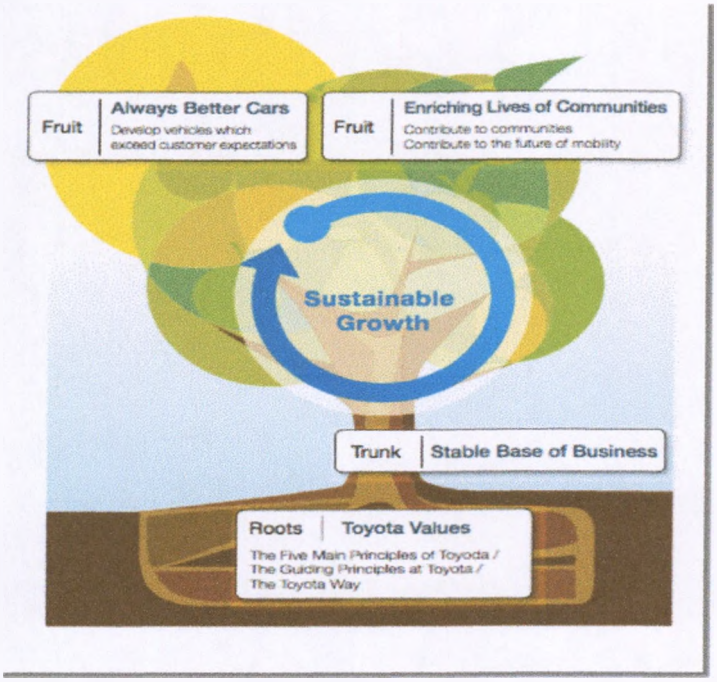


FIGURE 4.8: TOYOTA'S GLOBAL VISION TREE, SOURCE: TOYOTA, 2015

Toyota uses the 'CSR Policy: Contribution towards Sustainable Development' to guide manufacturing and to deal with environmental changes and increased societal interest. The Preamble to the CSR Policy is given below:

> *We, Toyota Motor Corporation and our subsidiaries , take initiative to contribute to harmonious and sustainable development of society and the earth through all business activities that we carry out in each country and region, based on our guiding principles. We comply with local, national and international laws and regulations as well as the spirit thereof and we conduct our business operations with honesty and integrity. In order to contribute to sustainable development, we believe that management interacting with its stakeholders as described is of considerable importance, and we will endeavour to build and maintain sound relationships with our stakeholders through open and fair communication. We expect our business partners to support this initiative and act in accordance with it* (Toyota, 2015).

The rationale is to contribute to sustainable development through manufacturing and provision of quality products and services. Toyota acknowledges that vehicle manufacturing contributes extensively to environmental ills and the goal is to seek harmony with people, society, global environment and sustainable development through monozukiri

(manufacturing). Figure 4.9 shows the targets set by Toyota to ensure that environmental sustainability is taken into account in manufacturing.

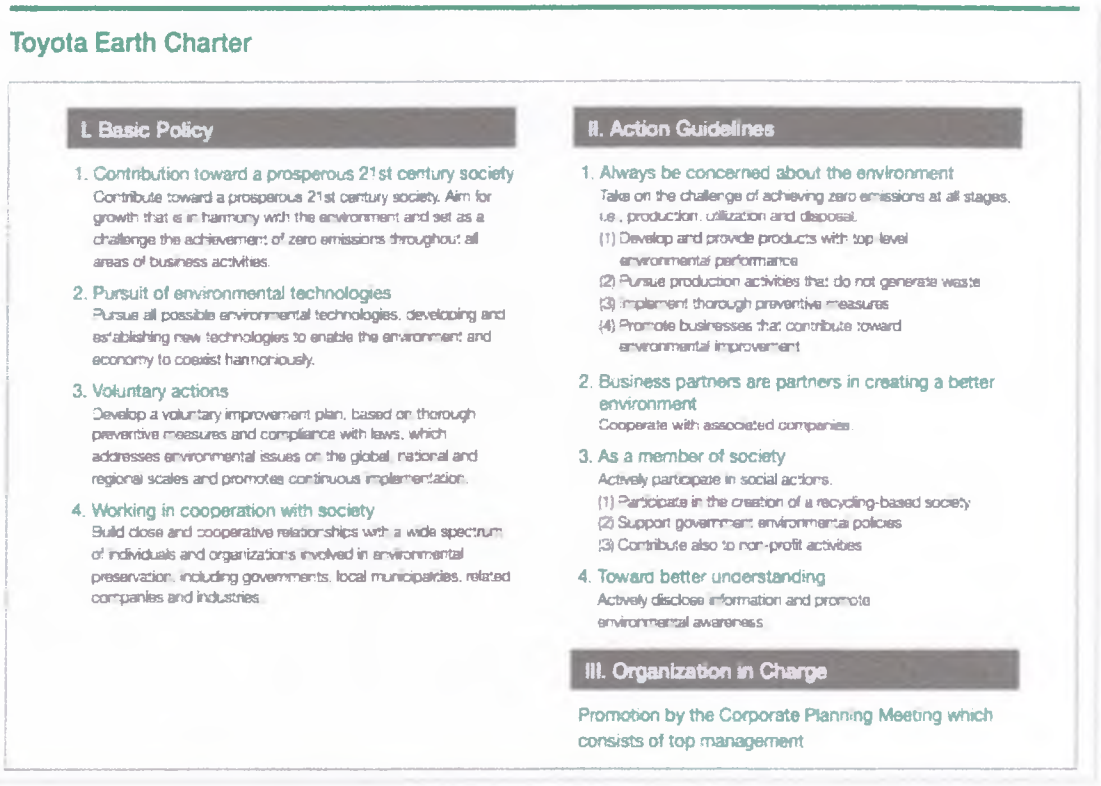


FIGURE 4.9 TOYOTA EARTH CHARTER, SOURCE: TOYOTA, 2014

As shown in Figure 4.9, the aspiration is to achieve zero emissions, use technologies to enable the environment and economy to co-exist harmoniously, comply with environmental laws and work together with society.

## 4.3 Raw Material Composition in Cars by Model and Make

Motor vehicle manufacturers use a variety of materials in production and Tables 4.1-4.4 and Figures 4.10-4.14 give the material compositions across makes and models. These materials are drawn from different industries and are given in the tables as percentage compositions.

**Table 4.1: A breakdown of material composition in the VW Golf**

| Material | Composition % |
|---|---|
| Steel and iron materials | 59% |
| Polymer materials | 18% |
| Light alloys, cast and wrought alloys | 10% |
| Operating fluids and auxiliary materials | 5% |
| Composites, renewables and other materials | 4% |
| Nonferrous metals, cast and wrought alloys | 2% |
| Process polymers | 1% |
| Electronics/electrics | 1% |
| Special metals | 0% |

**Source: VW, 2014**

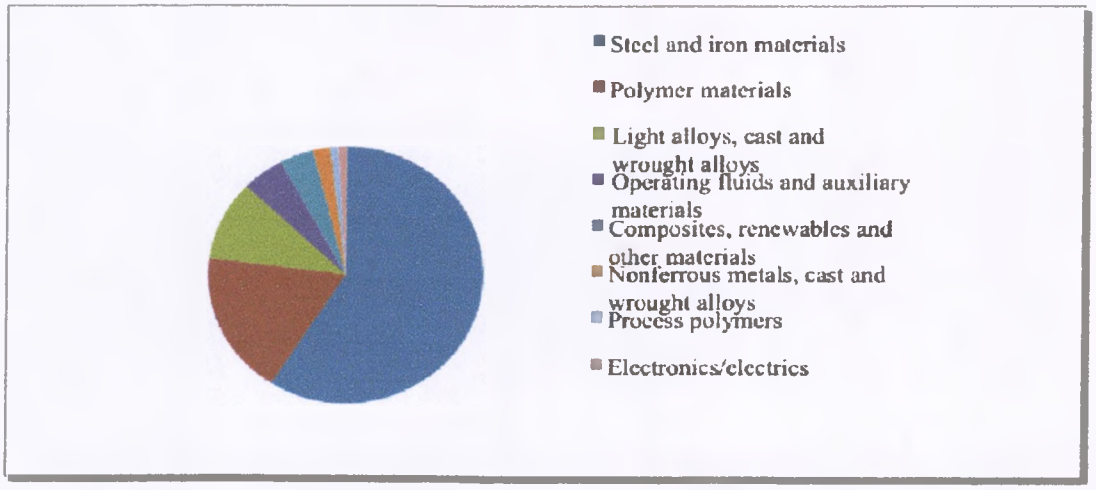


FIGURE 4.10 MATERIAL COMPOSITION IN THE VW GOLF, SOURCE: TABLE 4.1

Table 4.2: A breakdown of material composition in the Mercedes C-Class

| Material | Composition % |
|---|---|
| Steel and iron materials | 56% |
| Polymers | 15% |
| Thermoplastics | 12% |
| Light alloys | 4% |
| Service fluids | 4% |
| Elastomers | 4% |
| Nonferrous metals and other metals | 3% |
| Process polymers | 1% |
| Electronics, Other plastics, Duromers, Special Metals | 1% |

**Source, Daimler 2015**

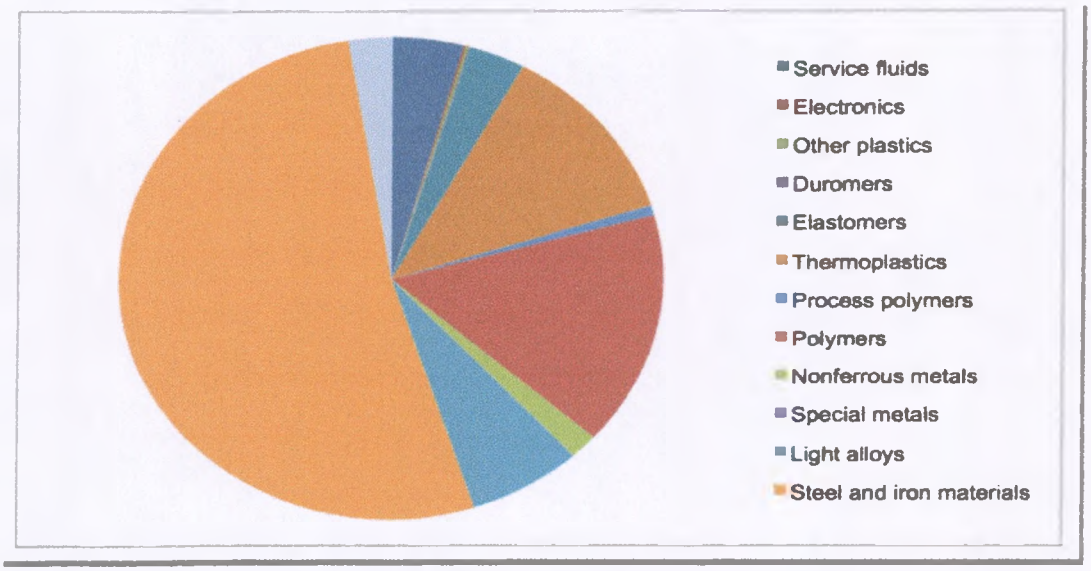


FIGURE 4.11 MATERIAL COMPOSITION IN THE MERCEDES C-CLASS, SOURCE: TABLE 4.2

Table 4.3: A breakdown of material composition in the Toyota Corolla

| Material | Composition % |
|---|---|
| Steel and iron materials | 55% |
| Rubber | 19% |
| Polymer materials | 12% |
| Aluminium | 8% |
| Glass | 3% |
| Fluids and auxiliary materials | 1% |
| Electronics/electrics | 1% |
| Composites, renewables and other materials | 1% |

**Source, Toyota, 2015**

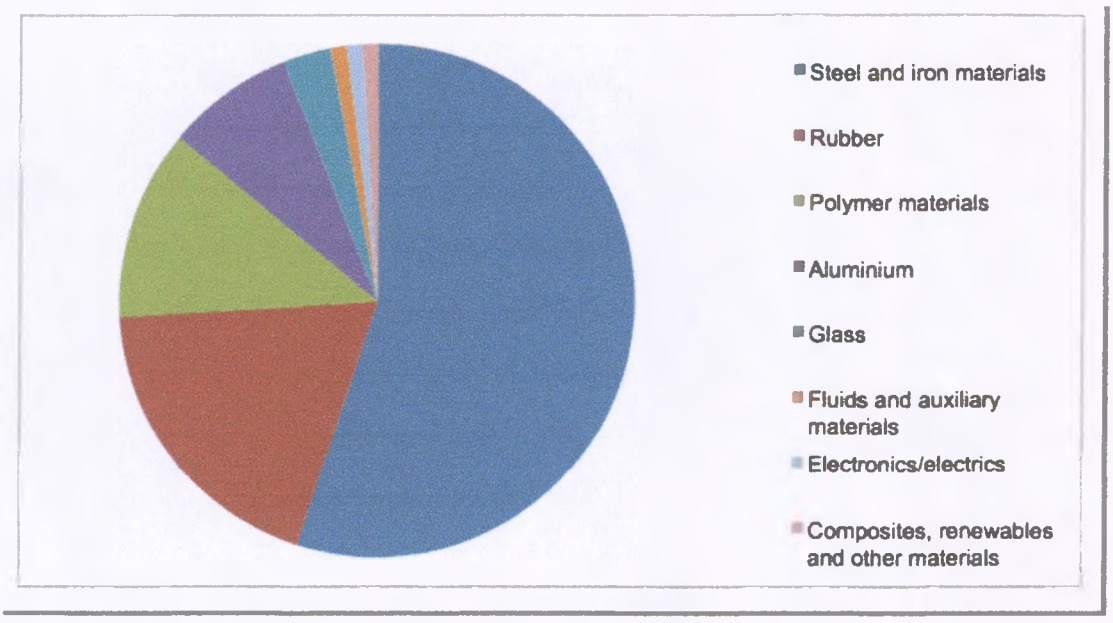


FIGURE 4.12 MATERIAL COMPOSITION IN THE TOYOTA COROLLA, SOURCE: TABLE 4.3

**Table 4.4: A breakdown of material composition in the BMW 3 Series**

| Material | Composition % |
|---|---|
| Steel and Iron | 56% |
| Non-ferrous metals | 18% |
| Thermoplastic Resins | 12% |
| Other | 5% |
| Elastomers (Tyres and seals) | 4% |
| Duroplastic Resins/Duromers | 2% |
| Textiles and other composites | 1% |
| Operating fluid | 1% |
| Modified organic natural materials | 1% |

**Source: BMW, 2012**

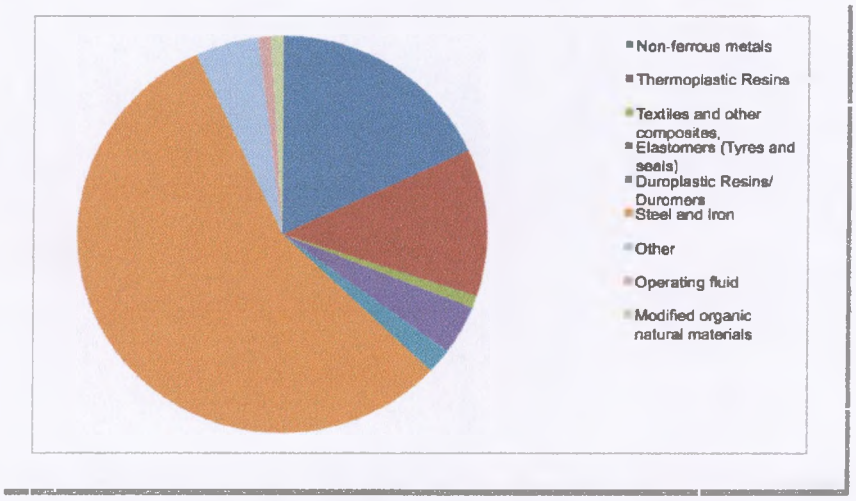


FIGURE 4.13 MATERIAL COMPOSITION IN THE BMW, SOURCE: TABLE 4.4

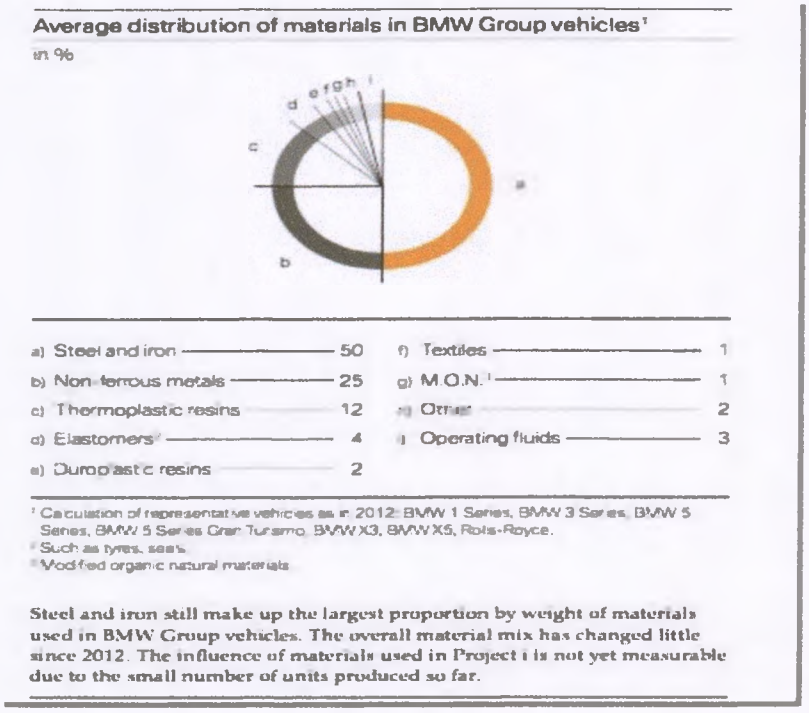


FIGURE 4.14: AVERAGE DISTRIBUTION OF MATERIALS IN BMW GROUP VEHICLES, SOURCE: BMW, 2012

The interviews with dealers revealed a similar breakdown of raw material to the ones given in Tables 4.1-4.4 and Figures 4.10-4.14. The main sources of the raw materials were cited as coming from some local sources but mostly from European countries. Steel and iron constitute a large proportion of materials found in the cars across models as shown Figure 4.15 below:

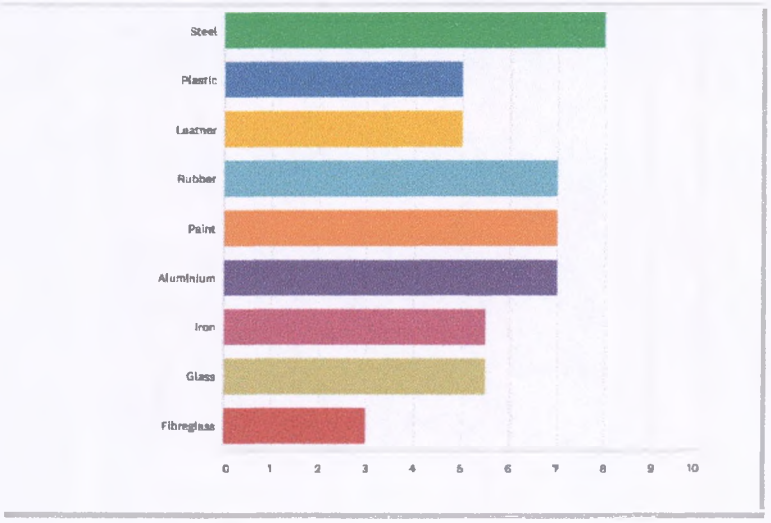


FIGURE 4.15: MATERIAL COMPOSITION DERIVED FROM INTERVIEWS WITH 24 DEALERS ACROSS MODELS IN JULY 2016 (SEE APPENDIX FOR DETAILED FIGURES)

The main materials utilised in vehicle manufacturing as presented in Tables 4.1-4.4 show that steel and iron make up the main component in cars across makes and models. The figures from the tables show that in every car the composition percentage is above 50% thus showing over half of a car is metal. This percentage increases considerably if non-ferrous materials are taken into account. This is what has led to research into lightweight body designs (integrating several functions into one component and using low density materials).

Aluminium can be used in lightweight body designs as it reduces vehicle weight, improves vehicle efficiency and reduces $CO_2$ during the use phase. Production, however, requires five times the energy that is required in steel production and this result in higher $CO_2$ during the manufacturing phase and this disadvantage on the environment can only be offset after many kilometres of driving. Toyota has replaced copper with aluminium for wiring. Aluminium is however more expensive than steel and the resultant expenses are passed on to customers and this explains why many small-medium car bodies are still predominantly comprised of steel. VW manages this by taking into account a wide range of environmental and cost factors and this is highlighted in the excerpt on the following page:

> *The Volkswagen Group brands always take an integrated approach to lightweight engineering, looking at the whole life cycle of the product, from manufacturing through to recycling. That said, it is perfectly possible to build a lightweight vehicle using steel. Use of high-tensile and ultra-high-tensile steels allows component gauges to be reduced, bringing a reduction in total body weight – with no reduction in crash performance. Another principle of efficient steel-based lightweight design is the use of varying grades of steel – that is to say the right grades of steel are used at the right points in the body to meet local stiffness requirements* (VW, 2014).

The use of steel in vehicle production is extensive as supported by a respondent who highlighted that:

> *"One BMW produced at this plant is made up of 412 pieces of steel sheets. This is plant number 9, the smallest amongst the BMW plants, but it produces 118 cars in 8 hours and 354 cars in 24 hours. Therefore in a working week 1,062 cars are produced and our operators go through rigorous training to ensure zero defects"* (Pers.Comm, 2015 a).

118 cars are produced in an 8 hour shift in the BMW's Rossyln Plant 9, the smallest plant in the world. In 24 hours this number increases to 354 cars, in a week this figure rises to 1770 cars, in a month approximately 7,080. A total of 68,771 units were produced at the Rossyln plant in 2014 and in 2015 this figure increased to 71,353. One BMW produced at this plant is made up of 412 pieces of steel sheets, therefore a weeks' production at the smallest plant uses 729,240 pieces of steel sheets for production. In 2014 the metal sheets utilised amounted to 28,333,652 and increased to 29,397,436 in 2015. In 2014 the BMW 3 series won the outstanding vehicle safety award and this is partly attributed to the use of steel as supported by a respondent who highlighted that:

> *"The steel reinforces the body and the chassis such that even upon crashing it is not easily bent. This ensures the safety of the passengers unlike in some car models that use plastic that can be reduced to a pulp crashing the occupants. The use of steel is a major selling point for the group particularly as far as the safety of the car is concerned"* (Pers. Comm., 2015b).

VW highlights that responsible and economical use of raw materials is mandatory at all sites the world over and that in 2012 they achieved the following improvements:

> *Bodywork components are made from sheet metal coils. Due to the complex shape of the body components, considerable quantities of offcuts are generated during this process. The Volkswagen therefore reduced coil widths. The result is a substantial improvement in materials efficiency on the production line for the new Golf, with a 15 percent reduction in waste volumes compared with the predecessor model. These and improvements to other models since 2011 have reduced steel consumption by approximately 73,000 tonnes annually compared with 2006* (VW, 2012).

Other approaches that have been adopted to replace raw materials extraction include use of recycled materials as VW advocates for below:

> *Producing a remanufactured gearbox, for example, uses one third less primary energy than manufacturing a new one. Since the Genuine Remanufactured Parts Program was launched in 1947, some 7.9 million engines, 2.9 million gearboxes and more than 78 million other vehicle components have been given a new lease of life, in the case of engines, for example, up to 70% of materials are reusable* (VW, 2014).

The use phase of all vehicles produced has the highest impact on the environment regardless of the efforts that would have gone into greening the production process. This is due to the fuel consumed during the use phase as well as the resultant noise, air pollution and recycling process at the end of life. Another innovation that has been introduced is the use of plastic to reduce vehicle weight and increase fuel efficiency. A BMW 3-Series contains 162 kilograms of plastic material and of these 90 kilograms is recyclable and is used in areas such as the rear shelf, floor panel covering, cable conduits, engine compartment shrouds, housings and brackets. This plastic makes up about 14% of the car meaning about 7% of it is recyclable as illustrated in the excerpt below:

> *Secondary raw materials are finding more and more applications in our vehicles. Between 15%-20% of the thermoplastic materials in our automobiles are already made from secondary materials or recyclates approved by the BMW Group for the respective component. One example is the substrate used for the centre console and the door balustrade. The use of recyclates in our vehicles enables us to offset the rising prices of raw materials (for example plastic components made from mineral oil, for instance) while contributing to resource efficiency and saving energy* (BMW, 2013-2014).

The use of plastic in vehicle manufacturing is gaining traction as illustrated in the excerpt above that was supported by a respondent who stated that:

> *"We make extensive use of plastic in the manufacturing of cars mostly because plastic is lightweight and it contributes to fuel efficiency. I am not sure of the exact quantities of plastic used but the proportions have increased over the years"* (Pers. Comm., 2015c).

As illustrated, secondary raw materials are constantly incorporated into vehicles. In 2012 up to 15% of the thermoplastic materials in the BMW were made from recyclates and this figure increased to 20% in 2013 and 2014. The recyclates make up an average of 12-14% of the vehicle weight. VW believes strongly that recycled and renewable materials not only improve the environmental footprint of the cars in which they are used but make good economic sense. According to calculations made in five models namely Polo 5, Sharan N F, Golf 6, Golf 7 and the Passat 8, one third of the vehicle weight is comprised of renewable and recycled materials in varying proportions. The Golf 7 contains between 34 and 35% recycled

material.

Recycled PET (polyethylene telephtarate) is also used as a plastic in vehicle production in seat covers. Toyota uses the ecological bio PET that is formulated from a sugarcane-derived substance in the making of carpets, seats and interiors for its cars. The figures and initiatives show the effort that has gone into material cycles in manufacturing vehicles thus contributing towards resource efficiency. Natural fibres and other renewable raw materials are used in cars for sound insulation, floor insulation, inner door panels and side panel trims, fleece carrier material in the luggage compartment, hood insulation (such as leather, flax, sisal, wood, cellulose, hemp, kenaf cotton fibres), and as surface trims as all these are easily recyclable and reduce the amount of carbon dioxide emitted into the air. These materials not only reduce costs, they are lightweight, not dangerous to the environment and this is highlighted in the excerpt given below but the only disadvantage is that some of the materials' functional properties are reduced:

> *Wherever it makes technical, business and environmental sense and is socially acceptable, we replace artificial materials with natural, renewable materials. In addition to leather for the interior, the focus here is on alternative materials with natural fibres as a substitute for classic plastics. Examples are wool upholstery, cotton in sound insulation panels, flax and sisal fibres in substrates for door panels and parcel shelves, or wood fibres in seat back panels* (BMW, 2014).

The percentage composition of materials in Tables 4.1-4.4 shows the contribution that these natural materials make to the overall composition of the cars is between 1-5%, a relatively small contribution in comparison with other non-renewable materials. All design innovations are however subject to the design engineers' approvals and the level to which they are cost neutral. Innovative designs are intended to reduce fuel consumption and reduce carbon dioxide emissions whilst maintaining a certain level of cost effectiveness.

Another important stride in vehicle manufacturing as highlighted by vehicle manufacturers is the use of rare earths as these have become a key raw material for a number of components in modern vehicles. Toyota ensures stable procurement channels for these materials. Rare earths contribute towards reducing fuel consumption by increasing the efficiency of the electrical systems within the vehicle. In using rare earths vehicle manufacturers are cognisant of the fact that this material is subject to availability risks hence they take care to balance weight,

function and cost factors. Research is underway to develop alternative magnetic materials to reduce the use of rare earths elements as these may become scarce soon. Daimler gives examples of some of the scarce materials used as well as the group's approach in dealing with these below:

> *Some metals (e.g. lithium, cobalt) and those that are needed for the production of catalytic converters are also increasingly required for batteries and electric drive systems and are very scarce worldwide. We employ efficient technologies so that the use of such materials can be kept to a minimum. Another aim is to take the recycling of materials from end-of-life vehicles into account as early as the product development stage. Various research projects have been launched in this regard in order to create closed loop systems over the long term* (Daimler, 2014).

Automakers form part of the industrial sector that consumes large amounts of raw materials and Daimler points out that its aim is to plan and use finite resources sparingly. Materials within the industry are supplied in the form of components and Daimler concurs that 'the components environmental impact does not directly affect environmental performance as described in reports but they are taken into account when Daimler makes holistic environmental assessments during product development and in selecting materials' (Daimler, 2014).

## 4.4 Vehicle Manufacturers and their Alignment with EMS such as the ISOs

Vehicle manufacturers have ensured that their plants are ISO certified and they apply established environmental management systems. BMW specifically utilises ISO 14001 and EMAS on the environmental side, ISO 9001 for quality assurance and OHSAS/OHRIS for occupational safety (BMW, 2010; BMW, 2011). The German and Austrian sites have undergone additional external audits to meet the required European Eco-Management and Audit Scheme standards (EMAS). All other production facilities worldwide and central planning departments are ISO 14001 certified. In line with the requirements of the EMAS, the BMW Group assumes responsibility for all its products and processes and this is reflected in the accounting methods based on their sustainability strategy. This accounting approach considers the environmental, economic and social impact of products across their entire life cycle and complements the long-standing Life Cycle Assessment system of the group that

draws from ISO 14040/14044. The research towards electric vehicles is an example of the drive towards ensuring that products and processes conform to sustainability standards and an example is of the BMW i3 but this is not yet produced at the Rossyln plant.

In response to a question on environmental management systems within SA, one respondent highlighted that:

> *"In dealing with environmental related aspects within this organization there are voluminous copies of detailed information I would have to go through to respond to questions on ISOs and environmentally sustainable manufacturing. The process is tedious as some of the aspects are interlinked and frankly it would take me a very long time to answer these questions fully. I can refer you to the company websites for you to go through this detail on your own"* (Pers. Comm., 2015d)

Another respondent highlighted that:

> *"Vehicle manufacturers are global in nature therefore the same way quality or environmental figures are controlled say from Germany or Japan is the same way environmental management is dealt with. We draw a lot from international standards on the environment because remember the cars that we make here in South Africa have to be made according to global standards as they are not only for use in here. I can give an example of the relevance of this, as operations are controlled by parent companies. Of the total number of cars produced here 87,5% are produced specifically for the export market. 61% are exported to the USA and this market makes up the largest export market for South African manufactured vehicles. Most cars produced are therefore left hand drives and are built to the highest level of quality standards to cater for this"* (Pers.Comm, 2015e).

VW has come up with environmental impact categories such as global warming (carbon dioxide and methane are classified in this group), photochemical ozone creation, ozone depletion and eutrophication to cite a few. The group then uses the results of the life cycle assessment that is carried out in compliance with ISO 14040 and ISO 14044 to identify the ecologically relevant solutions at an early stage. Development work is then aligned towards achieving the most environmentally beneficial processes over the entire vehicle's life cycle. Experts in the group work to bring harmony between the guidelines and the methods for life cycle assessments across the group and provide support structures to share the best practices.

The results are published as captured below:

> *For selected models, the Volkswagen brand publishes Environmental Commendations, which inform customers and the general public about the ecological progress represented by the new model at life cycle level, compared with its predecessors. The comparison is based on the detailed Life Cycle Assessments described above, which are certified for Volkswagen by independent auditor TÜV NORD to confirm that they are based on reliable data and were drawn up in accordance with the requirements of ISO 14040 and 14044* (VW, 2013).

At the end of 2013 VW had published 18 environmental commendations, a total of 53 from 2010. The idea is to ensure that vehicles use scarce resources efficiently whilst at the same time ensuring that comfort and convenience are not compromised.

The BMW Group monitors and optimizes energy consumption constantly and manages water utilisation through the use of environmental management systems as seen in the statements below:

> *To do this, we use an energy management system based on the environmental management systems ISO 14001 (at all production plants worldwide, the Research and Innovation Centre, the German BMW dealerships, increasingly at our international dealerships and at selected dealers) and EMAS (at all German and Austrian plants). We are continuously improving this system, for example by introducing tools to track the effectiveness of our energy efficiency measures. We use the environmental management system ISO 14001 to manage our water consumption. The three largest water consumers at the BMW Group are the sanitary facilities for our workforce (45%), evaporation mainly at cooling towers (around 33%) and the production processes, in particular at the paint shops (21%). We are continuously improving our resource efficiency in all three areas* (BMW, 2014).

In addition to the above the BMW group uses life cycle engineering to integrate pertinent environmental aspects into the design and development of the vehicles. To ensure that existing vehicles conform to this standard the company works on improving environmental impact from one vehicle generation to the next. The group acknowledges that ambitious targets have been set to attain this but the idea is to apply the life cycle assessment in line with ISO 14040/44 to measure the progress that has been made in the development process.

Life cycle engineering is carried out on all BMW Group vehicles combustion engines. The adoption of EMAS benefits vehicle manufacturers in a number of ways as illustrated below:

> *Resource efficiency reduces the risk of availability bottlenecks and price fluctuations, thus contributing directly to higher earnings by reducing costs. Between 2006 and 2014, energy and water consumption and waste and VOC emissions per vehicle produced in the worldwide BMW Group production network were reduced significantly. This allowed us to achieve €15.8 million in cost savings in 2014. Between 2006 and 2013, we were able to reduce energy and water consumption, waste and VOC emissions by around 40% per vehicle produced. In 2013, we reduced resource utilisation and emissions per vehicle produced by an average of 6.6% compared with the previous year. Increasing resource efficiency and minimising waste as well as the continuous optimisation of our environmental management processes, which are ISO 14001-certified at all BMW Group production plants, leads to lower investment needs on environmental protection* (BMW, 2014).

VW for example has a Group Environmental Policy and Environmental Principles and all plants are required to organize their own environmental management systems in line with international standards. The group ensures that there is group-wide adoption of EMS and these are used as the organizational basis for meeting environmental targets. The group also ensures compliance with national legislation in each country of operation. There is a structure that has been in place as illustrated below:

> *The Chief Environment Officer (Group Research) is responsible for the environmental management system at Volkswagen AG and at the Technical Development department of the Volkswagen Passenger Cars brand. Since 1995, the Volkswagen brand's German sites have participated in EMAS (the European Eco-Management and Audit Scheme) while its production sites worldwide have undergone environmental certification procedures to international standard ISO 14001. The brand has been driving forward certification of its energy management systems to ISO 50001 since 2009* (VW, 2013-2014).

In addition to the above, water use at VW is audited using standards such as the DIN ISO 14001 or the EU Eco-Management and Audit Scheme (EMAS). Employees are informed and involved in the management systems and the company has adopted ISO 50001 (energy

management) and ISO TR 14062 (concepts and current practices relating to the integration of environmental aspects into product design and development) as illustrated below:

> *To this end an intranet portal has been created to showcase best practice examples and facilitate direct contact with those responsible for their implementation. The portal also outlines basic regulations and provides tips on saving energy, including some generated by the central ideas management system. Nearly all of the Volkswagen brand's European sites have now been certified to the new energy management standard ISO 50001. Other sites will follow over the next few years. In 1995, the Volkswagen brand's Technical Development department established an environmental management system for the "development of motor vehicles with continuously improved environmental properties" to ISO 14001. Now in its 18th year, the system successfully completed its sixth recertification in 2013. Since 2009, the Technical Development environmental management system has also been aligned with ISO TR 14062* (VW, 2013).

VW highlights that by the end of 2014, 90 sites out of the 106 Group production sites held a valid ISO14001 certification. Daimler specifies that more than 98 percent of its worldwide production facilities have certified environmental management systems. Mercedes-Benz cars are described as meeting all requirements stipulated by ISO 14001 and EMAS and product development processes comply with the international ISO TR 14062 environmental standard. Daimler has adopted systematic integration of environmental aspects into product development in line with ISO TR 14062 (Design for the Environment). The group further highlights that:

> *Sites around the world are certified in line with the international environmental standard ISO 14001 and are regularly audited by internal and external experts to determine whether they meet the requirements of this EMS; almost all the sites in Germany are also validated in line with the EU's Eco-Management and Audit Scheme (EMAS). Today more than 98 percent of our employees worldwide work at facilities whose environmental management systems have been certified. In order to integrate environmental protection tasks into the processes even more closely, we are working to merge the management systems for quality, environmental protection, and occupational safety. We have also had the first locations certified in accordance with the new standard for energy management systems, DIN EN 16001, in close*

> *connection with the existing environmental management system. More than ten locations, including our major plants, have energy management systems that are certified in accordance with ISO 50001* (Daimler, 2012).

Environmental risks are analysed at all locations and this is done using the global uniform standards in order to reduce or prevent risks. The analysis is done using systematic monitoring and assessment of a location's environmental management system and relevant environmental aspects such as emissions, wastewater, contamination of soil and groundwater to cite a few. The elimination of the identified risks is done through binding agreements between Board of management and plant managers. Challenges are imbued in this process however as major differences inherent to specific locations make uniform application of systems complicated as highlighted below:

> *In order to better manage Group-wide environmental protection targets across all organizational levels, we have drawn up regular environmental protection processes that enable well-founded forecasts, reports to higher levels of the hierarchy, and the continued pursuit of annual local targets. The challenge during the current pilot phase is to develop a method that takes local conditions and the differences between the various production locations into account despite the need to standardize key indicators and parameters* (Daimler, 2011).

To counter such risks and to ensure compliance Daimler expects its suppliers to adhere to environmental management systems as well and this is illustrated below:

> *We regularly analyse the environmental risks at our locations in accordance with globally uniform standards so that the risks can be negated or reduced before they fully materialize. Suppliers have to fulfil our sustainability guidelines for suppliers. These guidelines require suppliers to have an environmental management system that is certified according to ISO 14001, EMAS, or other comparable standards. Our specifications also define the environmental compatibility standards for delivered components. In addition, the Mercedes-Benz contract conditions contain provisions regarding materials selection, banned substances, recycling requirements, and compliance with environmental legislation (Daimler, 2013).*

Daimler regularly organises trainings for employees, suppliers, managers and auditors on the practical application of environmental protection and the importance of environmental

responsibility. Daimler also trains auditors who monitor their environmental managements systems and in turn provide training to supplier auditors.

Toyota has ensured that the South African plant is ISO certified and this certification extends to its plants the world over as well as its suppliers. Over 7000 of the Toyota tier 1 suppliers adhere to certification and use environmental management systems (Toyota, 2014). The group has introduced an energy management system based on ISO 50001 standards and this is envisioned to help with more efficient carbon dioxide reduction. The chair of the Manufacturing Environment Committee (deals with group wide $CO_2$ emissions) incorporated the strengths of the ISO50001 that are not found in the ISO 14001 to attain greater reductions in carbon dioxide emissions whilst minimising energy use.

## 4.5 Environmental Awareness, Emergence of Green Economy and Impact on Vehicle Manufacturers

The global megatrends such as urbanisation, climate change and environmental regulation have led to shifts in some instances in customer mobility references. Environmental awareness has to some extent resulted in the shifts in customer demands but at the same time customers still focus on design and comfort. The BMW Group views all these changes as potential business areas that have the capacity to give a clear competitive edge to ensure the company's future success. In 2013 and 2014 for example the group reviewed its sustainability vision as well as its targets and measures and aligned these to the main challenges the automotive industry is currently facing. The main areas reviewed under sustainability included climate change and its consequences, air pollution, availability of resources, urban mobility and road safety. VW holds similar views and explains these by highlighting that:

> *The Volkswagen Group has identified climate change, air quality, resource conservation and shifting demographic structures, especially in Europe and China, as primary central challenges with a global impact. These factors also involve social developments, which can differ widely depending on the individual markets. We analyze these developments carefully and gear our strategy to them in the interests of*

> *long-term success and profitability. Examples include progressive urbanization, increasing transparency requirements for businesses and a growing public awareness of employment and resource efficiency issues* (VW, 2014).

VW views the rapid growth of emerging economies as substantial opportunities for sales as their approach to sustainability is customer oriented. Rapid urbanisation and population growth has given rise to potential buyers and this has resulted in intense competition amongst vehicle manufacturers. In order to access these new markets VW seeks to develop a localised and market-led product provided the profitability of the product is guaranteed. The group views the emergence of the green economy as a platform to innovate as seen below:

> *With innovative concepts we can ensure more jobs, greater resource efficiency and more renewable energy, and at the same time energetically pursue alternative drive technologies. However, we have no intention of limiting our marketing and advertising for our Group's vehicles. After all, commercial success is the yardstick of all business activities, and it puts us in a position to invest in technologies of the future* (VW, 2013).

The BMW Group sustainability leadership goals are characterised by four principles and these are entrepreneurial innovation, impact on society, alliances and scale effects. In entrepreneurial innovation the group views social challenges as a platform to provide new products and services, whilst on societal impact their actions and innovations are to benefit society as well as their customers. The goal is to form alliances with policy makers, businesses and decision makers in society to ensure the group has impact beyond its direct sphere of influence. The group realises that in some aspects its capacity is limited therefore it focuses investments and activities on constantly shaping areas of action. These efforts are all geared towards ensuring that the company survives amidst the changes brought about by increased environmental awareness.

Daimler regularly reviews the individual facilities to identify specific environmental risks and has developed standard reporting processes. All departments are tasked with identifying and assessing potential risks in the categories of economic, social or political risks (these have an impact on availability of raw materials), sector/company risks (linked to production, procurement and regulatory environment), compliance risks (potential violations on existing

environmental regulations) and reputation risks (those affecting public perception of the group). Relevant units develop and adopt measures to avoid or reduce the impact of the risks as they constantly monitor processes. This is done through integrating environmental protection features that cover the complete life cycles of the vehicles as illustrated below:

> *Like other development goals, environmental goals are pursued in the product development process and are part of the quality gate system in the development process. In accordance with the requirements of the German Law on Corporate Control and Transparency (KonTraG), we regularly conduct an environmental due diligence at our locations world-wide. The findings are made available to management. The analyses identify areas where there is a need for action and recommend measures for minimizing risk* (Daimler, 2011).

In addition to the above the Group Risk Management Committee (GRMC) is responsible for coordinating risk management initiatives and checks the implementation processes. The committee provides employees with an overview of key risks and shares information accordingly. The Corporate Auditing department helps the Board of Management and ensures processes are efficient and effective. Amidst all these measures Daimler acknowledges that extensive work input is still required to ensure proper environmental management as shown below:

> *A globally operating corporate group like Daimler, which has 63 production locations in 18 countries all over the world, faces a special challenge when it comes to managing the specific local environmental, social, and economic impacts of its business operations. Within our Group-wide sustainability management activities, we are currently working on improving the corresponding database and ensuring that our local reporting in this area is uniform. We have already made good progress in this regard in individual areas* (Daimler, 2011).

Vehicle manufacturers acknowledge their contribution towards rising carbon dioxide emissions as well as the resource consumption that is tied to production. Any risks that have a potential to impact on the financial result of the company are monitored and controlled. Due to increased environmental awareness, VW has included environmental and climate change risks such as extreme weather situations that impact on information flows/communication technology and supplier failure due to adverse weather as areas that need monitoring and

controlling. The regulatory environment also has a bearing on the company activities as explained by VW below:

> *Regulatory measures, especially sanctions resulting from failure to achieve $CO_2$ emission targets or to comply with emission standards required by cities and municipalities affect manufacturers. Emission requirements for vehicle taxation as well as the differences in $CO_2$ regulations between the major volume markets also play an important role here. Alongside the risks described, the development of new drive technologies (hybrid and electric) may result in advantages compared with our competitors. In view of a broad change in public awareness based on the depletion of fossil resources and a growing desire to protect the environment, these technologies promote the Group's sales opportunities* (VW, 2013).

Sustainability reporting reflects the growing need for communication brought about by increased environmental awareness. There is an increased demand for transparency from various stakeholders. Sustainability reporting plays a role in customer satisfaction and vehicle manufacturers included in this study highlight the need to maintain customer satisfaction. A combination of customer satisfaction and growth is considered crucial as highlighted by VW that states:

> *Customer satisfaction is of paramount importance for all Volkswagen Group brands. We monitor customer satisfaction using standardized performance indicators that are the same for all brands and include brand image, desirability, future purchase consideration, and product quality and brand communication awareness. Volkswagen's strategy is not about growth at all costs. It's about sustainable growth. Restricting corporate growth is alien to any competitive system. In fact it's inherent to competition to conquer new markets by offering superior solutions, by offering innovations* (VW, 2014).

Figure 4.16 gives an example of the disclosure that occurs in sustainability reporting

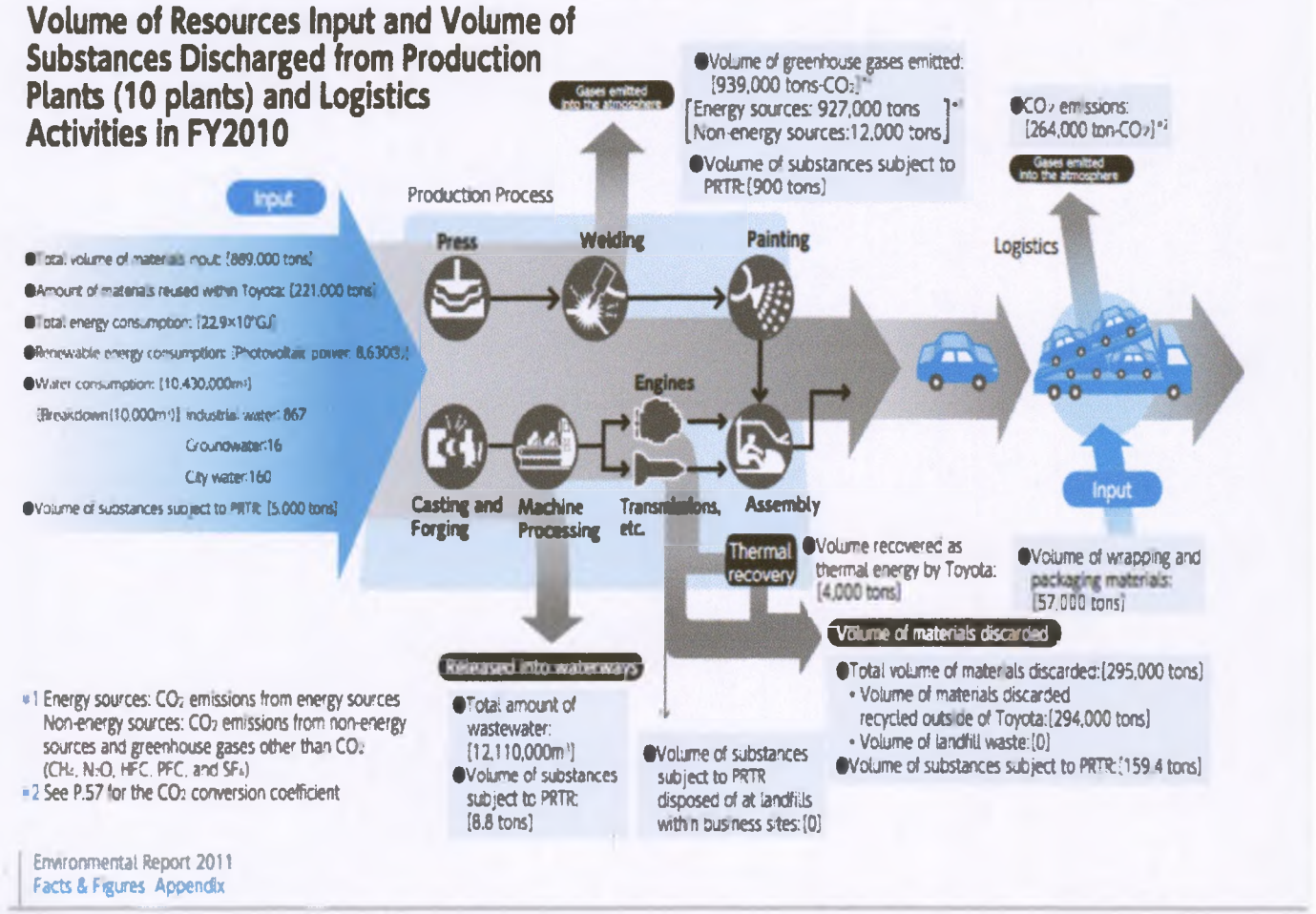


FIGURE 4.16: RESOURCE INPUT AND OUTPUT IN TOYOTA, SOURCE: TOYOTA, 2011

In addition to the above, key environmental factors such as energy and water consumption, wastewater disposal, exhaust gas, noise emissions, waste and hazardous materials, carbon dioxide and the use of solvents led motor vehicle manufacturers to rethink the way in which they utilise resources. BMW has developed six competence centres namely centre for water, waste, energy, emissions, training and environmental management systems. Efforts are continuously being made to ensure that the environment is protected in all stages of the vehicles' lifecycle. Resource efficiency and life cycle management are cited as the main pillars of the BMW's sustainability agenda. The group has a vital business based interest in the area of resource efficiency that goes beyond complying with legislation and end of life directives.

BMW views global scarcity of resources such as water, land, energy and raw materials as a risk to political and economic stability. Efficient use of resources in the group is deemed as a

source of competitive advantage in that it helps reduce dependence on external suppliers thereby dealing with price fluctuations and supply bottlenecks. BMW acknowledges that they have been working towards reducing carbon dioxide emissions through their efficient dynamics technology package and in the production plants the group uses the clean production concept (this reduces energy and water consumption). Efficient dynamics technology will not only be set for niche models but will be adopted as a standard component in all high volume vehicles. This will ensure that the company plays a greater role and has a greater effect in environmental protection initiatives. In line with this VW highlights that

> *Resource efficiency is a topic of exceptional strategic importance for Volkswagen. Across their life cycle, we must ensure that our products' consumption of natural resources is kept to a minimum. By using resources efficiently, we can reduce not only environmental impacts but also manufacturing costs. In line with the recommendations of the EU's European Resource Efficiency Platform, we focus particularly on our consumption of raw materials, energy, water, air and land* (VW, 2014).

The drive to improve resource efficiency is carried out by all business areas within the VW Group. Business areas make their own contributions and use tailor-made indicators to measure their performance. The Corporate Resource Efficiency Steering Group is responsible for coordinating, planning and implementing and this group is made up of people from different business areas and brands. The challenge VW highlights is that the term resource efficiency is interpreted very broadly depending on the different groups of people using it. To address this VW acknowledges that:

> *The challenge therefore is to develop a set of indicators that on the one hand are meaningful to the public, while at the same time providing a fit-for-purpose controlling tool for in-house decision-makers. In parallel, a pool of best practices on resource efficiency is being developed, which will be made available to other business areas and brands* (VW, 2014).

In vehicle production, reducing the amount of water consumed per vehicle is essential especially given that water is a very valuable resource. In 2014, VW focused on water preservation during production and identified the processes that consume most water over the

life cycle of VW models. The use phase of a car uses very little water compared to the production process. Most of the water consumed in production is attributed to upstream supply chain operations. VW concedes that it has to cut down on water consumption as 58% of freshwater consumed (24 million cubic metres) is used in locations where groundwater resources are at risk with South Africa included in these locations (VW, 2014).

Toyota has reduced the amount of water used in painting as painting consumes the largest volume of water in their production process. This has been achieved through rainwater collection as well as recycling wastewater. Toyota dealers in South Africa have also been encouraged to recycle wastewater and rainwater as the country continues to face increasing water scarcity. This initiative is illustrated in Figure 4.17 below:


Focus

Recycling of Wastewater and Rainwater at Toyota South Africa Motors (TSAM) Dealers

Amid an increasing water scarcity problem developing in South Africa year by year, laws and regulations on water use are under review. Under these circumstances, TSAM has been encouraging the affiliated dealers to implement water recycling activities since 2008. Some dealers have already installed five water storage tanks or solar-powered water purification system, which enable to store 100,000 liters of water allowing them to wash vehicles for up to 200 days by recycling discharged water and rain water. TSAM recognizes excellent dealer's great contributions to the environmental activities every year to motivate them in the region and addresses enhancement of their environmental activity level.

Recycling of wastewater and rainwater at some dealers

FIGURE 4.17: RAINWATER RECYCLING, SOURCE: TOYOTA, 2014.

Worldwide governments are taking measures to combat the effects of climate change and requirements are becoming more stringent in aspects such as increasing fuel efficiency and decreasing vehicle emissions (e.g. particles, CO, HC, NOx). To cater for these changes BMW ensures that 94% of the vehicles it sells are subject to regulations and legislation. The group ensures compliance with set regulations in each specific country and is aware that customer behaviour is affected by increased regulations, fuel trends, environmental impact as well as rising awareness of climate change. To cater for all these changes efforts have been made towards the production of low emissions vehicles with engines that are more efficient and that have a lightweight design. Other aspects the company has focused on include efficient engines, optimised aerodynamics, intelligent energy management, lightweight design, forward-looking drive control, the Auto Start Stop function, brake energy

regeneration, tyres with reduced rolling resistance and air flap control. The aim of these innovative technologies is to lower emissions and fuel consumption. A number of vehicle manufacturers train drivers on eco-driving in an attempt to lower fuel use and emissions. Toyota illustrates eco-driving in Figure 4.18 that highlights when to accelerate, apply brakes or stop the engine.

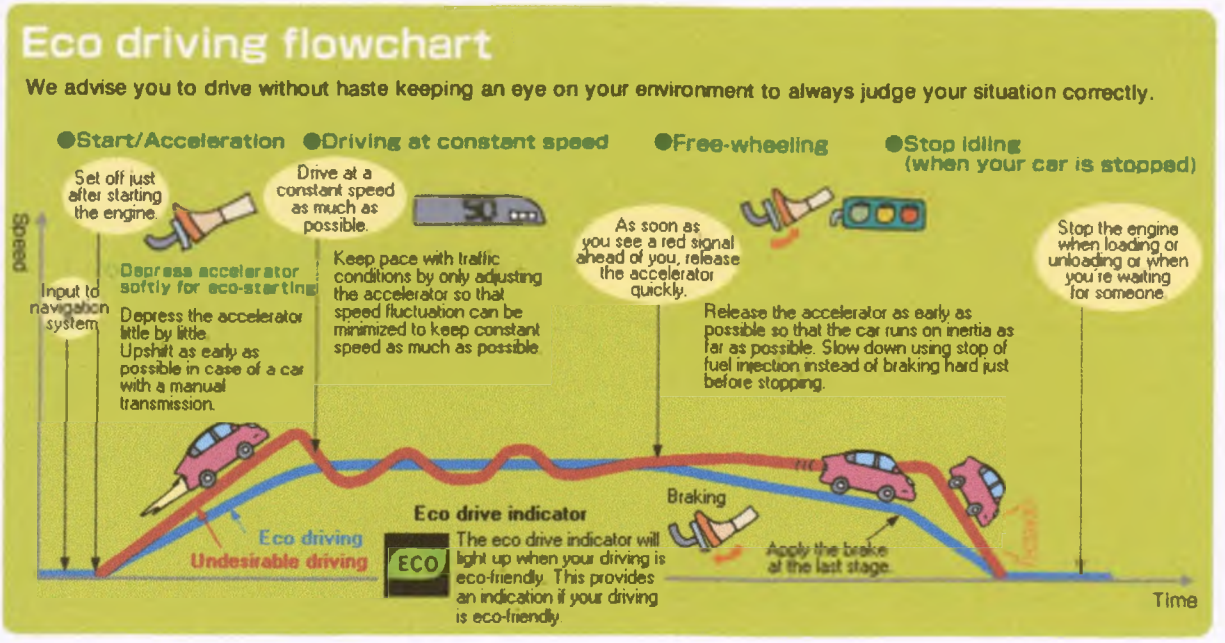


FIGURE 4.18: TOYOTA ECO-DRIVING CHART, SOURCE: TOYOTA, 2006

Daimler aims to reduce fuel consumption and to minimise pollutant emissions and is working on developing technologies that meet the stipulated requirements. This type of vehicle is designed with combustion engines that are optimised to lower consumption and emissions. Another angle the group is developing is hybridisation (combining combustion engines and electric motors). In 2011, the entire Mercedes-Benz fleet's average emissions were 150g $CO_2$ per kilometre and the goal was to reduce this to 125g by 2016. The group offers training programmes on economical and anticipatory driving and this demonstrates how fuel consumption can be reduced by up to 10% when driving for the environment. The various types of emissions have been reduced as a result of improved engines and efficient exhaust gas treatment systems. Total elimination of emissions however is not attainable as illustrated below:

> *However, due to technology-related reasons, future emissions limits for nitrogen oxides (NOχ) make it more difficult for us to further cut particulate emissions and fuel consumption* (Daimler, 2011).

Raw materials play a central role in vehicle manufacturing and the BMW group applies high standards to all current and future supply materials. All materials and material mixes are analysed, evaluated, approved and stored in a BMW database. Any material or series parts as well as auxiliary production substances and process materials such as paints or adhesives go through rigorous processes to eliminate undesirable materials thus ensuring environmental protection. BMW for example has ensured that materials that are used in the plant's paint operations are water-soluble (paint and wax for sealing). Paint vapour is accumulated and purified and the painting jigs are cleaned in a special unit to ensure pollutants are controlled. Efforts are made to introduce renewable materials such as fibres, leather and cotton to cite a few to reduce the harm on the environment. There is an acknowledgement in the reports that ecological responsibility plays a central role in keeping the BMW's performance as a corporate citizen. This in turn protects the company's reputation as it is seen as a responsible entity and has the overall benefit that society accepts and purchases products made by the group (BMW, 2010; BMW, 2011).

VW considers raw materials from two angles, the ecological and commercial perspective as it processes millions of tons of steel, plastics and various other materials yearly. Consistent, secure and economic supplies of raw materials are vital and the group controls this through the raw materials management strategy. Raw material risk analyses are carried out and the group identifies factors such as supply risk and cost relevance and uses these to place orders with research and development for development of alternative materials or to alert central procurement to safeguard raw material supplies. This ensures that there is always a secure and economic supply of raw materials over a relatively long period of time. VW introduced a new environmental strategy in 2013 that is implemented in the entire group at every stage of the value chain from product planning, development, supplier management, logistics, production, sales and recycling. In all of this the group believes that:

> *Eco-friendly products should never compromise on world-class technology, comfort and safety. One of our key goals is to cut $CO_2$ emissions from our European new car fleet to 95 g/km by 2020, to reduce fuel consumption by between 10 and 15% in each new model compared with its predecessor, to have the lowest fuel consumption levels in every vehicle class (for the Volkswagen brand), to expand our range of alternative powertrains, to achieve top rankings, ratings and awards for selected products, and*

*to become the market leaders in electric mobility by 2018* (VW, 2014).

To support the above every new vehicle produced should improve on the environmental performance of its predecessor across the life cycle and should be between 10-15% more efficient. In the Uitenhage paint shop in South Africa 'electrostatic atomising technology is used instead of pneumatic spray guns to apply the second paint coat. This doubles material efficiency from 35 to 70 percent and results in corresponding reductions in waste disposal volume and solvent emissions' (VW, 2012). Material efficiency is always tied to cost benefits and annual savings. Toyota conducted an extensive training on body and bumper painting, thinner recovery as well as use of paint and thinners in South Africa. The group has resorted to using robots to paint different coloured cars as the colour change process used to result in larger volumes of waste.

BMW has Sustainability and Environmental Protection representatives who report on any environmental issues and resource consumption aspects. Sustainability remains the central strategic principle with every project presented to the board verified for its sustainability. Environmental monitoring helps vehicle manufacturers in that they anticipate natural disasters, rising fuel prices and changing customer demands (due to increased levels of environmental awareness). The consumption and emissions targets for vehicles have also been set at specific levels and vehicle manufacturers adjust their engines and product development strategies to align with the stipulated targets. The fact that natural resources are increasingly becoming scarce has led vehicle manufacturers to use resources efficiently, think through recycling and to use alternative materials where appropriate. BMW states that:

> *Our new holistic accounting method provides a truly comprehensive view of the impact our products and production processes are having. Most of all, however, it enables us to ensure from the development stage onwards that we combine maximum resource efficiency with minimum environmental impact. Sustainability, therefore, is a key factor in every product development decision. In realising its commitment to product responsibility, the BMW Group is working to make efficient use of resources and minimise emissions across the life cycle of its products and employing a wide range of strategies and measures* (BMW, 2010/11).

In line with resource efficiency BMW has ensured that in the development phase an

interdisciplinary group evaluates the potential materials that go into the cars. This allows the group to select materials that are in line with environmentally legal requirements. Current and future products are tested against the BMW standards (series parts and auxiliary materials) and this forms the basis for consistent implementation of environmental laws. Material composition is documented in the material data sheets and the International Material Data Sheet System (IMDS) is the central data structure used globally by the automotive industry to capture the information. The material data sheets are passed through the value chain from raw material suppliers to automotive manufacturers and checked then approved. A similar system is used for chemical substances and it documents environmentally relevant substances. The adoption of these systems has aided in the reduction of emissions inside cars due to the changes in the materials used for automobile interiors.

Other measures that have been adopted to adapt to increased environmental awareness include ensuring suppliers are sustainable and they are recycling and reusing materials. Recycling and reusing was initially implemented in German and European markets with a plan to adopt this internationally. Old catalytic converters are an example of the parts that are recycled and the plan is to include thermoelectric generators. This is highlighted in an excerpt from a report that states that:

> *For us, dealing intelligently with resources and raw materials begins way before the time comes to dispose of them. Even in the early stages of vehicle development, the decisions our designers and engineers make will determine the reusability of our vehicles decades into the future. In line with our principle of Design for Recycling, we create our vehicles in such a way that their components can be reused or recycled with the least possible impact on the environment once the vehicle reaches the end of its life cycle. At the same time, our Recycling and Dismantling Centre (RDZ) in Munich is working continuously to come up with new solutions for vehicle recycling which we make accessible to external recycling businesses. Secondary raw materials are finding more and more applications in our vehicles. Already, up to 15% of the thermoplastic materials in our automobiles are made from secondary materials. Our four-cylinder diesel engine cover, which is just one example, is made completely of recyclable materials* (BMW, 2010; BMW, 2011).

Increased environmental awareness has led vehicle manufacturers to invest more in regular training on environmental issues, solvent reduction and saving water. VW for example

conducts trainings for employees as shown below:

> *The 1995 Factory Agreement on Environmental Protection motivates all employees to integrate the principles of environmental protection into their everyday work. Volkswagen also arranges training courses for employees to ensure that environmental management objectives and measures are upheld in practice across all its global production sites. In 2012, a variety of training courses were held, and attended by a total of 519 employees. Topics included environmental protection for supervisors and energy efficiency awareness training for planning staff* (VW, 2012).

Daimler offers trainings for employees, auditors and supplier auditors as shown below:

> *We want all of our employees to support the Group's environmental protection efforts. This is why we regularly organize awareness and training programs for employees and managers that focus on the practical application of environmental protection at the company and address questions concerning environmental responsibility. We also train our auditors — who monitor the environmental management systems of our plants — and provide training to supplier auditors. In addition, we offer refresher courses that allow participants to share ideas and experiences* (Daimler, 2011).

This is also in an attempt to keep abreast of the rise in resources and emissions costs in the future. Concerted efforts have been put into energy saving and a combination of savings in water consumption, process wastewater and waste reduction resulted in cost savings of approximately Euro 0.7 million across the BMW Group. The amount of money saved translates into value addition for the company. Efforts are made to align with the required environmental standards but the fact remains that waste, emissions are still produced and resources consumed to produce vehicles as well as in their use phase. An example of increased efficiency and the resultant effects drawing from the BMW group is illustrated in the Table 4.5 and it shows the percentage decrease between 2009 and 2010 in energy consumed showing a decrease of 4.8%, $CO_2$ emissions by 5.5% and VOC emissions by 9.6%. The group points out that even though the percentage decrease appears minimal, it takes great effect when multiplied by the number of vehicles produced.

**Table 4.5: Percentage Decrease in Energy Use, $CO_2$ and VOC emissions**

| Resource | 2009 | 2010 | Decrease | % Decrease |
|---|---|---|---|---|
| Energy consumption per vehicle produced | 2.89 MWh/vehicle | 2.75 MWh / vehicle | 0.14 | 4.8 % |
| $CO_2$ emissions per vehicle produced | 0.91 t / vehicle | 0.86 t / vehicle | 0.05 | 5.5% |
| VOC emissions | 1.77 kg / vehicle | 1.6 kg / vehicle | 0.17 | 9.6 % |

Vehicle manufacturers have made considerable effort in coming up with alternative sources of energy and in this instance green energy/energy from regenerative sources found in the local environments they are operating in. This is targeted at preserving the environment in terms of controlling carbon dioxide emissions but at the same time it is a solution in that there is an independence manufacturers potentially gain from fluctuating energy prices, carbon trading regulations and regulators' legislation. The advantages that go beyond environmental consideration are captured below:

> *The BMW Group is continually reducing its energy consumption and is intensifying its efforts to produce more power in-house and to use energy from local renewable sources. The company also actively supports the expansion of renewable energy. This enables us to increase our autonomy and profitability and ensure that our production is not impacted by energy bottlenecks. At the same time we are reducing our environmental impact and making sure that we work as efficiently as possible with scarce raw materials. The BMW Group uses the most environmentally friendly and sustainably profitable energy source at each production plant. Security of supply also plays a role here* (BMW, 2014).

The Rosslyn plant to the north of the capital, Pretoria, uses emissions from a local household refuse site to produce energy in a similar way the Spartanburg plant in the US does. The new independent operator Bio2Watt provides the required electricity from a twin-unit power

station based on landfill gas. This operator is said to have the potential to reduce $CO_2$ emissions by 8,300 tonnes per year. The principle in South Africa is to use methane gas produced from refuse as well as chicken and cattle manure to power the production plant. The BMW plant in Rosslyn also owns 25,000 cattle and this supports efficient use of residual material. Establishing a biomass power plant was ideal in that the BMW plant is surrounded by huge farming areas and is home to a number of rainwater basins. The water aids in the refuse fermentation process as well as to sustain the cattle. Fermentation residue from the animal excrement is utilized as a high quality fertilizer in the surrounding farmlands. The biomass power plant supplies a portion of the energy requirements in the Rosslyn plant and this is captured in the statement below:

> *"We can use the energy generated where we need it. That saves transmission charges and creates a genuine connection to what we are doing. When it comes to renewable energies, we rely on local solutions. The strategy we developed has allowed us to triple our percentage of renewable energies over the past five years. Sustainability doesn't happen by chance. We know exactly which location is suitable for solar power and which is better for wind power; how much green electricity we can buy; whether there are investment partners and what is going on in the political front. In this way, we have developed a viable technical and economical solution for each location, which we are now implementing step by step"* (Witschnig, 2016).

The picture below shows part of the BMW farm in South Africa that houses the 25,000 cattle.

Using new ideas: environmentally friendly energy from biomass for the South African BMW Group plant in Rosslyn.

FIGURE 4.19: PART OF THE BMW FARM IN SA WITH 25,000 CATTLE, SOURCE: BMW, 2013

FIGURE 4.20: BMW ROSSLYN PLANT — TWIN UNIT POWER STATION FUELLED BY LANDFILL GAS, SOURCE: BMW, 2015

The continued use of renewable energy within the BMW group resulted in a reduction of energy consumed during production from 2.25 MWh in 2014 to 2.19 MWh in 2015: an improvement of 2.7%.

BMW states that there are benefits associated with this as illustrated below:

> *In addition, the resulting reduction in energy costs in the face of rising energy prices in the medium term makes a significant contribution towards the BMW Group becoming more profitable and more competitive. Rosslyn/ZA- Since October 2015, a combined heat and power plant of an independent operator Bio2Watt has been supplying renewable energy to our plant in Rosslyn/ZA. The power plant runs on biogas drawn from waste from cattle and chicken farms as well as from food production plants. In 2015, the plant delivered 3.1 GWh, or 4.5 % of the entire electricity volume required by our plant* (BMW, 2015).

The energy consumed during production at VW in 2014 was also significantly reduced and this was attributed to a number of factors as highlighted that:

> *A wide range of measures were responsible for this result, including more efficient production technologies, optimized heating and ventilation systems and use of renewable energy, for example with the installation of a photovoltaic system in South*

*Africa* (VW, 2014).

During production vehicle manufacturers have put in a number of measures to ensure that electricity is conserved as highlighted in the communication below:

> *"We have come up with innovative ways to save electricity and lower consumption during production. We have mechanisms within the plants that detect inactivity and dim the lights accordingly. We also invest money in research and development to find more ways of using electricity efficiently"* (Pers. Comm, 2016f).

Daimler at the East London plant has also made the strides shown in the excerpt below:

> *For many years now, we have been using low-carbon natural gas to fuel the heating systems of our plants. We also use district heating wherever it is available. The Mercedes-Benz plant in East London, South Africa, is preparing to launch a pilot project that will for the first time incorporate stationary energy storage units into a real-life production environment as part of a smart grid* (Daimler, 2015- 2016).

Similar to Daimler, BMW and VW initiatives Toyota strives to reduce energy used in production and has come up with what it terms, 'No work-No watt' slogan. This entails switching off any electricity consuming equipment when not in use. This has resulted in increased cost savings as a result of reduced electricity consumption. Through observation the BMW plant has various 'Save Water' and 'Save Energy' stickers plastered all over the production plant.

From 2014, VW invested a considerable amount of money to research into ways in which the company can use resources in a sustainable manner. Through informal conversations with former VW employees it was apparent that the company has been making strides towards reducing the water and energy consumption in production as illustrated below:

> *"Research into sustainability within VW SA is mostly currently focused on the way energy and water can be utilised efficiently within the production plant. Other aspects being explored include adoption of carbon-neutral fuels in the form of renewable electricity for electric vehicles, or next-generation biofuels – most notably bio-methane from organic waste, and synthetic natural gas. This is being done to align with requirements for environmental preservation"* (Pers. Comm., 2016g).

The statement above is supported in the 2014 sustainable value report stating that:

> *We consider the environmental impacts of our products, particularly their $CO_2$ emissions, at every stage of their life cycle. Along with climate protection, the main objective of this approach is to conserve finite resources. Our measures center on efficient product and process design, the use of innovative environmental technologies, and sustainable energy supplies. For this reason, we not only aim for every vehicle to better the environmental performance of its predecessor over its entire life cycle, but also target the significant reduction of our environmental footprint by 2018. Specifically, we are aiming for 25% reductions in energy and water consumption, $CO_2$ and solvent emissions and waste for disposal per manufactured unit compared with 2010* (VW, 2014).

The emphasis on production processes seems evident amongst all companies and Daimler highlights that:

> *Environmental protection measures at our company focus on the production processes at our plants because that is where not only our responsibility is greatest, but also our range of options lie. In our third environmental guideline, we have committed ourselves to making all stages of production as environmentally compatible as possible. Our environmentally friendly production and processing technologies set benchmarks in operations-related environmental protection. We are particularly committed to climate protection, air pollution prevention, and resource conservation. We thus strive to: reduce direct and indirect $CO_2$ emissions, reduce solvent emissions, conserve resources and avoid waste* (Daimler, 2011).

There is acknowledgement from the part of vehicle manufacturers however that they are still way ahead on resource consumption in spite of the concerted efforts employed to reduce resource use. For example, production of a single car takes two megawatt hours and this is half of what a single family home uses in a year and in comparison the Rosslyn plant produces over 60,000 cars in a year meaning it uses over 120,000 megawatt hours in a year. One energy manager highlighted that:

> *A few years ago, we decided to put a price-tag on every megawatt hour consumed to make it clear just how much money is actually involved. This led the company to*

> *commit to reduce energy consumption per vehicle produced by 45 per cent between 2006 and 2020. Reducing energy consumption has saved us more than 150 million euros since 2006 – and that benefits the environment, too, of course. That is why we try to make what we do as transparent as possible to show our customers that we are behaving in a responsible manner and using resources carefully* (BMW, interview available online).

In an almost similar acknowledgement in response to the viability of the emissions targets set (125g of carbon dioxide/km in 2016) Daimler conceded that:

> *The overriding aim in setting the $CO_2$ targets is to send a clear message to society and especially to the environmental stakeholders that reduction of $CO_2$ emissions is a challenge that the group first of all recognizes and accepts, and secondly that it wants to make a significant contribution to mastering this challenge. Unfortunately, however, the group is also aware that nearly every country lacks the political master plan needed to ensure the presence of the requisite electricity or hydrogen infrastructure. The example of renewable energies for electric power illustrates that, that the creation of a new infrastructure is possible if the politicians want it and that the framework conditions must of course be designed in such a way to cover the costs that will initially arise. As is the case with renewable sources of energy, it should also be possible to develop a comparable master plan for a new infrastructure for the transportation sector, especially since the costs are much lower* (Daimler, 2011).

Another aspect vehicle manufacturers contend with is the fact that in as much as green energy is good on the environment; it does not make economic sense. They state that it would be impossible to generate the amount of heat required in the plants solely from renewable energies and this form of heat generation is not sustainable economically. One of the managers highlighted that it would take a sizeable number of football fields of solar thermal installations to provide the heat that is required in the BMW production processes at Rosslyn.

In terms of waste generation and disposal the goal is not to produce any waste but any unavoidable by-products are tested to determine whether they can be recycled, reused or whether they harbor any energy potential. Waste for disposal is the waste that is produced that cannot be reused or recycled and in 2010 the BMW Group produced 10.09kg of disposable waste per vehicle produced. Rosslyn plant produced well over 847,560kg

(847,56t) of waste in the year 2010. Wastewater and water usage are the other two elements from production that are expensive and the South African BMW team engaged in fighting water shortages and leakages in drinking water pipes.

Efforts are also put into the transportation of raw materials for production given that production and distribution of finished goods is on a global scale. Measures that have been put in place to reduce the carbon footprint in transporting raw materials and finished goods include ensuring that the company transports full loads whenever possible. Another option that has gained prominence is the use of rail and sea as modes of transporting freight. Dealers interviewed supported this by highlighting that vehicle transportation within South Africa is done mostly through rail with road utilised in instances where rail access is non-existent. The transport logistics department within BMW highlighted that transportation is a combination of environmental as well as business factors. Aspects such as cargo space, driver capacity and increasing fuel prices all influence transport capacity as much as the environmental concerns. VW employs intermodal options thus linking at least two modes of transport (road, rail, ship) together. This helps in instances where suppliers do not have access to their own rail link. The group also uses all modes of transport and is shifting more towards rail and sea transport as explained below:

> *For our incoming deliveries of raw materials and supplies, for inter-location shipments and for shipments of vehicles leaving our locations, we utilize all modes of transport. The aim is to make logistics processes as environmentally compatible and efficient as possible and to shift an increasing share of total transportation volumes to rail and sea. Since 2012 a special Corporate Steering Group has been responsible for coordinating this "Green Logistics" approach. In 2014 this Steering Group defined work packages for specific measures, accounting practices, communication, qualification and internal target achievement methods. The German Nature and Biodiversity Conservation Union (NABU) played an active advisory role during this period* (VW, 2015).

The BMW group has instituted a number of measures to ensure that competitive prices are secured to transport components and vehicles the world over. Examples of these initiatives include management of empty containers and a reduction of the material transported through air. In issuing new invitations to tender BMW aims to optimise capacity utilisation and transport mode. Rail transport is given preference and this means that suppliers as well as

transport service providers are expected to adhere to sustainability standards. In 2012 for example the volumes transported through rail rose to 8.9% from 8.2% in 2011 and the vehicles transported by road dropped to 13.3% from 15.8% in the same period. The Rosslyn plant is serviced by a rail network observed as one enters the plant and the manager concerned highlighted that:

> *"Most raw materials are delivered through rail and this is the preferred mode of transport for some finished products as well. We try and ensure we cut down on the $CO_2$ emitted through transport logistics and this explains why a number of our employees use company buses to commute to work"* (Pers. Comm., 2016o)

In 2013, VW joined the clean shipping network and the Clean Shipping Index (CSI) is used as a tool for evaluating environmental impacts of its ocean shipping. The CSI informs members on the emissions of ships and routes and allows taking environmental criteria into consideration when selecting vessels to use for shipping. This also extends to the handling of chemicals and waste disposal including include carbon dioxide ($CO_2$), nitrogen oxide ($NO_x$) and sulfur oxide ($SO_x$) emissions.

Vehicle manufacturers contend with carbon dioxide emissions in a number of areas and there are efforts to constantly reduce the emissions levels. Around 85% of the workers in South Africa use company buses to travel to work in an effort to reduce carbon footprints. In 2012 the group had a total transport volume of 30.9 billion tonne-kilometres and these emitted 1.25 million tonnes of carbon dioxide in the process. This explains efforts that go into centralised production where raw materials are sourced as close as possible to production sites, the location of dealerships in relation to the production sites as well as the low-emission transportation vehicles. The group also monitors carbon dioxide emissions and has classified these into three groups (scope 1, 2 and 3 emissions). Scope 1 emissions are generated directly from fossil fuels and scope 2 through electricity and heat consumption. Scope 1 and 2 emissions account for around 90% of the carbon dioxide from production facilities. Scope 3 emissions result from the use and disposal of vehicles, in the supply chain, in transport logistics and by employees commuting to and from work. The motivation behind reducing emissions is captured below:

> *Reducing $CO_2$ emissions along the entire value chain makes sense for the BMW Group, both from an environmental and a business perspective (due to lower energy*

*consumption, avoidance of $CO_2$ charges as well as attractive offers that fulfill the requirements of many of our fleet customers' green car policies). With this in mind, we are taking action along our entire value chain: generated directly from burning fossil fuels (Scope 1) and indirectly through the company's electricity and heat consumption (Scope 2). Our production locations generate approximately 90% of these emissions. This is why the strategic area of action we focus on is to reduce $CO_2$ emissions on the production line. Therefore, every unit of energy saved pays off twofold, as the costs of energy consumption and the purchase of emissions allowances can be reduced as a result* (BMW, 2014).

In 2014, the total emissions in the BMW production network amounted to 1,369,877 tonnes of $CO_2$ from 1,322,316 tonnes in 2013 an increase of 3.6% that was attributed to an increase in the volume of cars produced in 2014. This translated to 0.66 tonnes of $CO_2$ per vehicle produced in 2014 against 0.68 tonnes of $CO_2$ per vehicle produced in 2013. This means that the Rossyln plant produced 45,388,86 tonnes of $CO_2$ as this plant produced 68,771 vehicle units in 2014.

VW published a scope 3 inventory for $CO_2$ and this corresponds to the Scope 3 Standard of the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI). This inventory analyses $CO_2$ emissions generated outside of the production plants for example in the supply chain, use phase and disposal phase, logistics processes and business trips. The findings and challenges associated with this inventory are detailed in the excerpt below:

*The wider scope of this analysis poses a number of major challenges for companies in terms of both data collation and interpretation. Our data indicates that the emission category "Purchased goods and services" accounts for around 17% of the total Scope 3 Inventory, and the "Use phase" 75%. External auditors validate the data from both these categories. The Inventory reveals that our most effective lever for cutting CO2 emissions is the development of more fuel-efficient vehicles* (VW, 2014).

In order to counter the effects of the use phase, VW offers vehicles that are designed to use fuel saving and low emission technologies. In 2012, 245 models in the group had $CO_2$ emissions of less than 120g $CO_2$/km and this figure included 36 that emitted less than 100g $CO_2$/km and these figures increased to 324 and 54 respectively in 2013. This information is

communicated using efficiency badges on the cars to highlight the low carbon emissions and efficient technologies the cars offer. This is augmented by customer information given out to encourage drivers to adopt efficient driving styles to reduce emissions throughout the use phase of the vehicles. Extensive research and development activities are carried out to reduce $CO_2$ emissions as illustrated below:

> *The Volkswagen Group is facing up to the challenge of innovative powertrain development. In 2013 alone, our research and development spending totaled approximately €10.2 billion. Much of this investment was devoted to reducing the $CO_2$ emissions of our new-vehicle fleet, within the framework of our Powertrain and Fuel Strategy. Under this strategy we are continuing the electrification of the model range, increasing the number of natural-gas vehicles and steadily improving the efficiency of our gasoline and diesel engines* (VW, 2013).

Increased environmental awareness has led to vehicle manufacturers investing in employee training on environmental aspects. BMW and Toyota employees are trained on sustainability as well as on environmental programmes amongst other courses. The courses are tailor made to the different levels and needs of the participants and then the participants are evaluated. The branch offices carry out public analyses on the environmental, financial and socio-political topics and focus specifically on the relevant economic policy and industry specific issues. Examples of the topics under consideration include $CO_2$ regulation, trade barriers or social challenges to cite a few. The training and analysis help to ensure that the specialist departments at BMW comply with worldwide legal requirements for development, use and disposal of the cars.

The BMW group runs an environmental awareness project in South Africa known as the Schools Environmental Education Development (SEED) project. The aim of the project is to raise awareness on environmental issues amongst young people and to promote social responsibility. Learners in schools are taught to grow vegetables and tend gardens. Each school that is under this project undertakes an environmentally oriented project and they are rewarded financially based on their performance. Initially 15 schools close to the BMW plant in Rossyln were involved but over 60 schools currently take part in the project.

The adverse effects of climate change have led VW to develop risk management strategies and the climate protection strategy takes a number of risk factors into account. These factors

are largely intertwined with increased environmental awareness and examples include regulatory aspects (EU penalties for failing to meet average emissions targets), market related requirements (resulting from increased public awareness of climate issues) and physical aspects (potential supply chain disruption fuelled by droughts or excessive rainfall) to cite a few. Water shortages in South Africa pose a risk to VW's operations and such risks are taken into account when formulating environmental goals. VW views some of the risks as platforms for innovation to develop technologies for products and production processes, for example climate legislation and statutory targets. Vehicle manufacturing companies at times acknowledge that some targets they set as a result of pressure from increased environmental awareness are too ambitious and unrealistic. In 2012 for example VW highlights that it had to deal with protests as a result of failed targets as below:

> *At the same time, climate change and the associated changes in customer requirements are also opening up new challenges and opportunities. Environmental organisation Greenpeace staged various protests during the reporting year – e.g. at the Annual General Meeting in Hamburg, the presentation of the new Golf in Berlin's National Gallery and the Paris Motor Show. Greenpeace accuses Volkswagen of bringing vehicles onto the market with excessive fuel consumption and thus $CO_2$ emissions – and therefore failing to meet its responsibilities with regard to environmental protection* (VW, 2012).

In the same year, VW reported that its image had been tarnished by the vehicle magazines appraisals and it was ranked third from 2010 behind Toyota and BMW. The company's sustainability reporting approach was also criticised for failing to deliver on promises and failing to fight corruption. The weaknesses in the 2012 report were in that it did not devote space to critical issues, did not discuss conflicts of interest as well as lobbying. The report was not clear in terms of what happened to the cars after they had been sold as VW bears responsibility for the cars for their entire life cycle. Global companies are expected by stakeholders to extend strategic thinking outside of the group to include practical aspects such as the design of cities worth living in. Stakeholders are increasingly demanding clearer detail on the way in which manufacturers deal with conflict materials and this extends to the source of all raw materials used. In social projects, the public wants to know the connection between such projects and sustainability as well as information on the evaluation of such projects. Vehicle manufacturers are held to account as a result of increased environmental awareness.

An initiative that has come strongly within VW is a focus on localizing the value addition process in an attempt to address some of the environmental challenges. This is explained in detail below:

> *As a concept, localization stands for the regional integration and concentration of production activities and helps offset many of the drawbacks of an international distribution of labor in ecological, economic and social terms. Relocating supplier firms in the vicinity of new production plants creates new jobs and the local population benefits from rising prosperity. At the same time, the concept of localization also brings with it numerous economic advantages. These include lower logistics costs, procurement prices in line with local market conditions, elimination of import duties and immunity from volatile exchange rates* (VW, 2013).

As shown above localization has benefits for the environment and fits into VW's customer oriented sustainability focus in that it carries the potential to bring manufactured vehicles closer to the customers. Specific regional customer needs are identified and vehicles are designed accordingly and adaptations are made to VW models whilst production operations are kept lean and efficient. VW observes the different markets to obtain pertinent information and the decentralized production and research sites provide regional bases for this work. Localisation is an attempt to address the various concerns raised in relation to environmental degradation amongst other economic factors. Toyota is also in support of localisation.

Toyota positions environmental management as a key management issue and promotes business that is concerned with the environment. The increased environmental awareness has led the group to design a strategy to eliminate emissions and reduce water consumption by 2050. The goal is to reduce all emissions to zero in the entire life cycle. This is to be achieved through improved efficiency and energy use by adopting renewable energy sources (water, wind and solar, hydrogen). Materials in production will be recyclable and parts will be used for longer through development of recycle technology and only eco-friendly materials will be chosen for production. This will ensure an establishment of a society in harmony with nature as illustrated in Figure 4.21.


FIGURE 4.21: TOYOTA ENVIRONMENTAL CHALLENGE 2050, SOURCE: TOYOTA, 2015

## 4.6 Navigation of the Regulatory Environment on a Global and National Level

The automotive industry is important in driving global economic growth, income and employment. The use of cars affords mobility and flexibility and accounts for a proportionally large number of workers in manufacturing and this includes those directly or indirectly employed as a result of vehicle production. There are a number of global trends that affect vehicle production and product design such as urbanization, climate change and changes in the regulatory environment. These changes are however at times taken as opportunities to create new business and a competitive edge whilst in other instances they are treated as risks threatening the business. In as much as customers are becoming more aware of environmental concerns they are still concerned about design and the level of comfort offered by the cars. Drawing from a finance/trade world perspective a suitable concept for increasing the company's value globally is to set up corporate activities for the long term using sustainability as a value driver. In order to operate effectively however, relevant

regulatory structures have to be observed and Daimler points out that:

> *The basic precondition of every sustainable business activity is observance of all the relevant laws, regulations, voluntary commitments, and internal guidelines. We refer to such rules-based behaviour as "compliance." In publishing this Sustainability Report we are meeting our obligation to regularly report on our efforts regarding human rights, labour standards, employee rights, environmental protection, and the fight against corruption* (Daimler, 2011).

In order to navigate the regulatory environment amidst customer demands, potential business risks and global expectations, vehicle manufacturers adopt a number of coping strategies in the environments within which they operate. This is done through checking the level at which the materials they use are environmentally compatible, the environmental standards that exist in the country they operate in as well as anticipating future legislation to cite a few. VW explains this complex relationship by highlighting that:

> *Climate change, resource availability and urbanization are just some of the major global challenges facing the Volkswagen Group from an environmental perspective. These challenges are reflected in growing demands from all sides, be it politicians who enforce ambitious worldwide environmental regulations, investors who expect us to anticipate and manage the risks, or customers with their growing interest in fuel-efficient vehicles* (VW, 2014).

Daimler has developed principles and guidelines that are binding for employees worldwide and it continues to address the seventh Millenium goal that is, sustaining the environment. As a member of the UN Global Compact, Daimler joined other internationally operating companies in committing to uphold and promote the UN Global Compact's ten principles. The company's integrity code also addresses environmental protection. In endeavouring to comply the group concedes that this has been problematic in the past as illustrated below:

> *Compliance in the recent past has sometimes been too radical, too schematic, and tactlessly implemented. That offended some people, which he regrets. But compliance with laws and regulations is emphasized more than ever before, and Dr. Zetsche is taking a self-critical view of the past. Up until the 1990s, when bribery of contacts abroad was still tax deductible in Germany, Daimler also took part in potentially dubious business dealings. Today, integrity is defined differently; it demands*

*transparency and ethical standards* (Daimler, 2011).

A number of initiatives adopted in the various production plants to address the regulatory environment tend to originate from the European countries. The efforts are targeted at resolving regulatory requirements along the value chain. The BMW group for example refers its suppliers to the requirements set out in REACH, the EU regulation on chemicals from the component development stage. Various materials undergo rigorous verification processes to ensure they are ecologically sound. Emphasis in most European countries is on carbon emissions from cars and most companies work towards bringing these down and the BMW uses the EURO 5 emissions standards as a benchmark. The BMW 3 series that is produced in South Africa has the BMW Blue Performance technology that acts to bring nitrogen oxides in emissions down further than the required legal levels. The Blue Performance models comply with EURO 6 standards. The group also introduced what it terms holistic accounting whereby it assesses the sustainability of processes and products across the entire life cycle using the BMW group's sustainability strategy. Values are ascertained on the basis of environmental, business and social sustainability indicators. This system is used in conjunction with the Life Cycle Assessment system that draws from ISO 14040/14044 and this is deemed to afford transparency over resource consumption, emissions and potential environmental impact.

Daimler states that it is faced with challenges in identifying the effects that occur locally as a result of their business activities in their various locations around the world. The other dimension of challenges they are faced with is dealing with the effects that go against their sustainability goals. The management systems that have been set up have to ensure compliance is maintained from the smallest unit to the largest. Stakeholder engagement is also essential throughout these processes and is maintained through open and constructive dialogue. The Sustainability Board is also tasked with coordinating the centralized Group-wide sustainability approach with the local management systems associated with specific business units and topics. Preventing sustainability risks and working within regulatory structures remains key and this is also closely tied to exploiting opportunities that are tied to sustainability. This is because vehicle manufacturers exploit the potential that is presented through increased environmental concerns by proposing solutions geared towards environmentally friendly mobility. Balancing all the regulatory requirements becomes essential and Daimler points out that:

*If we want to continue to operate worldwide, we have to at least ensure that our business dealings comply with legal requirements everywhere. However, regulations sometimes differ widely at our company's locations around the world. To enable us to find our way around in this complex legal environment and also set standards in countries with underdeveloped legal frameworks, we have developed our own principles and guidelines, which are binding for our employees worldwide. Our aim here is to create a corporate culture that not only complies with legal requirements, but also lives up to the highest ethical standards and is therefore exemplary for the entire industry* (Daimler, 2011).

VW has come up with efficiency models named TSI and TDI in response to the carbon emissions regulations and the advantages of these models are outlined below:

*In the Polo TSI Blue Motion– the first ever Polo Blue- Motion model to be fitted with a TSI engine – in 2014 engine management improvements reduced fuel consumption by a further 0.2 liters to 4.1 l/100 km, with $CO_2$ emissions of just 94 g/km. As a result, the TSI Blue Motion is also the first ever gasoline-engine Polo to receive a class A label for energy efficiency and to achieve best-in-class ratings for fuel consumption and $CO_2$ emissions. Like all Polo models, it also complies with the strict Euro 6 emissions standards. Meanwhile the new Polo TDI Blue Motion, like its predecessors, is setting a benchmark in the five-seater diesel market. Its newly developed three-cylinder TDI engine returns fuel consumption of just 3.1-l/100 km (corresponding to $CO_2$ emissions of 82 g/km). This is an improvement of 0.2-l/100 km over the already highly efficient performance* (VW, 2014).

The EU has come up with a number of targets for example the new-car fleet-average emissions target of 130 g $CO_2$/km that is to be adopted in four stages and this started in 2012 (65% compliance required in 2012 rising to 100% in 2015). The target for 2020 is to reduce average fleet emissions to 95 g $CO_2$/km. VW, as well as the other manufacturers has adopted 95 g $CO_2$/km as the 2020 target but this is generally not without its challenges. VW for example refers to this as an 'ambitious goal' and Daimler in 2011 highlighted that:

*However, we will not be able to set concrete targets for this period until various unresolved regulatory and political issues (e.g. the framework conditions for e-mobility and the test cycle) have been clarified. In terms of the Euro 6 standard for*

> *cars the goal is early compliance with the Euro 6 standard by 50 percent of all Mercedes-Benz and smart new vehicles in Europe by the end of 2014* (Daimler, 2011).

There are a number of EU regulations that affect the automotive industry as outlined below:

> *i) EU Directive 2009/33/EC on the promotion of clean and \energy-efficient road transport vehicles ("Green Procurement" Directive), ii) Energy Labelling Directive 1999/94/EC, iii) Fuel Quality Directive 2009/30/EC, amending fuel quality specifications and establishing energy efficiency requirements for fuel production, iv) Renewable Energy Directive 2009/28/EC, establishing sustainability criteria and v) Revision of Energy Taxation Directive 2003/96/EC, amending minimum tax rates for all energy products and electricity* (VW, 2012).

Global reporting structures have been set up to ensure transparency and compliance to the above stated directives amongst others. VW collects data in line with these requirements as illustrated below:

> *In order to manage its sustainability performance, the VW collects central performance indicators in line with the requirements of the Global Reporting Initiative (GRI) and the ESG (Environment, Social, Governance) indicator framework of the European Federation of Financial Analysts Societies (EFFAS). Shareholders and investors are increasingly demanding transparency, which makes them an important target group for VW sustainability reporting* (VW, 2014).

The idea behind using mother countries to benchmark processes is to aid in the transfer of what is learnt in these plants to the rest of the subsidiaries in various countries to facilitate a certain level of standardization in vehicle production the world over. The external factors however in any given locality such as government policy and energy prices in the various locations means variations are inevitable as the holding groups expressly admit they do not have much influence over such factors.

BMW is a signatory to the Global Compact of the United Nations and this is an initiative that aims to create synergies between business and politics to enhance companies' roles as advocates of sustainability and this role is encapsulated in observation of human rights, labour and to some extent the environment. The BMW and Daimler are committed to

complying with the Ten Principles of the United Nations Global Compact and the International Declaration on cleaner production of the United Nations Environmental Programme as highlighted in the excerpt below from Daimler:

> *Daimler is one of the founders of the UN Global Compact and has been a member of this UN initiative's LEAD group since January 2011. It is strongly committed to the ten principles of the Compact. In 2011 we continued and expanded our involvement in the relevant thematic and regional working groups and initiatives. In May 2011 we hosted a LEAD group event on "Competitive Advantages through Sustainability." In publishing this Sustainability Report we are meeting our obligation to regularly report on our efforts regarding human rights, labour standards, employee rights, environmental protection, and the fight against corruption. The UN Global Compact is currently the world's largest multinational sustainability initiative. Daimler was one of the initiative's founding members in the year 2000. Since then we have intensified our involvement in the initiative by, for example, becoming a member of the German Global Compact Network (DGCN). Following our election to the network's steering committee, we have been actively involved in its processes* (Daimler, 2011).

The BMW Group also complies with the OECD's principles for multinational corporations and the Business Charter for Sustainable Development (issued by the ICC-International Chamber of Commerce). Vehicle manufacturers participate actively in environmental initiatives as highlighted below:

> *For example, we took part in the United Nations Conference on Sustainable Development (Rio+20) in Rio de Janeiro, Brazil, in summer 2012. At a number of events, the BMW Group presented its view of the future of mobility. A further example of how the BMW Group is positioned on the international political stage as a responsible carmaker is our regular participation in UN climate and sustainability conferences. In summer 2012, the BMW Group clarified its own position on the future of sustainable mobility at a number of events at the UN Conference for Sustainable Development Rio+20* (BMW, 2013).

Another example of BMW participation in UN Climate Change Conferences was in 2015 at the 21st climate change conference that took place in Paris. The agreement obliges all

countries to engage in climate protection by international law. The BMW Group participated actively in the discussions during this conference and it has participated from as far back as 1992. This is highlighted in the statement from the group captured below showing engagement in climate change related conferences:

> *At the conference in Paris, the BMW Group announced that it had joined the American Business Action Climate Pledge. Companies participating in this initiative support far-reaching agreements within the scope of the Climate Change Conference and commit to company specific goals as well as action against climate change. In addition, the BMW Group participates in the RE100 Initiative of the Climate Group in which influential companies worldwide commit to using 100 % renewable electricity in the future* (BMW, 2015).

VW also shows that it engages in sustainable development issues as captured below:

> *At Group level we particularly cultivate membership of organizations that involve an intensive dialogue on sustainable development issues. At international level these primarily include our engagement with the World Business Council for Sustainable Development (WBCSD), our participation in CSR Europe, a leading European network for social responsibility, and our work within the network of the UN Global Compact. We are also an active member of econsense, the sustainable development forum of German industry, and the international initiative "Biodiversity in Good Company". The information we gain from these sources is passed on to the brands and regions. Details of Group membership of other organizations can be found on the Internet* (VW, 2013).

The demands placed on the automotive industry constantly increase and government interventions on activities that have an impact on climate change are intensifying. This can be seen through regulations such as city tolls or carbon dioxide taxes, changes in fuel prices and changing environmental values and statutory requirements for returning and recycling of vehicles. Some mega cities have started restricting traffic and most changes are made on short notice. In addition to this customer behaviour is changing subject to regulations as well as environmental influences. Overall, global climate change has an impact on legislation, regulations as well as customer behavior.

BMW negotiates these changes through anticipating changes and putting up frameworks to

counter the legislation even before it comes into effect. The group also offers a wide range of mobility services such as car sharing and electro-mobility as alternative transport systems that are environmentally friendly in the European context. The group chooses production locations based on prevailing regulatory environments within each specific location. Financial derivatives are used to hedge against price risks for precious metals such as platinum, palladium and rhodium; nonferrous metals such as aluminium, copper, lead and some steel and basic steel substances such as iron ore as these are used extensively in vehicle production. Medium and long-term supply agreements characterized by fixed prices are also used as additional security for steel and synthetic materials. To cater for increases in crude oil prices (crude oil is a basic material for all components) BMW has developed efficient and low-consumption engines and alternative drive train technologies. The BMW Group has a cross-hierarchy management system in place that ensures legal requirements and BMW specific goals in the field of sustainability and product responsibility are maintained.

In line with regulations all products are supposed to be labelled and vehicle manufacturers are obliged to inform customers about risks, hazards or the recommended use of their products. Vehicle manufacturers are bound by statutory regulations to issue reports for example sustainable value reports, fuel economy of vehicles and carbon dioxide emissions for each brand and these can be accessed on the vehicle manufacturers' websites. The European Union for example set the target for new vehicles for 2015 at 130 g of $CO_2$/km based on the vehicle weight and this is supposed to go down to 95 g of $CO_2$/km by 2020. The BMW group has managed to bring down emissions and this is illustrated below:

> *Between 1995 and 2014, we reduced the $CO_2$ emissions of our newly sold vehicles in Europe (EU-28) by 38%. Average $CO_2$ emissions were 130 g/km in 2014. The BMW Group had already achieved the EU target by 2012* (BMW, 2014).

In 2013 VW published the figures tabulated in table 4.6.

**Table 4.6: VW figures on emissions and energy consumption**

| Resource | 2013 | 2012 | % Change |
|---|---|---|---|
| $CO_2$ emissions of European new vehicle fleet in g/km | 134 | 128 | 4.68 |
| Direct $CO_2$ emissions in kg/vehicle | 449 | 422 | 6.39 |
| Energy consumption in kWh/vehicle | 2, 213 | 2,205 | 0.36 |

**Source: VW, 2016**

As outlined in BMW's 2014 excerpt, the group had attained the EU targets by 2014 whilst VW, according to table 4.6 had not yet attained set targets by 2013. In spite of attainment/non-attainment of the EU target emissions limits, vehicles are produced subject to differing national climate protection regulations set for each specific country making comparisons across countries problematic. Targets have been set in Europe, Japan, North America to cite a few but these targets cannot be compared as they are not uniform across the globe due in part to different calculation cycles. In the USA for example vehicle manufacturers were to achieve 155g $CO_2$ by 2016 and 101g $CO_2$ /km by 2025. Japan set a target of 117 g CO2/km (20.3km/l) whilst China set an average consumption of 20km/l for 2020. The approaches to environmental sustainability vary widely based on region regardless of the existence of international regulations.

Volatile organic compounds (VOC) emissions are also regulated and companies have to report on them. The BMW Group in 2014 had an average of 1.59 kg VOC emissions per vehicle produced and the group accepts that the South African plant had not yet attained the strict German VOC levels by 2014 as stipulated below:

> *With an average of 1.59 kg VOC emissions per vehicle produced, we are below the maximum levels stipulated in Germany at almost all plants worldwide. The only exception is the South African BMW plant in Rosslyn near Pretoria, which is below the maximum worldwide limit but not yet below the stricter German VOC levels.*

*Plans have already been made to reduce VOC emissions in the paint shop there* (BMW, 2014).

Waste management is another area that is regulated specifically with international laws on life cycle management. Recording and reusing waste within the BMW group is managed through its waste information system (ABIS) that determines the best method for disposal of a particular type of waste. The suggested method is then implemented at all plants provided the possibility to do so is open in the specific country. ABIS is used to keep records of waste flows and categorises waste as hazardous or safe and this is done in accordance with country specific regulations. At the Rossyln plant for example measuring devices were installed to monitor and manage resource consumption especially water as it is considered a scarce resource in the country. BMW highlights that:

*What we think of as waste is often a valuable resource. With raw materials worldwide becoming increasingly scarce, the BMW Group engages in recycling management throughout material life cycles* (BMW, 2014).

Global, regional and national regulations play a part in environmental management but municipalities have also structured their green policies to manage resource use in their localities. VW explains that automobile manufacturers function in a complex and highly regulated environment and this necessitates active involvement in creating frameworks for business activities. This is achieved through lobbying and the group has a division termed the Group function 'External Relations and Government Relations' that seeks to widen the scope for action. The roles of these divisions are explained below:

*Within the Company, 'External Relations' promotes a culture of openness and dialogue and helps to facilitate communication with the world of policy-making and other business sectors. This Division operates like an early warning system, identifying and gathering information, analysing its policy and technical relevance, and formulating differentiated strategies for the Group's Board of Management. It supports managers responsible for lobbying. The Group's 'External Relations' function is an intermediary between the Company and policy-makers, including governments, parliaments and administrative agencies but also political parties and associations, non-governmental organisations, and other sectors of industry. It ensures that the Company's views and expertise are brought into the legislative and*

*administrative decision-making process by openly providing comprehensive information and reliable, competent advice based on credibility and professionalism. In line with the Group's commitment to social responsibility, 'External Relations' also provides input into sustainable policy-making in the areas of industrial, transport, environmental and social policy and appropriate focusing of public investment strategies. This confident dialogue with stakeholders in society helps to enhance the Company's profile, boost its reputation, forge new alliances, and build on existing goodwill. The aim is to create and maintain stable relationships with all key Company stakeholders* (VW, 2012).

Another area that is regulated and affects the motor vehicle manufacturing industry is the management of conflict minerals such as tantalum, tin, tungsten, and gold. The manufacturers engage political decision makers and take part in trying to find joint solutions. In other instances they use the influence they have on direct suppliers to dictate the position to be adopted. Daimler highlights that vehicle manufacturers face special challenges in developing and emerging markets particularly with the environmental regulation structures found within these countries. The group however strives to reduce emissions in these countries as demand for vehicles is continuously increasing in these locations.

The Constitution of South Africa undergirds the legislative framework and Chapter 2, Section 24 in the Bill of Rights states that; Everyone has the right (a) To an environment that is not harmful to their health or wellbeing; and, b) To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation, promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development. (Bill of Rights, Chapter 2, Section 4, Page 9).

The regulatory approach within the country is clear on the protection of the environment as a right to the people within the country. Regulatory structures exist within the country but at times are not implemented properly at the operational levels or suffer from troubled relationships with other sectors within the economy. In response to whether the DEA has the ability to enforce laws and its interaction with DTI one respondent highlighted that:

*"The DEA is basically powerless- there is only a White Paper on the environment and no Act. Without an Act the DEA can only suggest and direct and not enforce or*

*bring environmental violators to account. Any environmental activities that either pose a threat to economic activities or challenge economic activities in the country are challenged and nullified. Economic concerns and interests particularly at this point in time such as earnings potential or job creation are considered first and more important above everything else let alone the environment"* (Pers.Comm. 2016h).

Another respondent pointed out that:

*"Any environmental policies from DEA that challenge economic yields from manufacturing industries are either ignored or the DTI challenges these policies outright"* (Pers. Comm., 2015i).

The above response related to the national regulatory framework and trying to get answers from provincial and municipal levels proved fruitless in that most of the people identified as being in charge would give the answers below:

*"I am not the best person to deal with this, I have no idea how vehicle manufacturers are regulated in terms of environmental protection within the province- colleagues please advise on who can give the best responses to the enquiry on the green economy as my knowledge is limited to a specific area, not environment?"* (Pers.Comm. 2015j)

Further attempts to establish the nature of the regulatory environment vis-à-vis vehicle manufacturers through different respondents suggested within the municipal levels yielded the response below:

*"We will revert back with a response once we have all the necessary information and we have located the best person to address the specific queries you raise as they are not handled in this department"* (Pers.Com. 2016k).

## 4.7 Green Practice Adoption in the Value Chain to Ensure Green Production

The BMW group highlights that sustainable development makes a difference when it involves the entire value chain; meaning sustainability is embedded in all processes including suppliers and partners (BMW, 2010/11). This entails making efficient and sparing use of resources over the entire life cycle from product development, purchasing and production as well as the product use phase and end of life (BMW, 2013). At VW, the group's environmental management ensures all ecological aspects of sustainability are anchored in

product development and production at all sites. The priority areas are water, energy, minimising materials use, minimising emissions, noise, pollutants, and wastewater as well as preserving and promoting biodiversity. BMW requires business partners to comply with social and environmental standards meaning all production and extraction methods are expected to take environmental protection and conservation of natural resources into account. This is reinforced by an acknowledgement stipulating that:

> *Around three-quarters of a product's future environmental impact will already have been decided during development. This is why Design works USA, a 100 % subsidiary of the BMW Group working on several of our vehicle development projects, takes the longer view. Taking into account the complete life cycle of a product from the outset, it draws on strategic design consultancy services, innovations and input from a wide range of branches, industries and markets. In doing so, it is able to form new connections and ideas delivering the kind of innovation potential customers can find in all our vehicles. Today, our European fleet has an average fuel consumption of 5.4 l diesel or 6.6 l petrol per 100 km. Its average $CO_2$ emissions stand at 148 g per kilometre.* (BMW, 2010/11)

BMW has a vision of a $CO_2$ free energy supply to ensure that production is environmentally friendly but the company concedes that replacing fossil fuels such as coal, oil and gas with wind or solar is possible but not economical. An example given was that of the paint shop that uses about 50% of the total energy used in production as paint needs heat for drying and liquids in the dip tanks have to be at specific temperatures. There are also 100-200 metre-long areas to purify the air in the plant and all these use energy. Efforts have thus been made to reduce, reuse and recycle energy where possible. Some processes have been combined and others eliminated such that to date half the amount of energy is now required in paint shops. Through observations in the production plants the researcher noted that the plants are highly mechanised and generally very clean, the use of robots in production also eliminates generation of waste as they are programmed to use resources efficiently. In the BMW plant the researcher observed a small amount of smoke emission and the explanation given was that this was due to a leak that had been identified and was being attended to. The water that is used in the paint shop in the BMW plant is recycled to minimise waste. One respondent explained that:

> *"We use demineralised water in the tanks and we have 16 tanks that are used to clean the cars in the paint shop. There is a process that we use to clean the water and any sediments that collects at the bottom of the tank. We use large volumes of water in the tanks but we do not throw it away. We recycle it so it can be used continuously up to a certain point of course"* (Pers. Comm., 2015o).

In terms of the use cycle of the car particularly the amount of fuel a BMW uses is attributed to customer preferences. This view is also similar pertaining to the custom made cars that at times demand what BMW ordinarily would not make. This is highlighted by a respondent who stated that:

> *"What the customer wants the customer gets, the customers set the pace and not us. We take care of our customers and put a lot of effort and love into the making of our cars. We however take a lot of pride in the quality and performance of our cars. We protect our cars from potential scratches from watches, rings and any sharp metal objects–remember the goal is do it right first time"* (Pers. Comm., 2015l).

Daimler holds similar views in terms of its customers and states that it produces:

> *Vehicles as different as the wishes of our customers. No matter whether special equipment, bodies or paint jobs are needed, every special vehicle is precisely adapted for its intended use and the customer's requirements. In many cases, customer requirements lead to innovations that are subsequently used on a large scale* (Daimler, 2011).

BMW also positions customers first as this has an implication on the earnings potential as explained below:

> *We are seeing accelerated global growth and already sell around 85% of our vehicles outside South Africa, we increase revenues by improving our focus on the customer and finding the perfect fit in global markets with different customer requirements. This increases the appeal of our products at local level and steps up our global growth, resulting in additional earnings potential* (BMW, 2014).

Customers are valued by vehicle manufactures and Figure 4.22 shows some of the views customers in South Africa hold in terms of purchasing vehicles. This information was derived

from interviews with 24 dealers selling the four models used in the study who were asked to rank what influenced car purchases. The price was largely the determining factor and ranked highest, with the model and make closely following. Aspects such as the materials used or the direct effect the car or the making of the car has on the environment were ranked least important when buying a car.

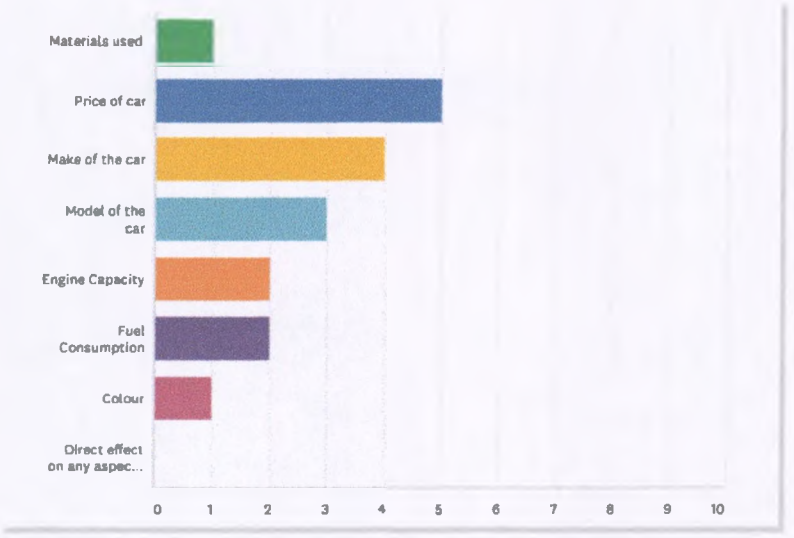


FIGURE 4.22: FACTORS INFLUENCING VEHICLE PURCHASING DERIVED FROM INTERVIEWS WITH 24 DEALERS IN 2016

Customer satisfaction has an overall bearing on the company's intentions to use resources sustainably. An example cited was the use of leather in the cars and customers highlight that leather epitomises luxury for them regardless of a shift towards more responsible use of resources. The same customer oriented focus pertains to the shift towards electric cars. Customers in this case set the pace concerning the type of driving experience they require and they dictate that they prefer petrol/diesel-powered driving over electricity powered cars. Vehicle manufacturers have a drive to lower emissions and they attribute this drive to the stipulations set out by law.

Figures 4.23 and 4.24 show the BMW and Daimler Group life cycles and the measures that have been put in place to ensure environmental sustainability.

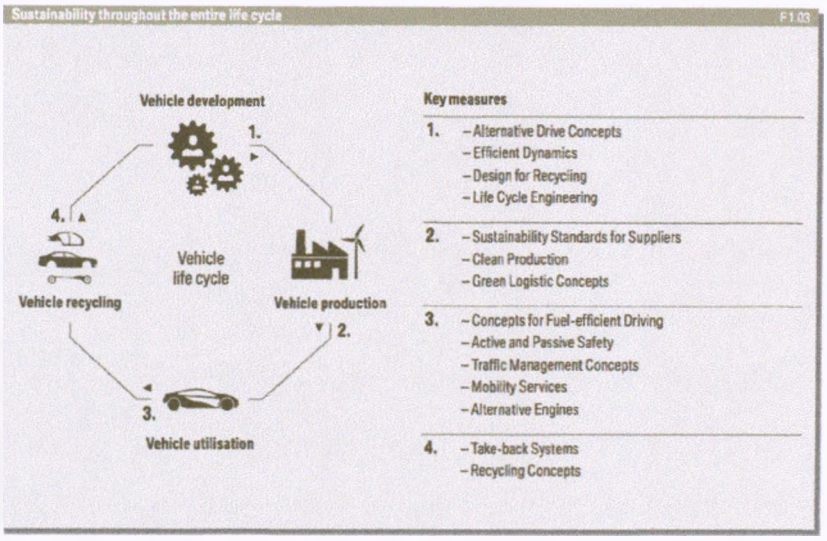


FIGURE 4.23: BMW GROUP LIFE CYCLE, SOURCE: BMW, 2014

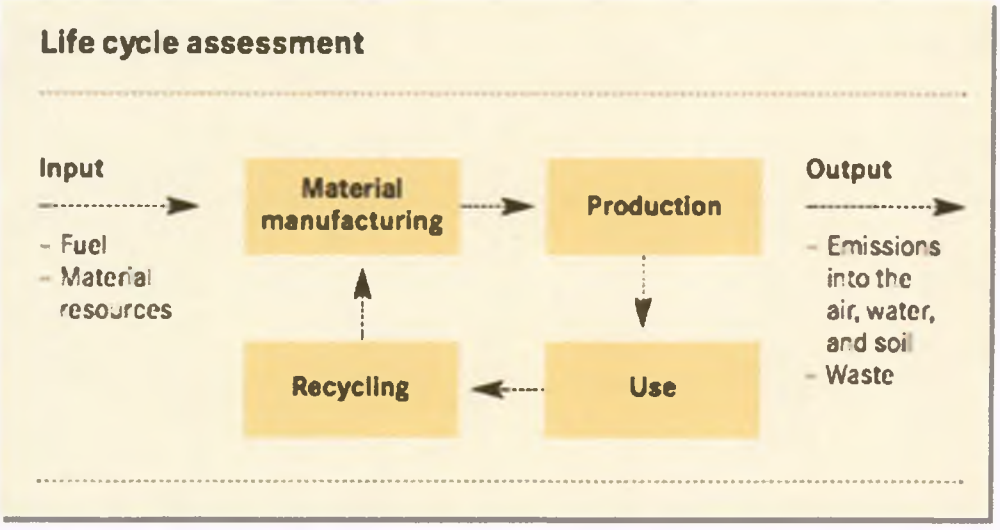


FIGURE 4.24: DAIMLER GROUP LIFE CYCLE, SOURCE: DAIMLER, 2011

Daimler highlights that a car's environmental impact is ingrained in the first stages of its development and this makes design for the environment (DfE) essential in that the impact on the environment can be minimised. DfE ensures environmental standards are met and natural resources are conserved accordingly as DfE takes into account the entire product life cycle that is from material manufacturing, production, use and recycling. Recycling capabilities are incorporated into vehicle designs in the initial stages of the vehicle's development. Daimler makes use of the specifications in the ISO TR 14062 standard to ensure an ecologically oriented product development. In the development phase, vehicles are designed with a view

to minimise the use of resources and this is supported by processing manufacturing waste in a bid to draw secondary raw materials. The BMW group uses the Design for Recycling concept to ensure components can be reused or recycled efficiently once the vehicle reaches its end of life. BMW highlights that:

> *What we think of as waste is often a valuable resource. With raw materials worldwide becoming increasingly scarce, the BMW Group engages in recycling management throughout material life cycles. We manage and gather data on all waste and materials at BMW Group production plants worldwide. To do this, we use our central waste information system "Abfallinformationssystem" (ABIS), which is installed at all BMW Group production plants* (BMW, 2014).

In an almost similar view VW states that:

> *One of Volkswagen's core environmental goals is to reduce its consumption of primary raw materials. This is why use of quality-assured recycled materials is explicitly stated as a requirement in Volkswagen's general environmental specifications, which apply to all projects. The recycled content of the new Golf, calculated by means of a certified method based on DIN EN ISO 14021:2012, is between 34 and 35 percent of vehicle weight* (BMW, 2013).

The emphasis on recycling and reusing is placed in the European context where BMW and VW meet the legally required recycling rate of 85%. This is captured in the excerpt below that stipulates that:

> *A further important instrument for promoting resource efficiency is recycling. Reuse of recycled material reduces the need for extraction and processing of primary resources. In the LCA, therefore, recycling can effectively be treated as a life cycle "credit". At Volkswagen, recycling capability is built into new vehicles from the very beginning of the development process, ensuring that the company's new vehicles are now 85 percent recyclable. And thanks to the Volkswagen SiCon process, which is capable of recycling shredder residues, end-of-life vehicles are even 95 percent recoverable* (VW, 2014).

An extensive network thus exists in the European Union for recovery of end of life vehicles and in Europe the BMW group has contracts with 1,700 vehicle recyclers. No figures are

given for the African context on end of life recycling. The model for recycling followed is the five step model set down by the EU that entails prevention, reusing, recycling, recovery and disposal. Prevention is ensuring the waste is not created in the first instance and this is deemed the best way economically and environmentally. Reuse involves making use of any viable waste material in its original areas of application and if this is not feasible the materials are recycled for use in another area. In recovery most non-recyclable waste materials are incinerated amongst other disposal methods. The remaining volume of non-recyclable waste is then disposed of and the waste earmarked for disposal indicates the reuse and recycle success rate. In 2012, 6.11kg of waste for disposal was recorded per vehicle produced and this equated to 366 600 kg given BMW SA produced over 60 000 cars in that year. VW gives the following illustrations of reductions in the production process:

> *Between 2010 and 2012, $CO_2$ emissions from the production process were cut by approximately 129 kilograms per vehicle produced (passenger cars and light commercial vehicles), while metallic production waste was reduced by more than 28 kilograms per vehicle. Over the same period, the Volkswagen Group also reduced its output of wastewater per vehicle produced by around 440 litres. Between 2008 and 2012, European fleet-average $CO_2$ emissions were reduced from 159 g $CO_2$/km to 134 g $CO_2$/km. That equates to a reduction of approximately 15.7 percent* (VW, 2012).

There are vehicle components that do not require recycling and these are reconditioned and reused. VW runs a Genuine Remanufactured Parts programme that has remanufactured millions of engines, transmissions and a variety of other components. This range comprises of more than 16,000 components from 63 product groups and genuine remanufactured parts cost 40% less than new parts. VW explains that:

> *Genuine remanufactured parts cost on average 40 percent less than genuine new parts, while nevertheless offering as-new quality and functionality, and being backed by the same warranty. And in addition to the benefits for the customer, this is good news above all for the environment. For example, engine remanufacturing alone delivers annual savings in the order of 7,000 tonnes of steel* (VW, 2012).

Daimler also remanufactures parts the world over as explained below:

> *All in all, Daimler now offers 12,000 parts and components for cars and commercial vehicles as genuine spare parts. Remanufacturing also isn't limited to the activities of*

> *the 350 or so specialists for replacement engines in Mannheim: From the U.S. to Brazil, South Africa, and Japan, some 2,100 Group employees are involved in remanufacturing activities around the world* (Daimler, 2014).

The recycling challenge lies mostly in electric vehicles as they contain large amounts of valuable resources such as cobalt, lithium and rare earth. Of all these materials cobalt is mostly recyclable and reusable whilst 90% of the raw materials used in a lithium-ion battery can be recovered.

To ensure vehicles are sustainable BMW sets goals in the strategic planning phase by applying holistic accounting methods to assess the environmental, economic and social impact of products across their entire life cycle. This complements the ISO 14040/44 (Life Cycle Assessment). Potential environmental effects are anticipated from the selection of material, production, use and recycling and the sustainability targets have the same significance attached to cost or weight in the development process of the vehicle. This is done in order to improve the environmental impact from one generation to the next in accordance with Life Cycle Engineering ISO 14062. Holistic accounting methods are adopted to assess the environmental impact of innovative technologies and materials in the predevelopment stage. This helps to identify potential for building sustainability into the life cycle. The Rosslyn plant for example offers a recycling scheme for the local population and this serves to raise public awareness of the importance of waste separation and recycling. The same plant also has measuring devices that trace resource consumption patterns.

VW uses LCA to calculate the life cycle process that generates the biggest environmental impacts in an attempt to minimise the environmental impacts from its vehicles. The analysis of new vehicles, components and materials starts from the first design sketches right through to final disposal. An example of what the analysis yields shows that with water use, consumption and environmental impacts are low in the use phase but very high during recycling and production. The company has a four-stage approach to the Life Cycle Assessment and these four stages are inventory, impact assessment, materials composition analysis then certification. In the inventory stage data is collected on every component and process in the life cycle and this is extracted from the VW Materials Information System (MISS) and the processing database GABI. The quantity of raw materials and energy consumed over a lifetime by each component and process is calculated. The useful life is estimated at 150 000 kilometres and fuel consumption, energy consumption and $CO_2$

emissions are calculated based on the New European Driving Cycle for the useful life. In impact assessment the goal is to calculate potential environmental impacts of the vehicle such as global warming potential or ozone depletion potential to cite a few. Materials composition analysis shows the materials composition of a vehicle and from this is derived the methane, carbon monoxide, sulphur dioxide or methane the vehicle emits. The certification is carried out using the requirements defined in the ISO 14040 and results are published in an Environmental Commendation. VW gave the example below to illustrate LCA:

> *At the Volkswagen brand, one example is the analysis of "LCA hotspots in the vehicle production phase". This analysis identifies the most environmentally significant components and processes in the manufacture of the Polo, Golf and Passat. It has shown that in absolute terms, the upstream supply chains for sheet steel and blanks have the biggest impact on $CO_2$ emissions at the production stage. It also established that offcut waste (38 percent of raw material input) offers significant improvement potential, and that platinum-group metals (PGM) in catalytic converters, along with electronic components and magnesium, make significant contributions relative to their weight. By carrying out analyses of this type, the Volkswagen Group brands can identify the most effective ways to make their production processes more efficient, thereby reducing energy consumption, emissions and consumption of valuable resources such as water and raw materials* (VW, 2012).

The statement above is similar and supported to some extent by a respondent who highlighted that:

> *"Although the biggest share of the vehicle's total life cycle impact is generated during the use phase or service life, the production phase too offers enormous potential for improving environmental sustainability"* (Pers. Comm., 2016m).

Toyota uses the eco-vehicle assessment system (Eco-VAS) to carry out lifecycle assessments of a vehicle's total environmental impact. This is an environmental impact assessment system that allows systematic assessment of vehicles impacts from production to disposal. In as much as efforts are made to ensure that environmental impacts are taken into consideration across the entire life cycle of the car, the task is not necessarily simple as illustrated by the assertion below:

> *Analyzing the life cycle environmental impact of a vehicle is a complex task that is not*

*necessarily easy or straightforward* (Toyota, 2013).

**Table 4.7: Examples of resources that are measured and monitored in LCA**

| Resource Measured | 2012 | 2011 | 2010 |
|---|---|---|---|
| Energy consumed/vehicle | 2.21MWh | 2.40 MWh | 2.53 MWh |
| Metallic waste produced/vehicle | 188.72kg | 210.59kg | |
| Hazardous waste for recycling | 10.62kg | 11.27kg | |
| Hazardous waste for disposal | 10.37kg | 9.86kg | |
| Non-hazardous waste for disposal | 10.62kg | 11.74kg | |
| Non-hazardous waste for recycling | 34.46kg | 34.14kg | |
| Direct $CO_2$ emissions/vehicle | 425.13 kg | | 555.02 kg |
| NOx emissions | 271.01 g | 322.08g | |
| $SO_2$ emissions | 28.42g | 76.88g | |
| VOC emissions | 3,521 g | 4,045g | |

**Source: VW, 2012**

Table 4.7 shows the decreases in grams, kilograms and megawatt hours in a life cycle assessment of vehicles produced by VW. Between 2010 for some resources and 2012 there is a reflection of a certain level of decrease in the consumption of materials or emissions released in the vehicle life cycle. This is explained in the excerpt below that stipulates that:

> *A closer look at energy consumption makes this clear. In 2012, an average of 2.21 MWh of energy was consumed for every Volkswagen Group vehicle produced – a reduction of 0.32 MWh compared with 2010. At first glance such improvements may seem small, but when multiplied by the total number of vehicles produced, they actually represent an important lever for improving sustainable production* (VW, 2012).

Vehicle manufacturers constantly research into ways to ensure production is not harmful to the environment. VW for example makes use of warm forming in the production of the new Golf and this is a process in which steel is simultaneously formed and tempered by cooling it from 950°C to 175°C in seconds. Warm-formed steel has greater yield strength and this makes it possible to produce thinner and lighter components. This process uses considerable amounts of energy but results in energy savings as a result of the total life cycle energy consumption that is significantly low due to lower weight. An example is the Golf with weight savings of up to 100kg and as a result fuel consumption is reduced by 23%. Resource efficiency in production processes is a key factor in that sparing use of energy and raw materials contributes significantly to cost-effectiveness according to VW and the group has set targets outlined below:

> *By 2018, the Volkswagen Group is aiming to have cut specific energy and water requirements, waste volume and $CO_2$ and solvent emissions (VOC) per vehicle by 25%, compared with the 2010 baseline. This goal applies across the board to all the Group's production sites, and builds on the general production process requirements defined in the Group's environmental principles. The overarching aim is to minimize the environmental impacts of production. By the end of 2013 we were already halfway to our goal, having cut the environmental impacts of production by 12.5%* (VW, 2014).

This commitment to increase resource efficiency is demonstrated by the groups undertaking to improve plant operations as reflected below:

> *The Volkswagen plant in Uitenhage (South Africa) was built during the apartheid era. Today some 4,500 employees work here, building the Golf, Polo, Polo Vivo and Polo Stufe models as well as Vivo engines. In March 2013 a state-of-the-art press shop came on stream at the Uitenhage plant in South Africa. The new facility forms the core of an extensive range of measures that have made Uitenhage one of the most eco-friendly production plants in the southern hemisphere. These include aspects such as the use of recycling-friendly materials, a lighting system equipped with presence detectors, and a storm water retention basin. In 2012 this already led to us winning the title of "Greenest Manufacturer" from the South African Department of Economic Development, Environmental Affairs and Tourism* (VW, 2013).

The above shows a focus on energy, water and recycling of various materials. VW has been working on waste strategies across all plants in order to reduce and prevent waste. The strategy includes dealing with adhesive residues, paint sludge and wastewater. 96% of water consumption is attributed to production processes with a larger percentage upstream and around 10% in production plants. Water availability differs from region to region but water in South Africa is identified as a threatened resource. The goal is to ensure green practices are adopted in every stage of the value chain to preserve all resources.

Toyota has adopted what it terms 3R's (reduce, reuse, recycle), as there is a realisation that the earth's resources are limited amidst increased consumption that is tied to population growth. Mineral resources essential for automotive parts production are faced with near-future depletion and Toyota highlights that agriculture constantly competes with manufacturing for water. Waste continues to increase and is disposed of wrongly as there is a shortage of treatment plants, rampant illegal dumping and trans-boundary movement of hazardous waste (Toyota, 2013). The 3R's are used to address such concerns through recycling limited resources in end of life vehicles and these initiatives are included from the design stage and every stage of vehicle life cycle. Figure 4.25 shows the recycling process that has been designed for tungsten under this initiative.

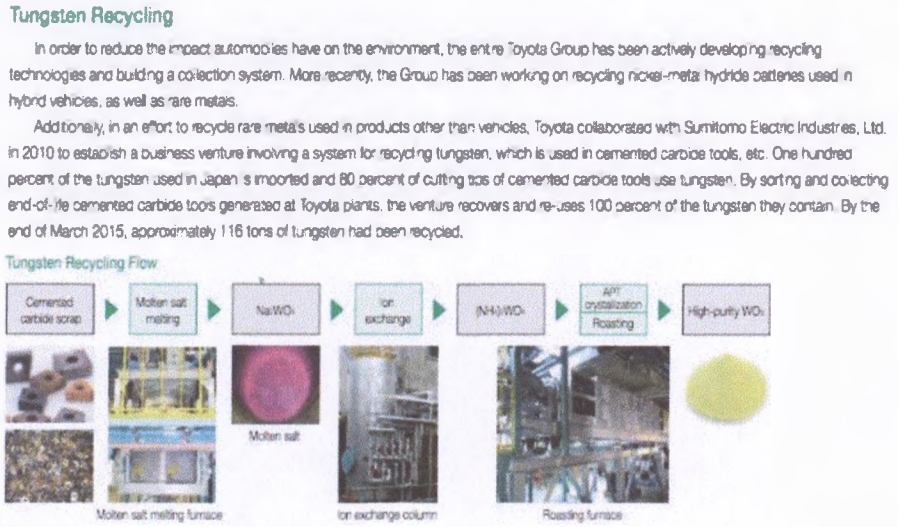


FIGURE 4.25: TUNGSTEN RECYCLING, SOURCE: TOYOTA, 2013

A number of strides have been attained within vehicle recycling and end of life across the various vehicle manufacturers. One of the ways that used vehicles in South Africa are disposed of is through the used vehicles departments that sell used cars (Interviews with vehicle dealers in SA, 2016).

## 4.8 Vehicle Manufacturers' Interaction with Suppliers and Contribution to Sustainability

The vehicle suppliers' network is extensive and cuts across different industries. In order to maintain a certain level of control vehicle manufacturers dictate their expectations to their suppliers and they set the criteria for suppliers to adhere to. This is illustrated in the interview below where a respondent explained that:

> *"Suppliers to vehicle manufacturers adhere to stipulations set out by the manufacturers. In this instance vehicle manufacturers are the customers and the power and financial muscle they yield dictates what a supplier is expected to deliver. This becomes problematic especially when the delivery timelines are not realistic or the specifications required are not feasible and vehicle manufacturers push suppliers to produce and deliver or else risk losing the contract. This at times compromises the quality of the finished goods and the suppliers take the fall for the mishap" (Pers. Comm.*, 2016n).

Tied to this expansive network and various demands suppliers have to satisfy is the global location of suppliers that adds another source of complexity. Figure 4.26 shows one component that goes into a car thereby giving a picture of the vastness of the supplier network vehicle manufacturers deal with to ensure production.

WORKING WITH SUPPLIERS WORLDWIDE — Seat suppliers in China.

FIGURE 4.26: WORKING WITH SUPPLIERS, SOURCE: BMW, 2013

Supplier-manufacturer relationships require a certain level of administration. In interacting with suppliers BMW for example ensures that the supplier management relations department verifies the supplier's viability (business, technology as well as social and environmental credentials). Three specialist departments namely Sustainability in the Purchasing and Supplier Network, Sustainability and Environmental Protection, and Raw Materials Management work together to ensure sustainability in the supply chains. There is a compliance committee set to support the process and the BMW Group purchasing selects the right locations to purchase raw materials from as well as the best supply routes. This is highlighted in the excerpt below:

> *We have also integrated several sustainability risks into the process, including physical and regulatory risks to our reputation relating to the environmental and social standards of our suppliers. Our Supplier Relationship Management department has identified and established sustainability as being an equally important criterion*

*for the supplier selection process. In addition, exchanges with other companies, regular training courses, workshops and information events within our risk management network have enabled us to prepare ourselves and our employees to meet new risk requirements.* (BMW, 2013)

The above approach is similar to that adopted by Daimler as it ensures that suppliers align with the requirements of the group as shown below:

*We have formulated in a special set of guidelines our expectations regarding the sustainability activities of our suppliers. These guidelines are a binding component of the contractual stipulations of Mercedes-Benz and of our general procurement requirements for non-production materials. We are also incorporating sustainability clauses step by step into our international procurement conditions. To support and monitor these activities, we use training sessions, assessments, dialogue, and communication measures. We have also started to integrate sustainability aspects into our audits for selecting new suppliers. We support our suppliers' fulfilment of these requirements through measures such as targeted information and training courses. The central dialogue medium is our online Daimler supplier portal, where we have also stored all of the current requirements and standards in a number of languages* (Daimler, 2011).

Toyota is guided by respect and works with suppliers based on mutual trust and evaluates all potential candidates based on their strengths. The group engages with the suppliers and this relationship is guided by the Toyota Supplier CSR Guidelines. Suppliers are expected to base their own CSR activities on the Toyota ones and in turn extend these to their own suppliers. Suppliers are expected to comply with all regulations and their progress is monitored and followed up by the group. Similarly suppliers are discouraged from unlawful purchase of conflict minerals. The approach in dealing with suppliers is illustrated in Figure 4.27.

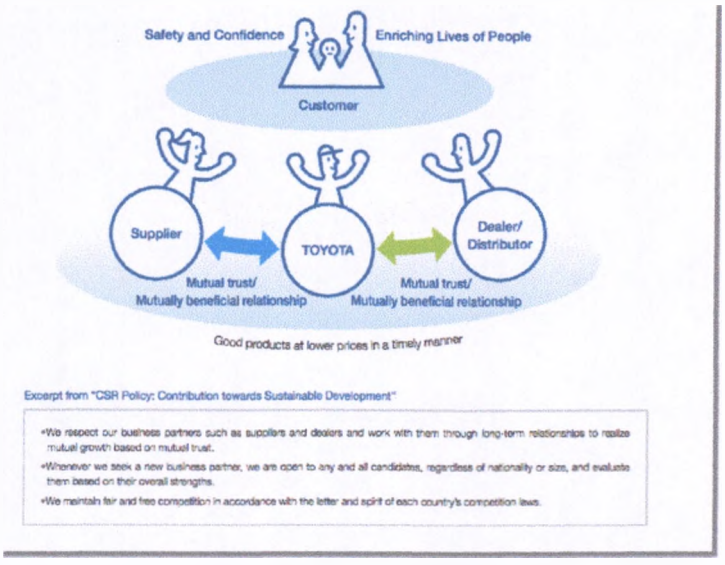


FIGURE 4.27: TOYOTA-SUPPLIER RELATIONSHIPS, SOURCE: TOYOTA, 2015

BMW has departments such as the purchasing division, sustainability and environmental protection, parts quality management and supply chain academy. The supply chain academy sensitises the purchasing department on issues pertaining to the human rights and environmental protection aspects of sustainability. Managers receive training and one of the modules focuses on sustainability. Global purchasing officers identify and train local suppliers as well as support future partners to set up the structures required of them to fulfill the environmental and social standards the company sets as illustrated below:

> *Our sustainability training programmes are designed for purchasers and suppliers. We raise their awareness on the topic and they learn about cause and effect. We also clearly communicate our expectations to them. In this way, we enable participants to make decisions that contribute towards greater sustainability in the supply chain. In 2015, around 247 new purchasers (2014: 581) took part in this training. We also provided training for 20 of our suppliers (2014: 38) and carried out cross industry training courses for BMW suppliers with identifiable sustainability deficits- in India (15 suppliers) and South Africa (46 suppliers)* (BMW, 2015).

In addition to the trainings undertaken, extensive dialogue and transparency are some of the measures the BMW group has put in place to ensure lasting collaborations with suppliers. The way in which the group deals with suppliers is reflected below by one of the managers who stated that:

> *"We take pride in doing it right first time and we build cars that are of the best quality possible, we ensure our suppliers adhere to our standards and any faulty supplies are returned-even manuals that come with folded pages are not good enough for us to use"* (Pers.Comm, 2015a).

Daimler provides a dialogue platform and gives an example of how this was put into practice at the East London plant in 2012 as shown below:

> *To enable us to live up to our responsibilities, we work together with our direct suppliers on the basis of the principles of fairness, reliability, and credibility. We require our suppliers to implement sustainability standards in their own supply chains. In order to ensure the high impact of our measures and use resources effectively, we strive to intensify our dialogue with the suppliers at all our locations and to promote the supplier industry's local activities. For example, we organize supplier forums on a regular basis. In one of these forums, we met with business and political leaders at the Mercedes-Benz plant in East London, South Africa, in early February 2012. The main topic of the meeting was the question of how the local supplier industry can further improve its global competitiveness. In addition, Daimler is a member of the U.S. organization for standardization activities in the auto industry (Automotive Industry Action Group, AIAG). This association offers a neutral platform on which automakers, suppliers, service providers, and an appropriate number of academic representatives can meet in order to develop, harmonize, and improve standards, technologies, business practices, and processes in the automotive supply chain* (Daimler, 2012).

The global reach of vehicle manufacturers makes it essential for them to ensure sustainability standards are adhered to amongst their suppliers. VW states that:

> *This means that our Company, with over 500,000 employees producing more than eight million vehicles a year over 90 production sites worldwide, has a growing responsibility to make a sustainable contribution to a global mobility system* (VW, 2011).

The BMW group for example in 2015 had a production network comprised of 30 locations in 14 countries and over 13,000 suppliers in 70 different countries and as the purchasing network increasingly becomes more complex the group has to develop more strategies to deal

with the supplier network. This complex value chain undoubtedly has effects on the environment and requires proper management. The communication between the group and the suppliers starts with the supplier selection process where new suppliers are requested to meet the same environmental and social standards set for the group before they are accepted as partners. An example is the use of renewable energy as a large share of the $CO_2$ emissions in vehicle manufacturing is generated from suppliers. BMW therefore supports the use of renewable energy in the supply chain as well. This is done to maintain the product and production quality required by the group.

Suppliers are required to provide information on how they fulfill the sustainability criteria and they do this through responding to a self-administered questionnaire with 27 questions. These questions are mostly targeted at first tier suppliers and they seek information on aspects of the ISO 14001 environmental management systems, recycling strategies as well as waste disposal concepts. The sustainability risk filter forms the basis for the next step – the supplier submits a voluntary self-assessment questionnaire. Since 2009 suppliers have been expected to complete the questionnaire to provide a self-evaluation of their sustainability management and related activities. The questions cover whether they have an ISO 14001 environmental management system in place, the extent to which recyclability is considered in product development, and information on waste utilisation concepts and compliance with human rights. The statistics captured below show the response rate BMW had in 2013 and 2015:

> *In 2013, around 3,000 BMW suppliers submitted the information that was requested. In 2015, a total of around 1,900 nominated, active and potential suppliers were assessed via this questionnaire. By establishing sustainability requirements in the tendering process, we not only increase transparency along the supply chain but also raise the awareness of this topic on the part of our suppliers' top managers. As a result, a number of our suppliers have taken decisive measures to better establish sustainability within their companies. In 2015, our system logged corrective action plans with target deadlines for around 400 supplier locations. An external service provider checks that the measures have been implemented by the date agreed upon* (BMW, 2015)

Daimler ensures that suppliers are environmentally responsible as below:

> *Our guideline on sustainability requires environmentally responsible production processes, to give just one example. Our suppliers either comply with the ISO 14001 norm or EMAS or can provide proof that they are using a comparable environmental management system. The environmental compatibility requirements for the components they deliver are defined in our specifications. We have also embedded the criteria for materials selection, environmental laws, banned substances, and recycling requirements in the Mercedes-Benz contract conditions* (Daimler, 2012).

The companies that provide the full and complete set of sustainability information and are not in breach of any of the group's exclusion criteria are selected. Suppliers are bound to comply with human rights legislation from the production of materials to vehicle components and in South Africa annual in-house courses keep staff abreast of developments or changes in legislation. There is a continuous monitoring of suppliers as illustrated in the excerpt below showing that:

> *As part of the continuous improvement of our risk management process, we introduced two new aspects in 2014. One was the "nomination process", an upstream step before the procurement process to ensure that nominated potential suppliers comply with our sustainability requirements. We also carried out modular online assessments of suppliers in addition to our sustainability audits* (BMW, 2014).

VW requires similar compliance from its suppliers as illustrated below:

> *In the course of the business process, all suppliers are required to complete our sustainability questionnaire and to document their activities in the areas of environmental protection and social standards. By December 31, 2014, 15,405 Group suppliers had returned the questionnaire. In terms of procurement volume this equates to 87%* (VW, 2015).

The diagram in figure 4.28 shows the BMW distribution of purchasing volumes in 2013 and gives an idea of the various locations resources are sourced from.

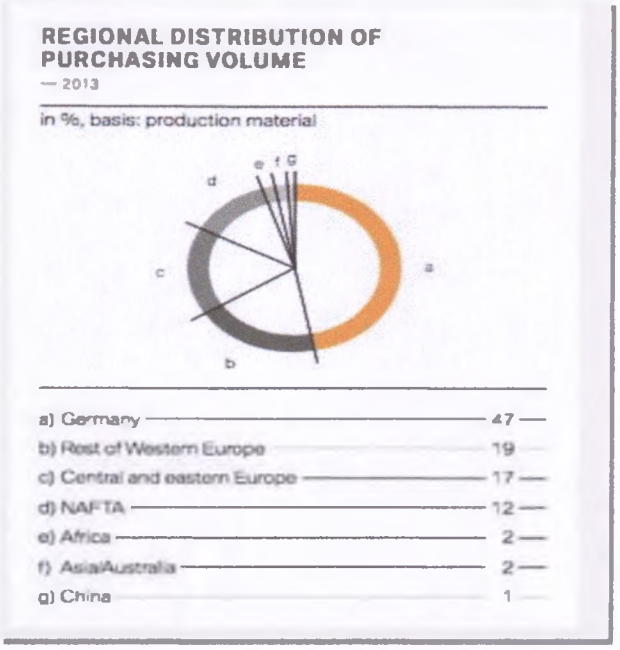


FIGURE 4.28: DISTRIBUTION OF SUPPLIERS WITHIN THE BMW GROUP, SOURCE: BMW, 2013

BMW acknowledges that the purchasing model illustrated above is fraught with risks such as currency risks, increased $CO_2$ emissions, and costly transportation logistics. The plan is to expand local sourcing to counter such risks. Vehicle manufacturers attest that ensuring environmental sustainability is complex and laborious given that their supply chains span a multitude of sub-suppliers around the world. As a global enterprise, the BMW Group faces the challenge of using sustainability management to find the right solutions under very diverse local conditions. Increasing procurement in regions such as Eastern Europe, Asia and Latin America has led to new and bigger sustainability risks given the varied regulation structures in these regions. Consider a respondent who highlighted that:

> *"The components that we use in our cars come from various locations the world over. I can give an example of the engines that we use in our cars that are sourced from Austria or Germany depending on whether the engine is for a diesel or petrol powered car. This just goes to show you how vast and extensive the supplier network is within the vehicle manufacturing industry if engines alone are sourced from 2 different locations"* (Pers. Comm., 2015a).

The vehicle manufacturers have to continuously improve their sustainability risk management systems in order to become familiar with the respective country, industry and product risks

and to ensure compliance with their sustainability standards. This is particularly the case with second and third tier suppliers as the main contact occurs via vehicle manufacturers' first tier suppliers. BMW states that:

> *Raw materials are the basis for every industrial production process and thus indispensable to industry. However, with today's multi-layered global and dynamic supply chains, the intermediate trade and processing stages, and commodity trading on the stock exchange, actually tracing the route of a raw material from the mine to the end product is an extremely complex undertaking. This is mainly due to the intermediate trade and processing stages and commodities trading on the stock exchange. It is therefore quite a challenge to implement sustainability standards as early as the raw materials extraction stage. It is therefore a great challenge to influence sustainability standards in raw materials production. Our approach is to focus on selected, relevant and critical raw materials and supply chains. To this end, we analyse and assess these supply chains and the need for action. From this analysis we derive measures that we implement in conjunction with our suppliers* (BMW, 2014).

The BMW group has joined initiatives such as the Aluminium Stewardship Initiative to improve sustainability standards and it outlines that:

> *In December 2012, for example, we were the first carmaker to join the Aluminium Stewardship Initiative (ASI). Aluminium plays a major role in lightweight construction, because it weighs significantly less than steel and hence contributes to weight reduction. The aim of the ASI is to create sustainable standards along the entire aluminium value chain – from responsible corporate governance to compliance with environmental and social standards. The ASI is the first comprehensive initiative for creating a sustainable standard for the value chain of a metallic resource* (BMW, 2012).

Another strategy the group uses is working closely with suppliers to promote resource efficiency through training and qualifying suppliers. VW also engages in trainings and these are extended to employees as shown below:

> *Volkswagen also works on sustainability in supplier relations from the inside out, educating its own employees. New hires in Procurement participate in the WISTA*

*familiarisation programme, which includes skills related to sustainable supplier relations.* (VW, 2013)

With all the direct suppliers, vehicle manufacturers expect sustainability standards to be upheld and they analyse specific raw materials and resources along the entire supply chain. The aim is to continue to verify supplier sustainability across all sectors of the industry. Random checks are carried out on the first tier suppliers 2-3 times a year and if suppliers are found in breach an escalation process is followed in which the supplier can follow corrective action or risk an ultimate loss of the contract. VW equally conducts random checks on its suppliers to ensure compliance and this is complemented by certification as outlined below:

*In addition, Volkswagen requires its main suppliers to put in place a certified environmental management system in accordance with ISO14001 and/or EMAS. Such systems have been verified and documented at 87% of our main suppliers. As part of the EMAS and ISO14001 environmental certification and auditing at the Volkswagen AG locations, the contractors and suppliers who work on the plant grounds and have an environmental impact are also subject to regular monitoring. Taking all suppliers into account, 77% have EMAS/ISO 14001 and 7% social certification* (VW, 2014).

Defaulting suppliers or supplier production facilities at risk of breaching sustainability are audited independently and the first step involves inspecting facilities using special criteria. In instances where the need arises verifications and certifications will be carried out by an external auditor or a complete external sustainability audit will be initiated. Audits include plant inspections, interviews with management as well as employees to verify whether standards are being implemented and whether supplier's sustainability performance is up to the required standard. BMW clearly states that:

*We continue to strive to make our supply chain the most efficient and sustainable in the automotive industry. In 2010, we began to increase our focus on integrating this topic into selecting, monitoring and training our suppliers. Over the longer term, we aim to work only with partners that comply with the same principles as we do, namely those of the ILO, the UN Global Compact, UNEP Cleaner Production Declaration, OECD Guidelines and the ICC Charter* (BMW, 2010).

VW fosters sustainability along the value chain through the Sustainability in Supplier Relations Concept formulated in 2006. The group continues to refine this process and it has

been integrated with traditional priorities such as quality, price and delivery times. Applying and monitoring sustainability standards in the supply chain helps to minimise risk, prevent potential supply shortages, guard against damage to reputation and ensures quality of the purchased supplies and services remains consistent. The suppliers and the group profit from the relationship and the potentially negative social, environmental and financial impacts are minimized or prevented altogether. A platform was re-launched in 2011 (www.vwgroupsupply.com) to promote direct global exchanges between VW and its suppliers and the Sustainability in Supplier Relations has become central to this portal.

The Sustainability in Supplier Relations Concept is based on four pillars and these are acknowledgement of sustainability requirements, an early warning system used to identify and minimise risk along the supply chain, integration in the procurement process and supplier monitoring and development. Tier 1 suppliers (direct suppliers) are required to acknowledge sustainability requirements before submitting quotations. In analyzing risk the group seeks assistance from independent institutions and this is done prior to negotiations with potential suppliers. Results from one of these audits revealed that:

> ...*There is an increased risk of non-compliance with sustainability requirements in Brazil, India, China, Mexico and Russia. In 2013 this led to supplier audits being conducted in India and Mexico. In 2014 these will be extended to other high-risk countries and groups of suppliers* (VW, 2013).

To integrate into the procurement process suppliers register on the business platform and acknowledge sustainability requirements that have been included as part of the terms and conditions of purchase, fill in a sustainability questionnaire, enroll and complete an e-learning module and suppliers are monitored in cases of non-compliance. In Daimler procurement is represented at more than 50 locations and requirements are applied in the same way across these locations. Below are some of the successes of the supplier management efforts:

> *In the course of the business process, the supplier is required to complete a sustainability questionnaire: by December 31, 2013, 11,749 tier 1 suppliers had done so. In terms of procurement volume this equates to 82%. In the interests of continuing supplier development, in the course of our business relations we make available to all suppliers an electronic learning module in eight languages, including Chinese and Russian. After completing this task, the supplier has to perform a self-check. The*

*module is not regarded as "passed" until this check is successfully completed. By the end of 2013, 8,652 tier 1 suppliers had successfully completed the E-Learning module, which equates to 50% in terms of procurement volume* (VW, 2013).

In the cases of non-compliance, the defaulting supplier is asked to write a statement describing sustainability status and remedial action to be followed. Other measures that are adopted include site visits or review of documents conducted with Wolfsburg experts accompanied by expert teams from the relevant brands and regions. There are cases that were identified and dealt with and VW gave a few examples of these as shown below:

*In 2011, 12 suspected cases of non-compliance by suppliers in respect of pay, industrial health and safety, working hours, discrimination, human rights, freedom of association and environmental protection were successfully clarified by Volkswagen. In 2013 there were 29 ad-hoc cases in all, eight of which involved tier 2 suppliers. Eleven cases occurred in Europe, 13 in Asia, four in North and South America and one in Africa* (VW, 2013).

Supplier relations are based on the VW Group's Code of Conduct for Business Partners. The code of conduct is based on the principles of the UN Global Compact, Business Charter for Sustainable Development (ICC) the International Labour Organization. In addition, Volkswagen's Environmental Policy, environment targets and regulations derived from it, the VW's Quality Policy and the Volkswagen Declaration on Social Rights supplement the principles.

An example of what is required from suppliers is given below:

*For example, when wood from rainforests is used a seal of approval from the Forest Stewardship Council (FSC) must be provided. The requirements apply to all outsourced goods and services worldwide. We expect our tier 1 suppliers to not only respect these requirements but also pass them on to their own suppliers. Our main suppliers are also required to put in place a certified environmental management system in accordance with ISO 14001 or EMAS. Such systems have been verified or documented at 84% of our main suppliers (*VW, 2013).

Daimler in an almost similar approach stipulates that:

*Our expectations regarding ecological, social, and business ethics issues are formulated in our Sustainability Guidelines for Suppliers. These guidelines are a binding element of the Mercedes-Benz special terms and the General Conditions of Procurement (for non-production materials) that apply to the majority of our suppliers. We are also incorporating sustainability clauses step by step into our international procurement conditions. This has been the case in Australia, China, Indonesia, Mexico, Singapore, Thailand, Hungary, Vietnam, Argentina, South Africa, and Turkey since the end of 2011* (Daimler, 2012).

The supply chain is complex and is made up of thousands of parts from all over the world that must comply with the requirements of sustainable supplier management. Figure 4.29 illustrates diagrammatically the components that make up a car thereby giving insights into the vast nature of the supply chain network.

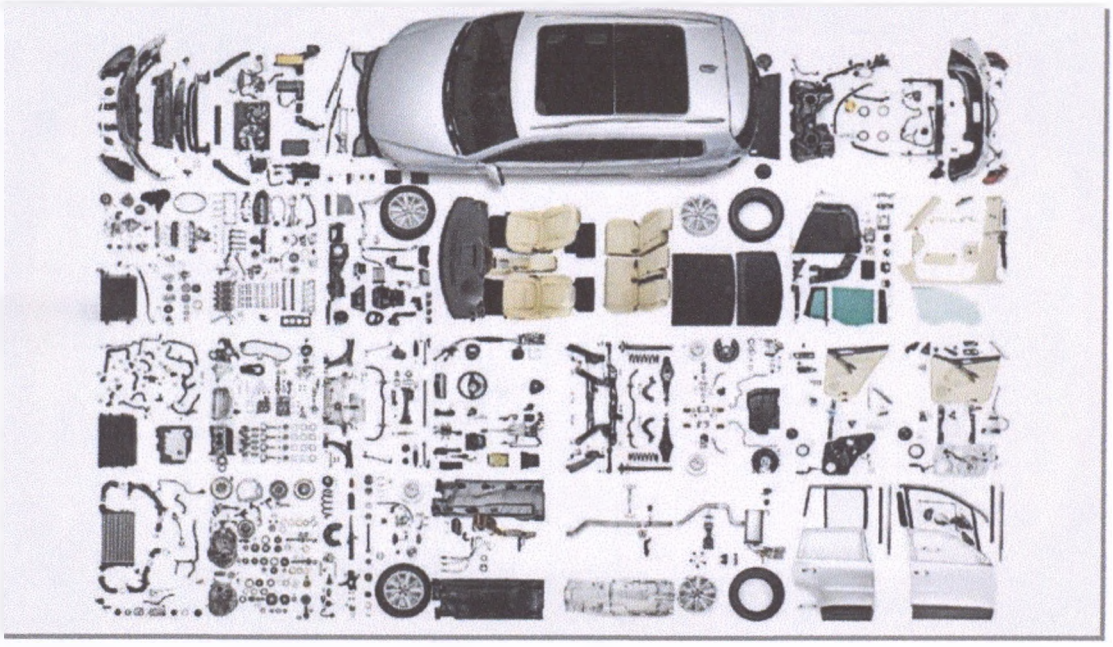

FIGURE 4.29: AN ILLUSTRATION OF THE PARTS THAT GO INTO THE MAKING OF A CAR, SOURCE: VW, 2013

In light of the complexity associated with global supply chains, VW and Toyota encourage localisation in production and this is viewed as a central element of corporate social responsibility. Through localisation, a company ensures that value creation is at the individual production plants within immediate business environment. Suppliers relocate to

production areas thus enabling creation of jobs. Localisation benefits both the people and VW in that the local people get a chance to participate in the economy whilst VW benefits economically from reduced logistical costs, prices that are aligned to local market conditions (cars made are cheaper), currency risks are reduced and VW does not incur additional transportation costs or customs duty. This is summarized in the excerpt below:

> *Localisation therefore represents a win-win situation, with economic, ecological and social advantages for both Volkswagen and the regions in which the Company's plants are located* (VW 2014).

## 4.9 Conclusion

The results presented in this chapter show the various ways in which vehicle manufacturers have tried to make adjustments in production to align with sustainability demands in the search for profit. Increased environmental awareness has shifted demand on the type of materials that go into production as well as the reporting process required from manufacturers. The advent of environmental management systems has contributed to a greater emphasis placed on stages of production where green practices can be adopted in terms of energy and water use as well as designing, recycling and disposal of vehicles. Regulations on a global and national scale have also influenced the entire value chain and the overall adoption of green practices. The data presented in this chapter was then used to inform chapter five that analyses and discusses the findings in the context of the research.

# CHAPTER FIVE

# ANALYSIS AND DISCUSSION

## 5.0 Introduction

Drawing from the empirical findings presented in the previous chapter, this chapter discusses the relevance and the meanings of the findings in relation to and in the context of this research. The empirical evidence has to some extent revealed how vehicle manufacturers engage with environmental sustainability in their operations in search of profits. The discussion addresses the research aims and objectives set out in chapter one and is informed by literature. The aims and objectives of the study were geared towards understanding the ways in which the motor vehicle manufacturing industry has aligned with the requirements of sustainability demands as there is a movement towards greener production. This alignment also covers the entire value chain as vehicle suppliers interact with a vast array of suppliers on different levels from designing, raw material sourcing right up to the disposal of the used vehicles. As corporations seek to profit, the study also took into account the way the environment is positioned by vehicle manufacturers vis-à-vis the profit mandate.

## 5.1 Initial Response from Contact with Manufacturers

The first section in this chapter analyses the initial responses from vehicle manufacturers. The responses that were given raised questions pertaining to the adoption of sustainability initiatives amongst the vehicle producers, as they were unwilling to engage the researcher on sustainability issues. The same vehicle manufacturers use sustainability in their corporate sustainability communication where they make consumers aware of their commitment to environmental protection initiatives. An example of such types of communication comes from VW's 'Think Blue Initiative' (Fricke and Schrader, 2011) that talks about caring for the environment to the public. The company goes on to sell the fact it preserves and cares for the environment in production and Tower and Rusmin (2012) allude to the fact that sustainability communication is used to legitimise the corporate's activity to the public thereby aiding brand visibility. The fact that sustainability information becomes 'sensitive/confidential' information upon request by the public casts doubt upon the company's approach and commitment levels to environmental protection initiatives. The strict confidentiality

procedure adopted by VW brings into question the companies' sustainability practices. VW SA refrained from responding to any questions pertaining to environmental sustainability by making it very clear that the company does not divulge information relating to sustainability practices to the public through a curt response.

There is a hesitancy that is portrayed when dealing with the public and reporting at all levels is centrally controlled and coordinated. Newig *et al.* (2013) define 'communication of sustainability' as a managerial function that is uni-directional and targeted at providing information to a broad audience specifically to give sustainability related information. This type of communication is to satisfy demands for sustainable behaviour from stakeholders and in some instances to defend or legitimise corporate activity (Newig *et al.*, 2013). This is the type of communication corporates engaged in by refusing to entertain dialogue in line with sustainability. BMW highlighted that it gives general information by stating 'Unfortunately, we cannot provide you with the detailed material that you requested, General information on our company and its products is available at www.bmwgroup.com, meaning there is a level of control that is administered on the information released.

The amount of information released is to aid in achieving specific goals such as gaining the attention of decision makers or customers (Newig et al., 2013; Tower and Rusmin, 2012). The information available on websites is greatly rehearsed and lacks some of the voices and perceptions of the people working on the ground as it is also used for public relations, marketing/advertising and communication purposes. A company policy that refuses to indulge public queries despite having open platforms for dialogue accessible on the websites becomes worrisome. This to some extent casts some doubt on the information provided as this shows that companies have the potential to withhold undesirable information to the public or to extensively control the information released to the public to maintain their reputation or to gain user confidence (Tower and Rusmin, 2012). Sustainability information is classified as 'sensitive/confidential' and 'Any communication of such information to the general public would go against this policy', yet vehicle manufacturers use the term 'sustainable' to sell their products to the same public they withhold detailed information from.

## 5.2 Sustainability Defined by Vehicle Manufacturers

The sustainability debate is fraught with inconsistencies in that sustainability is interpreted differently depending on the user, a phenomenon Stave (2010:2763) refers to as the 'complexities of sustainability'. This phenomenon is equally reflected in the way in which vehicle manufacturers define sustainability and the different premises they adopt to define sustainability. Giddings, Hopwood and O'Brien (2002) have drawn attention to the contestations surrounding sustainability and these arise due to the user based interpretations attached to the concept as seen in the various vehicle manufacturers' interpretations of the same concept to suit their needs. Sustainability in one instance is viewed through the three-pronged focus that entails economic, environmental and social lenses that are linked to long-term economic success or viability. Giddings *et al.*, (2002) supported by Hahn *et al.*, 2010 argue that integrating economic, social and environmental aspects has been a classic problem in that it raises contestations and has been a subject of heated debate over many years as these fields can never operate in harmony.

Bryson and Lombardy (2009) caution against assuming the economic, societal and environmental aspects can exist in harmony as conflict will arise. As trade-offs and conflicts arise in vehicle manufacturing, the economic imperative dominates as business is set up to make money (Hahn *et al.*, 2010). Figure 4.1 illustrates the ideals in business by showing that the central aim in this company is value creation and every other aspect namely people, raw materials or energy use to cite a few are the means with which value creation is attained. The argument adopted is that sustainable resource use increases the value of the company through cost reductions (savings), increased productivity, and an enhanced company image or reputation a view that is supported by Carroll and Shabana (2010). The value that is ultimately created is then what can be adopted to practice environmental sustainability.

BMW classifies sustainable operations as an investment into the future and as a value driver through cost savings and revenue generation thereby validating the argument on the business case for sustainability. In as much as the environmental and societal aspects are considered the ultimate goal is a lasting contribution to the economic success of the company. According the Figge and Hahn (2012), the driving force behind corporations supporting the environment and society is enhancing financial outcomes termed 'the business case for sustainability'. Sustainable operations are therefore viewed as a way to leverage new business opportunities and overcome risks posed by climate change and resource scarcity. In areas where reduction

of energy, waste and volatile organic compounds are attained this is translated more as cost savings (€100 million), than environmental protection with the cost savings resulting in profits of over €7,8 billion for the entire group in 2012.

Sustainability activities are examined on the basis of their profitability and this is what is deemed attractive to investors. BMW's Strategy Number One in Figure 4.2 shows that the company strives to achieve growth, profit, shape the future and to access new customers and technologies using sustainability as the basis. The main idea behind this vision is to contribute towards the competitive advantage of the company. Moreira *et al.* (2010) bring out the controversy surrounding the adoption of sustainability by business as a means with which to gain competitive advantage and ultimately profit without concern for the environment. Success in the group is measured by taking into account social and environmental responsibility as this builds a good corporate image. The overarching goal therefore points to the image of the company and the benefits that this yields and not necessarily a deep rooted concern for the environment (Sheikh and Beise-Zee, 2011). A tool that is used to measure sustainability levels of investments (the Dow Jones World Composite Sustainability Index), was developed along economic lines to show the benefits of adopting sustainable practices to investors over using unsuitable material in production as this results in losses. A number of sustainability initiatives are rooted firmly in the economic arm of sustainability even in areas that are not necessarily measuring economic aspects. This limits the extent to which environmental sustainability can be addressed by viewing it through the economic lenses as some environmental aspects can never be fully quantifiable in the economic sense.

On the varying interpretations of sustainability, VW believes growth is interlinked with responsibility, environmental protection and social protection to a point where all three aspects become value drivers. Sustainability is interpreted as taking responsibility particularly given vehicle manufacturing is global and profits from global growth. Sustainable development thus entails taking equal account of the economic, social and environmental interests in a balanced way. This is illustrating sustainability as three interconnected rings whereby the three can be brought together in a balanced way without conflict and it ascribes to the ideologies informing weak sustainability (Giddings *et al.*, 2002; Carter and Moir, 2012).

VW still however believes in ensuring stability and ultimately profitability as this ensures a basis for sustainable growth and future investment. The group addresses all these areas under

corporate social responsibility (CSR) and believes CSR is its contribution to sustainable development. A number of authors view CSR as a loose way to explain sustainability that has the effect of trivialising, misrepresenting and overshadowing the real importance of the environment (Sheikh and Beise-Zee, 2011, Carroll and Shabana, 2010; Gray, 2010). The ideal in this approach to contributing towards sustainable development is ensuring economical, societal and environmental goals are pursued in the same measure and this contributes to the company's long-term viability. The three core areas VW considers in its sustainability management include the political level-as it influences corporate reporting, customers as they demand compliance to sustainability and financial markets as investors base their recommendations on CSR and sustainability profiles. VW seeks to combine the traditional approaches that valued entrepreneurial activity and the more modern model of responsibility and sustainability. Traditional approaches however, argue that business should use resources to maximise on returns and this is already in conflict with what sustainability principle advocate for (Figge and Hahn, 2012). The ultimate goal clearly is to ensure that business profits from growth and long-term survival of business and its activities. Sheikh and Beise-Zee (2011) draw attention to the fact that corporates conformed to increased pressure by adopting CSR as a way to derive maximum benefits from the society and environment under the guise of responsibility.

As shown in Figures 4.3 and 4.4 corporate donations and sponsorship in the typical area of CSR are limited in terms of the environment. The environment normally receives very little in CSR budgets as shown particularly in Figure 4.3 where the allocation is 8% in comparison with 34% for art and culture and community or charity. CSR typically assists in increasing the visibility of the corporation whilst at the same time increasing financial success by reducing political and social costs (Carroll and Shabana, 2010). In Figure 4.4 Toyota's environmental projects tend to be more concentrated in the originating country as opposed to all the other production sites with relatively very low figures in Africa. BMW runs the SEED project in South African schools and it highlights that the focus of this is to train children on environmental sustainability. Environmental projects are done under this project and in addition children are taught to plant vegetable gardens. The focus of the project seems misplaced in that as a manufacturing company they would do better highlighting effects of manufacturing on the environment and encouraging children to come up with potential solutions. VW acknowledges that in as much as it is concerned with the people, economy and the environment, implementing sustainable practices at all levels, in all stages of the value

chain and across numerous supplier networks is a very challenging and ambitious goal. In spite of the contentions, Figure 4.5 highlights how the groups strives to attain this to become the 'most successful, fascinating and sustainable automaker in the world.

Toyota and VW have a similarity in that they both use CSR as their basis to make contributions towards sustainable development. Toyota uses CSR to guide manufacturing and to deal with environmental changes and increased societal interest. The group explains this contribution as 'harmonious and sustainable development of society and earth through all business activities carried out' (Toyota, 2014). The goal is to comply with all laws and regulations as well as interact well with stakeholders through open and fair communications. All business partners are expected to operate in a similar manner. This points out to image-building efforts that directly influence public perceptions thereby making vehicles produced more acceptable.

Figure 4.8 shows Toyota seeks to grow through making cars that exceed customer expectations and in a way that enriches community lives. As customers are satisfied this leads to a stable business base and the company grows thereby contributing to sustainable development. Vehicle manufacturing contributes extensively to environmental ills and Toyota's goal is to seek harmony with people, society, global environment and sustainable development through manufacturing. Figure 4.9 gives a view of some of the basic policies and action guidelines that have been set to ensure environmental sustainability is taken into account in manufacturing. An example is the contribution towards a prosperous 21$^{st}$ century that has growth in harmony with the environment with zero emissions in all business activities. The actions to achieve this are premised on a concern for the environment demonstrated through zero emissions in all stages of production, use and disposal, products with top level environmental performance and attaining zero waste generation to cite a few. This goes directly against what manufacturing entails and is almost contradictory as manufacturing is known to consume massive amounts of natural resources and emit harmful gases and substances into the environment (Kehbila, 2013).

VW's sustainability goals although expressed differently to BMW's are very similar in that the reductions aimed for are geared towards cost cutting. Ersty and Winston (2009) allude to the fact that the driving force behind reductions undertaken by manufactures are geared towards cost cutting thus reinforcing that VW and BMW's initiatives are geared towards cost and not the environment. VW expresses this by highlighting that the 'Think Blue initiative

aims to reduce environmental impact for vehicle and component produced by 25% by 2018 using 2010 as the base year with a potential resource saving of €114, 3 million'. Sustainable ultimately means a form of long term economic activity. Despite acknowledging that sustainable practices implementation is 'challenging and ambitious' VW scored highly in environmental management in 2011 based on the Dow Jones Index. This to some extent poses questions pertaining to how these achievements are attained or awarded. These sustainability indexes also play a central role in company image building thereby casting doubt on their objectivity.

Daimler defines sustainability as responsible behaviour that results in long term business success but is conducted in harmony with the society and environment. All employees and business partners are expected to operate in a sustainable manner in all aspects such as sustainability management, products, environmental protection, human resources and social responsibility. The goals in doing all of this are to achieve profitable growth and increase the company's value albeit in a sustainable manner, an approach that Wanner (2015) and Brand (2012) describe as a guise to support capitalistic accumulation in a strategic manner. The driving force behind sustainability is to ensure the company safeguards its position in established markets and gains entry into new ones and strengthens its position. This is shown in Figure 4.6 that positions profitable growth as the pinnacle of the pyramid supported by passion, integrity, respect and discipline as the base with employees, sustainability, superior products, brands, innovation and technology leadership and a global presence and network in the middle interacting with the base and the pinnacle.

Adopting sustainability is an attempt to control economic, environmental and social consequences and to minimise negative effects these pose. Daimler however points out that the issues that they deem crucial are the ones that inform their sustainability approach and are thus incorporated into their business strategy. Bebbington and Larinaga (2014) and Morelli (2011) attest that sustainability has a broad definition that can be easily manipulated to suit context and underplay the importance of environmental sustainability. There appears to be an ambivalent tone to the practicality of adopting sustainability as Daimler describes its goals as 'ambitious' and goes further to explain that the 'program is worded in a much more binding manner than was the case in the past'. This appears as if there is a certain level of uncertainty in terms of whether sustainability is attainable within vehicle manufacturing. Daimler has grouped competitiveness and making profits as part of social responsibility with environmental protection and compliance regarded as closely related to attaining profit and

levels of competitiveness. The sustainability concept has also been used extensively in marketing/ advertising products such as the Mercedes C-Class, a dimension Cock (2012) describes as manipulative advertising. The ultimate impact that is targeted is value creation or economic performance using the environment to attain economic goals.

The value created in business is what Daimler uses to cater for the environment and bringing harmony to economical, ecological and social goals ensures long-term success. Drawing from figure 4.7 Daimler draws on international principles such as OCED guidelines for multinational companies, UN Global Compact and UN Global Compact LED Group to cite a few as its binding frame of reference. The most important principles and guidelines of Daimler are centred around the Group Integrity Code, Environmental and Energy Guidelines, Supplier Sustainability Standards and Principles of Social Responsibility.

## 5.3 Raw Material Composition in Cars by Model and Make

Vehicle manufacturers strive to produce in ways that conserve resources and avoid waste but generally admit that zero emissions production and total conservation remain a long-term dream. Vast selections of raw materials that are used to make components essential in vehicle manufacturing are drawn from a large number of industries (Kehbila, 2013). An overview of Tables 4.1-4.4, figures 4.10- 4.15 shows that steel, iron and other metal materials in combination make up the bulk percentage of the cars represented. In vehicle production over half the weight of the car is made up of various metals but steel is mainly used to make the chassis, the body of the vehicle, wheels, door beams, roofs and body panels to cite a few. This material is also deemed cheap, strong, easy to work with and readily available. Steel is made from iron ore and is directly linked to mining as the ore is mined. This shows that the raw materials that make up over half of the weight of the car are directly linked to mining. Mining activities cause various environmental ills and since vehicle production derives components from mining activities, vehicle manufacturers' needs contribute directly to the resultant environmental damage. As steel is extracted from mining related activities that cause significant environmental damage the predicament then lies in tying vehicle manufacturing to sustainability in working towards greening the economy.

Steel used is tied to customer satisfaction and this explains why it has been used extensively. A number of initiatives undertaken in the area of sustainability by vehicle manufacturers are tied directly to customer satisfaction, marketing and advertising points and this is tied directly

to overall profit. The use of steel as one respondent highlighted is a major selling point as it reiterates the levels of safety afforded by the cars. BMW SA uses a total of 412 metal sheets in making the BMW 3 Series 4 door Sedan body shell. This use of metal is one of BMW's selling and marketing basis, and it rides on the fact that reinforced metal in the body of the car contributes to the high safety levels afforded by the car. The metal sheets are a combination of steel and aluminium that are traced back to mining thereby casting doubt on the sustainability aspects of the company. In terms of raw materials use, VW highlighted that material use has to be responsible as well as economical in explaining the sheet metal coils reduction that resulted in reduced steel consumption. Remanufactured parts have also contributed to a reduction in materials used and this is tied to the costs that will be passed on to the customers. The minimal levels these costs are kept at also translate to the returns vehicle manufacturers can draw from the vehicle sales.

Another raw material that is now finding application in vehicle manufacturing is aluminium and it is derived from bauxite. Bauxite is the ore most commonly mined to get aluminium in which aluminium occurs as hydroxide minerals. Aluminium is a lightweight material that conducts electricity well and is resistant to corrosion amongst other properties (Toyota, 2014). Aluminium used in combination with other metals provides lightness and strength but this metal is also traced back to mining. An innovation that is discovered at times presents different challenges in another area. An example that is given to illustrate this dilemma within the vehicle manufacturing industry is the use of aluminium that reduces vehicle weight, improves vehicle efficiency and reduces $CO_2$ during the use phase. Manufacturing aluminium on the other hand requires five times the amount of energy used in steel manufacturing and produces voluminous amounts of carbon dioxide that pollute the environment.

Parts such as dashboards, door handles, floor mats, seat belts and airbags are made from different types of plastics. This extends to the parts inside engines such as oil dipsticks and the rationale behind using plastics is because they are lightweight. Plastic is made from petroleum and hundreds of litres of oil are used to make plastic parts. Production of plastic is highly energy intensive and causes pollution. Steel and aluminium production also are energy intensive and cause pollution. Plastic is not 100% recyclable and some plastics are hard to separate thereby making them unavailable for reuse. Discussions held with research participants revealed plastic as one of the major components used in VW and Toyota production processes. Plastic is linked to the exploitation of resources such as coal, gas and

oil. Toyota and VW make extensive use of plastic but Toyota highlights that up to 20% of plastics used in its cars is derived from plant materials and is recycled plastic.

Another material that is used extensively in vehicle production which is durable, cheap and flexible and has a wide number of uses in the vehicles is rubber. It is used to make parts like tyres, wiper blades, engine mounts, hoses and belts. The rubber used in tyre manufacturing is derived from both natural and synthetic processes (Mekkriengkrai *et al.*, 2006). The natural rubber is found in the bark of the rubber tree, Hevea Brasiliensis whilst synthetic rubber is produced from polymers found in crude oil (Mekkriengkrai *et al.*, 2006). Burning crude oil or natural gas with a limited amount of oxygen produces carbon black which is a soft fine black powder used in tyres together with sulphur and other chemicals (Mekkriengkrai *et al.*, 2006). Oil extraction globally is associated with oil leaks that destroy habitats and ecosystems through extensive pollution on various levels. Rubber producing countries are renowned for exploiting workers and the natural environment.

Glass is also used in many areas of the car but can be traced back to mining activities. The use of glass in cars is mostly for windshields, rear and side-view mirrors. Closely related to glass is fibreglass which is used as an insulation material on cars. Glass is made up of a number of oxides that fuse together and react when heated to form glass and these are silica (sand), sodium oxide (soda ash) and calcium oxide (limestone), components that are derived from mining (Tite *et al.*, 2006). Several other oxides are used in glass production such as potassium, magnesium and aluminium.

Leather is described as epitomising luxury for customers and it is a desirable option for luxury cars such as the BMW and Mercedes. It is prepared from animal hides and in this instance it is usually from cows as it does not tear or stain easily. The use of leather makes the cars more expensive as it takes longer to stitch and trim but customers in this market segment tend to be more concerned about the quality than the price. Manufacturers have tried to move towards using artificial leather for financial reasons but are still forced to produce to customer expectations as natural leather has more appeal.

Using plastic to increase fuel efficiency poses the same dilemma aluminium use poses in that not all the plastic used is recyclable. As plastic is not biodegradable it causes a number of environmental problems for example if it finds its way into the aquatic environment or just dumped on land. Plastic makes the vehicles lighter but drawing from the BMW example, of the 14% used in the car only 7% of the plastic is recyclable and this again is described in

terms of the contribution it will make in offsetting the ever increasing prices of raw materials. Recycled and renewable materials are adopted to cater for the environment to some extent, but largely because they make economic sense. Vehicle manufacturers tend to gravitate towards solutions that make economic sense over the ones that are solely for the benefit of the environment.

Natural materials have been adopted in vehicle manufacturing but the proportion in relation to the various other materials is still small. According to tables 4.1-4.4 natural materials contribute largely between 1-5% of the total vehicle. The main drive behind raw materials use is mainly the level to which they contribute to the cost effectiveness of the finished product. Rare earth elements are increasingly finding more and more use in vehicle production as they are vital to technological advancements, car electronics and clean energy to mention a few. These elements possess magnetic and electrochemical properties that assist technologies to perform with reduced weight, emissions, energy consumption ultimately increasing efficiency and performance. The challenge lies in that a number of the rare earth elements are not recycled even though they fall under very scarce resources. The automotive industry consumes considerably large amounts of raw materials spanning from industries such as agriculture, mining, energy, crude oil making it difficult to clearly say the industry can function efficiently as a green industry. The materials drawn from the various industries are explained as 'not affecting environmental performance directly' as cited in sustainability reports but are nevertheless an intricate part of the finished vehicles that can be traced back to unsustainable production practices.

The plastic, steel, glass and aluminium are examples of some of the materials used in vehicle production that can be traced back to mining activities. Mining activities cause significant environmental damage in both the extraction processes and disposal of waste generated therein. Given this background to some of the materials used in production, it becomes problematic to state that sustainability can be realised outright in vehicle production given the extent to which vehicle manufacturers derive their materials from industries that are not necessarily environmentally sustainable due to the nature of their activities.

## 5.4 Vehicle Manufacturers and Their Alignment with EMS such as the ISOs

All the vehicle manufacturers in the study have ensured that their plants are ISO certified and they ensure application of the environmental management systems. Khanna *et al.* (2009) highlight that EMS have taken root in most manufacturing companies as they show the cost reduction benefits associated with adoption. Examples of the ISOs adopted include and are not limited to ISO 140001, 9001, 14040, 14044, 50001 and 14062. Given the global nature of vehicle manufacturers, European/Asian standards are also incorporated into the running of the companies. ISO 9001 is for quality assurance as vehicle manufacturers are very particular about the quality of their finished product. Focus in production is on customers and customer satisfaction such that the lines between environmental sustainability and quality control/management become blurred. In trying to ascertain whether BMW takes any measures to protect the environment or to minimise damage to the environment during production, the response referred instead to the fact that all raw material go through rigorous quality checks. This quality management mind set filters through to the protective gear handed out at the beginning of every tour. The impression is that the visitor is to be protected from possible harm within the plant, which is of course true to some extent. Further explanation however was given and the reason behind protective gear was to prevent possible scratches on cars. The ultimate goal is to ensure that the finished product meets the quality standards, will not be returned or found defective in any way thus contributing to a successful sale and ultimately profit.

The life cycle assessment systems draw from ISO 14040/14044. Environmental management systems are at times viewed as demanding and detailed in line with a respondent who pointed out perceptions on the levels of the detail contained therein. EMS have to some level contributed to a form of standardization of operations as shown by a respondent who explained that local manufacturers draw from international standards given that production has to be of global standards as cars manufactured are mostly for the export market. ISOs are used to identify solutions that are relevant for global warming mitigation or ozone depletion. VW has established environmental impact categories and uses the results derived from life cycle assessments to come up with processes that are most beneficial to the environment over the entire vehicle's life cycle. In compliance to this, environmental commendations are published to inform customers and the public on the progress represented by each new model over the preceding vehicle. In using resources efficiently the goal is partly to preserve the

environment but also to ensure safety and comfort is not compromised and this is communicated extensively to the customers. Aspects of the environment that are widely focused on across all manufacturers are optimum use of water and energy and reduction of emissions. ISO 14001 is used to manage water and energy.

Life cycle engineering is used to integrate important aspects into the design and development of vehicles. Vehicle manufacturers describe the targets set using the ISO 14040/14044, as 'ambitious' communicating that there is a certain a lack of conviction that they can attain sustainability in manufacturing. Adoption of environmental management systems is described as beneficial to vehicle manufacturers in a number of ways such as reducing costs and increasing earnings. The energy and water consumption as well as waste and VOC emissions reduction translate directly into measurable cost savings. Manufacturers also affirm that increasing resources efficiency and keeping waste minimal and streamlining environmental management processes results in lower investments in current and future environmental protection initiatives. In environmental management, VW expects each plant to organize its own systems in line with international standards and this has the potential to be abused particularly in plants located in countries that have weak regulatory structures. Uniform application of systems is also cited as a complex task as local conditions and differences unique to each production location are vast and varied despite standardized internationally acceptable processes of operation.

Employees, auditors and suppliers are trained constantly on the practical applications of environmental protection. Such trainings raise awareness but they also demonstrate the level of control vehicle manufacturers have in that they train auditors who will ultimately audit their environmental operations. The aspect of auditor, supplier, and supplier auditor training shows the power the manufacturers yield in that there is a high level of interference in the environmental management as well as environmental assessments by vehicle manufacturers (Shiva, 1993). Suppliers are required to subscribe to the same environmental management systems as dictated by vehicle manufacturers and this is good to some extent, but ultimately shows the power dynamics in the manufacturer-supplier relationships. Adoption of EMS by motor vehicle manufacturers largely reflects compliance to set regulations, company image preservation to retain customer base and attract new ones, cost reduction strategies, increased earnings opportunities and an inherent desire to maintain power and control over environmental processes in the entire vehicle life cycle.

## 5.5 Environmental Awareness, Emergence of the Green Economy and Impact on the Vehicle Manufacturers

Customer mobility requirements change over time and a number of considerations influence these changes. Increased environmental awareness is one such consideration that has a bearing on customer demands the world over. Vehicle manufacturers view the changes brought about by increased environmental awareness and the emergence of the green economy as areas on which to leverage competitive advantage (Moreira *et al.*, 2010). Challenges considered as potential business innovation areas include climate change and its consequences, depletion of resources and air pollution to cite a few. VW highlights that it analyses these developments and strategizes to position itself for long term success and profitability. The profit mandate permeates all initiatives and motivations for success within vehicle manufacturers' approaches to environmental considerations (Wanner, 2015; Jackson and Victor, 2011).

Rapid growth of emerging economies with the resultant population growth and urbanisation, in spite of all the associated environmental challenges it raises is viewed as a platform for sales and increased profitability, particularly with vehicle manufacturers as they are customer oriented. The green economy is viewed as a platform to create more jobs, use resources efficiently and adopt renewable energy to ensure commercial success (Death, 2014). BMW is of a similar view in that its sustainability leadership goals are characterised by provision of new products and services and provide innovative products that benefit society as well as customers. Another survival strategy adopted in vehicle manufacturing includes forming strategic alliances with policy makers, businesses and decision makers in society to access impact beyond direct areas of influence. The power dynamics are evident in this particularly as these forms of alliances will result in vehicle manufacturers influencing and interfering in policy structures and formulations as well as any aspects of the green economy that can potentially affect manufacturing. The undeniable motive in these strategies is survival in a changing operational environment brought about by increased awareness where business sets the dominant discourse (Ahi and Searcy, 2013).

In order to curb potential environmental risks BMW has developed reporting processes in which departments are tasked with identifying potential risks and addressing them. Examples given of the risks include potential impacts on raw material availability, threats on production, procurement and the regulatory environment, reputation of the company and

potential violations on environmental regulations. This is necessary in that global operations are expansive and challenges arise in trying to manage specific local environmental, social and economic impacts of business whilst trying to maintain uniformity and standardisation. Vehicle manufacturers are cognisant of the carbon dioxide emissions and extensive resource consumption but constantly monitor risks (environmental risks included) that have a bearing on the financial results of the company. VW gives an example of regulatory measures such as $CO_2$ emissions targets that have a direct impact on production and highlights that innovations such as hybrid or electrical technologies widen sales opportunities in light of public awareness of the depletion of natural resources and desire to protect the environment. Innovations are generally adopted in light of their financial earning capacity and potential to boost the manufacturers' reputation as an environmentally conscious entity (Carroll and Shabana, 2010).

Sustainability reporting is addressed in line with demands for increased transparency and the potential it holds to satisfy customers as this is tied directly to growth. VW stipulates that customer satisfaction is of 'paramount importance' and further explains that corporate growth is essential and is attained through competitiveness of the entity that can be achieved through offering superior solutions. Figure 4.18 gives a view of the disclosure that occurs in environmental reporting. A brief overview of the figures given show the differences in recycled quantities and renewable energy use against volumes of new raw materials included as well as non-renewable resource use. In the 2011 reporting period from only 10 plants the total volume of material inputs was 889,000 tonnes and materials reused amounted to 221,000 tonnes meaning brand new materials introduced amounted to 668,000 tonnes thus showing the resource intensity of the vehicle manufacturing industry. Of the total $22{,}9*10^6$ GJ of energy consumed renewable energy used amounted to only 8,630GJ. The volumes of $CO_2$ emissions and waste discarded are also in excess of hundreds of thousands of tonnes. In as much as manufacturers report that they take environmental sustainability into account the consumption of electricity generated from non-renewable resources, the use of new raw materials and the resultant waste generated remains generally very high.

The general focus in vehicle manufacturing that can partly be tied to adoption of EMS and carbon dioxide targets is on energy, water consumption, carbon dioxide emissions and life cycle assessments. Most vehicle manufacturers have developed centres dealing with water, waste, energy, emissions, training and environmental management systems. BMW for example cites resource efficiency and life cycle management as pillars of its sustainability

agenda. Scarcity of resources is viewed as a risk to political and economic stability and efficient resource use therefore anchors competitive advantage as it reduces dependence on external suppliers ensuring that price fluctuations and supply bottlenecks are removed. Even though vehicle manufacturers mention that all these initiatives will have a greater impact in environmental protection the underlying driver is always mentioned along the importance and benefit to the bottom line. VW clearly alludes to the fact that efficient use of resources 'not only reduces environmental impacts but also manufacturing costs'. BMW concedes that introducing renewable materials such as leather or cotton, purifying paint vapour as well as using water soluble paints is to protect company reputation, conform as a good corporate citizen with the benefit that society accepts and purchases the group's products. In a similar view VW acknowledges that the electrostatic atomising technology used in the Uitenhage paint shop to apply the second paint coat doubles material efficiency from 35% to 70% and that material efficiency is tied to cost savings and annual savings.

Vehicle manufacturers have tried to reduce water consumption during production as the production process has been identified as consuming the most water in the entire life cylce. 58% of freshwater is consumed during production and this translates to 24 million cubic metres in areas such as South Africa and other locations where groundwater resources are at risk. Wastewater and general water usage are elements in production that are expensive and BMW helped to fight water leakages in drinking pipes as part of their environmental care programmes in South Africa. Toyota in South Africa has adopted rainwater collection strategies as well as recycling water to cater for shortages. Toyota has also encouraged dealers to collect and use rain water as shown in Figure 4.17 and this was amidst a review of laws and regulations on water use within the country. As laws and regulations become more stringent vehicle manufacturers adjust their operations. They are aware that customer behaviour is directly altered by increased regulations, fuel prices and increased awareness. This goes to show that many other factors apart from environmental considerations influence compliance in vehicle manufacturing as non-compliance will eventually affect sales. In this case stricter environmental regulations induce compliance as well as influence customer behaviour.

Toyota has come up with what it terms eco-driving and this is captured in Figure 4.18, to encourage drivers to drive with the environment in mind. Such an initiative to teach drivers on greener ways of using cars is not only adopted by Toyota but BMW, Daimler and VW have variations of this in an attempt to limit environmental effects in the use phase and this

has a bearing on the amount of fuel consumed. Daimler conducts trainings on what it terms economical and anticipatory driving and this teaches ways of driving that reduce fuel consumption by up to 10%. In addition the group makes vehicles with combustion engines that lower consumption and emissions. In spite of all these innovations total elimination of emissions and fuel consumption has not yet been attained meaning the use phase of the car still has considerable effects on the environment. Fuel used in the cars is derived from petroleum and petroleum extraction is marred in a myriad of environmental ills. Daimler outlines that cutting particulate emissions and fuel consumption further will be difficult in future. Efforts that go into ensuring environmentally sustainable vehicle use tend to be countered in most instances by the sources of raw materials that are not always as sustainable yet cannot be ignored as they play crucial roles in the vehicle life cycle.

Raw materials are viewed from an ecological as well as economical/commercial perspective. VW for example processes millions of tonnes of steel, plastic, rubber every year to cite a few and a consistent supply of these is crucial. Throughout raw material sourcing, eco-friendly products are monitored to ensure they do not compromise technology, comfort and safety. This means that eco-friendly products that do not satisfy the set criteria regardless of their potential good on the environment are not used. Great strides have been made in environmental monitoring to anticipate areas that affect raw material supplies, to utilise alternative resources in place of the more scarce materials, recycling and using legally accepted materials. A commendable achievement has been the reduction of vehicle interior emissions due to the changes in the materials used for interiors. Suppliers are also urged to adopt environmentally friendly initiatives in production.

Reusing raw materials is done through recycling but a number of the recycling centres highlighted in the sustainability reports tend to be in European countries and this might be a function of stricter environmental legislation or customers that hold companies to account. In terms of recycling on the African continent no centres are acknowledged and this raises concern specifically on the reasons behind such variations given companies are global. Vehicle manufacturers ensure environmental management to some degree by training suppliers, employees, managers and auditors on sustainability. All these efforts are an attempt to keep abreast of rises in costs in the future so a combination of training, energy and water saving, waste reduction eventually translates into cost savings and value addition. BMW in 2010 had cost savings of approximately Euro 0.7 million across the group meaning each plant contributed to the total savings. Table 4.5 shows the percentage decreases between 2009 and

2010 and BMW points out that though these appear minimal they have a great effect when multiplied by the numbers of vehicles produced. The reverse will also hold true that the total energy consumed, carbon dioxide emissions produced and VOC emissions produced per vehicle manufactured will be tremendous when the multiplication is done. If for example 60, 000 vehicles were produced at the Rosslyn plan in 2009 and 2010 the energy consumed would be 173,400MWh and 165,000MWh; these figures are high considering a single family home survives the whole year on half the amount of energy used to produce one car.

Efforts have been put into finding alternative energy sources that are green such as solar. Vehicle makers, however, allude to the fact that green energy sources offer solutions in terms of the independence they afford manufacturers from fluctuating energy prices, carbon trading regulations and regulators' legislation. There seems to always be deeper motives behind any strides to protect the environment that are made within the vehicle manufacturing industries. Green energy is also deemed to increase autonomy, security of supply and profitability as production is not affected by energy bottlenecks. The BMW's Bio2Watt provides electricity powered by methane gas to the plant and has the potential to reduce $CO_2$ emissions by 8,300 tonnes a year. In as much as it provides green energy that is generated at the location where it is needed BMW explains this more in terms of the transmission charges that are saved as well as the extent to which the solution is economical. The reductions in energy costs are thus described as making the company more competitive and profitable (Monden, 2011).

South Africa relies on energy that is coal powered and this shows the magnitude of the negative environmental impacts this generates (Death, 2014; Kehbila, 2009). BMW states that the amount of green energy it produces supplies 3.1GWh translating to 4.5% of the total energy required by the plant to operate. VW draws its green energy from a photovoltaic system, Mercedes in East London uses natural gas and is also preparing to use stationary energy storage units into the production environment and Toyota uses solar energy. Processes in production have also been streamlined to use less energy and this includes switching off idle equipment or lights, mechanisms that detect inactivity and dim lights as well as optimising heating and ventilation systems. Toyota uses the 'No work-No watt' slogan and BMW has 'Save Water' and 'Save Energy' stickers all over the plant to constantly remind employees of the importance of environmental sustainability. Vehicle manufacturers also invest money into researching more ways of using electricity efficiently. VW has been researching into renewable electricity, bio-fuels, bio-methane and synthetic natural gas. The focus ultimately is on the production plant as BMW highlights that their greatest

responsibility lies on the production plant as they have a wider range of options there. Responsibility on the plant is commendable but the nature of the vehicle manufacturing industry is such that it draws from various other industries. Focusing only on the production plant yet each car component has contributed to untold environmental ills along the value chain becomes myopic and irresponsible.

An example is the emphasis vehicle manufacturing companies place on saving energy within the plant such that the focus is no longer on the source of the electricity that is clearly not green but the actual use of the electricity on production sites. These initiatives are relevant but production of the vehicles using coal-powered electricity raises questions as to whether the finished product was made in a sustainable manner (Cock, 2012). From the BMW example 95.5% of the energy used at the Rosslyn plant is coal powered but sustainability reports write extensively on the use of renewable energy. All these attempts at saving energy are eventually quantified and a price tag is attached showing the amounts that were saved as a result of the reduced energy consumption. The benefits to the environment are alluded to but what is celebrated more are the cost savings and showing the customers that vehicle makers behave in a responsible manner. Vehicle manufacturers admit that they are still way ahead on resource consumption but the reports show that they capitalise on communicating the more positive side.

Daimler accedes to the fact that countries lack the political will and master plans to set up the requisite infrastructure for green energy. Such infrastructure according to Daimler is possible if the politicians want to push for it and cover the initial setting up costs. In as much as vehicle manufacturers state that they are committed to reducing emissions and making a significant contribution they shift the blame to the political frameworks in the countries they operate it. This almost appears that none of the manufacturers or stakeholders at various levels are prepared to take full ownership as far as greening production is concerned (Cock, 2012). An environment that is tainted with such inconsistences ultimately becomes unhealthy to charter any solutions and it opens up countless opportunities that manufacturers can take advantage of, particularly if there is no one to hold them accountable. As vehicle manufacturers are concerned about their profits, they argue that green energy is good for the environment but not for business. This strengthens the argument that business will always adopt solutions or raw materials that do not affect financial earnings regardless of their possible advantages on the environment. The example given was that it would require

sizeable numbers of football field sized thermal installations in order to generate enough energy/heat to power the Rossyln plant processes.

In production the goal is not to generate any waste but this is not feasible so manufacturers test by-products to determine whether they can be recycled or reused in any way. The waste that is eventually disposed of is the waste that cannot be used in any way. In 2010 BMW produced 10.09kg of waste for disposal for every vehicle produced and for the total number of vehicles produced in 2010 this amounted to 847,560kg of waste. Vehicle production requires an extensive network of interlinked transportation services to cater for both the raw materials and finished goods. The unique nature of vehicle manufacturers is that this transportation occurs on a global scale as raw materials are sourced from various continents and finished products equally distributed across continents. Measures have been put in place to limit carbon footprints such as using rail over road, sea over air and transporting full loads. Transportation within South Africa is largely done through rail and road and BMW highlighted that transportation is a combination of environmental as well as business factors. VW uses intermodal options and this involves linking at least two modes of transport.

As with most considerations in vehicle manufacturing, competitive prices are sought to enable transportation of materials and finished goods. The transport network also extends to transporting workers to work. BMW emitted 1.25 million tonnes of carbon dioxide in total for the entire group and in 2014 the Rosslyn plant which is the smallest BMW plant produced 45,388, 86 tonnes of $CO_2$. Efforts are made to green transportation and logistics but the sheer size and reach of the vehicle industry means emissions will be high regardless. The emissions are classified as Scope 1, 2 or 3 but the ultimate sum total of all three groups shows the levels of emissions produced in the vehicle production are high. BMW highlights that reducing $CO_2$ emissions along the entire value chain 'makes sense from an environmental as well as an economic sense as this results in avoidance of $CO_2$ charges'.

VW on the other hand highlights that it has adopted an inventory from the WBCSD and WRI that analyses $CO_2$ generated outside of production. The company concedes that the data analyses and interpretation poses a number of challenges potentially as a result of the volumes of data collected. The inventory reveals that the most effective way to cut emissions is through the development of fuel efficient cars. This in a way disregards emissions accumulated along the way and paints the picture that fuel efficient cars address all other environmental ills along the value chain. Information on fuel efficiency is also communicated

through the use of efficiency badges on the cars and these give prominence to the fact that the cars offer efficient technologies and are low carbon emitters. The focus on customers points back to sales and ultimately profit.

VW concedes that some of the targets they set are a result of increased pressure to comply from the various responsible environmental authorities that have largely also influenced public perceptions and knowledge on environmental sustainability aspects. This means some of the targets are unrealistic particularly given the nature of the manufacturing environment that draws raw materials from multiple segments of the environment. Toyota for example has come up with what it terms 'Toyota Environmental Challenge 2050' illustrated in Figure 4.21that aims to manufacture cars in a way the results in no environmental (zero environmental impact) impact whatsoever by 2050. In 2012 for example, VW had to deal with countless protests that were partly originating from over promising. Greenpeace accused VW of selling vehicles with excessive fuel consumption and high $CO_2$ emissions. The resultant effect was that VW was ranked low in vehicle magazines and the sustainability reporting was criticised for failing to deliver on promises. All these problems arise in that some of the statements in the sustainability reports promise customers amazing deliverables and are futuristic. BMW in one of its sustainability reports put a disclaimer highlighting that it is not always liable to deliver on some of the promises. All this goes on to show that sustainability reporting to some extent is a marketing strategy that strives to position vehicle manufacturers favourably in the eyes of the public.

The concept of localisation that has been adopted largely by VW and Toyota to some degree is a concession to the level of damage manufacturing poses on the environment. Localisation entails relocating supplier firms close to production sites and this can potentially raise the economic prosperity of the local population. In as much as this concept is beneficial to the environment, vehicle manufactures describe it in terms of 'the lower logistics costs, procurement price lines that are based on the local market, elimination of import duties and immunity from volatile exchange rates, custom made cars fit for customers in locality' thus bringing out the profit mandate that influences decisions within vehicle manufacturing.

## 5.6 Navigation of the Regulatory Environment on a Global and National Level

BMW is cognisant of the fact that observing all the laws and regulations is the basis for any sustainable operation. Sustainability reporting is one such condition that has been placed on vehicle manufacturers to show that they indeed adhere to global regional or national regulations governing environmental preservation. Adherence to set regulations is what is termed compliance and Daimler emphasises that in publishing sustainability reports 'we are meeting our obligation to regularly report on our efforts regarding human rights, labor standards, employee rights, environmental protection, and the fight against corruption'. Rules and regulations therefore govern corporate behaviour to varying levels. VW mentions the complexities that the regulatory environment posits for vehicle manufacturers by stating that 'Climate change, resource availability and urbanization are just some of the major global challenges…these challenges are reflected in growing demands from all sides, be it politicians who enforce ambitious worldwide environmental regulations, investors who expect us to anticipate and manage the risks, or customers with their growing interest in fuel-efficient vehicles'.

Due to the nature of the pressure emanating from various angles Daimler acknowledges that compliance has not always been straightforward in the past. The company was at certain points implicated in unethical practices. Vehicle manufacturers have developed various coping strategies to ensure they comply with set regulations and as this industry is global in nature, a number of regulations governing the groups are global in nature and passed down to various countries. Various models that are made comply with Euro standards such as the BMW 3 series manufactured in South Africa which has the blue performance technology that complies with Euro 6 standards. VW has come up with the TSI and TDI models in response to the EU carbon emissions regulations (95 g $CO_2$/km by 2020). Targets set are not always attained as shown by BMW that highlighted 'The only exception is the South African BMW plant in Rosslyn near Pretoria, which is below the maximum worldwide limit but not yet below the stricter German VOC levels'. Targets sets are also not always similar as approaches to environmental sustainability vary immensely in relation to region in spite of the efforts to standardise sustainability initiatives.

Compliance also means cars are worthy of the export market and they represent the BMW brand and any fault in one carries the potential to tarnish the company image. The challenge

identified by manufacturers is that of identifying effects that occur locally as a result of operations around the world. This necessitates countries to have strong environmental legislation to cater for environmental management. Daimler points out that regulations, their application as well as the political agendas differ extensively across locations in different countries as some countries have underdeveloped legal frameworks. The global regulatory environment despite being ordered is equally imbued with its challenges. Daimler in 2011 pointed out that it would not set concrete targets until regulatory issues were resolved in stating, 'However, we will not be able to set concrete targets for this period until various unresolved regulatory and political issues have been clarified'. To retain a certain level of control most vehicle manufacturers are founders and signatories to the United Nations Environmental Programmes. They participate actively in environmental initiatives such as the UN Conference on Sustainable Development (Rio +20), or UN Conferences on Climate Change in Paris to cite a few. This participation is what has caused the voice of business to emerge strong in dictating what is good for the environment from a business perspective over what makes environmental sense. Daimler for example 'in May 2011 hosted a LEAD group event on Competitive Advantages through Sustainability' showing where business interest lies. Business protects business interests and uses environmental resources to foster the advancement of the profit mandate.

VW makes use of lobbying and it has an, 'External Relations and Government Relations' division that is responsible for facilitating communication with policy makers and other business sectors. The division identifies and gathers information that is used to formulate requisite strategies that are of use to managers responsible for lobbying. Communication occurs also with governments, parliaments, administrative agencies, political parties and non-governmental organisations. The purpose of lobbying is to influence the stated bodies by bringing in vehicle manufacturers' views and expertise thereby playing a part in the legislative and administrative decision-making processes. A further description of lobbying is captured in the following statement that shows the motives go beyond environmental responsibility to boosting company image- 'External Relations' also provides input into sustainable policy-making in the areas of industrial, transport, environmental and social policy and appropriate focusing of public investment strategies. This confident dialogue with stakeholders in society helps to enhance the Company's profile, boost its reputation, forge new alliances, and build on existing goodwill'.

The same approach is used in dealing with conflict minerals that are used in vehicle production such as gold and tungsten. Manufacturers engage political decision makers and influence the decisions by offering joint solutions. This shows the power and control vehicle manufacturers wield over decision-making processes on a global scale. This same level of control and power is used over suppliers to dictate the final position to be adopted in dealing with raw materials of a controversial nature. Daimler mentions that amidst the regulatory environment that exists, vehicle manufacturers face special challenges in developing and emerging markets and the environmental regulation structures found therein. The countries however offer lucrative markets as the demand for vehicle continues to increase in these locations and this guarantees financial earnings.

This profit drive raises considerable concern as South Africa is actively involved in green economy initiatives and has come up with the National Climate Change Response White Paper (NCCRWP). The environmental legislation in the country is undergirded by Section 24 in the Bill of Rights that explains the nationals' rights to the environment. The country however does not have a Green Economy Act in place as yet. The White Paper therefore acts as a platform for giving suggestions and formulating direction. The limitation however, is that whatever is suggested within the White Paper is not enforceable in the absence of an Act. This uncertainty and lack of clarity filters through to the environmental regulatory departments (Death, 2014). The DEA for example, has a Green Economy team in principle, but getting environmentally related input from them proved unfruitful as they lack structures determining whom the team members are. The responses from the members specifically given as contacts and experts in environmental management included statements such as "I am not the best person to deal with this, colleagues please advise".

The responses from environmental authorities at Provincial and Municipal levels were very similar to those mentioned above. Most of the individuals who were referred to as experts in sustainability explained they were either not responsible for environmental sustainability or were not clued up on sustainability aspects. This reinforces the fact that approaches to sustainability and green economy initiatives within South Africa are neither clear co-ordinated nor interlinked (Death, 2014; Cock, 2012). The movement therefore towards green jobs/green growth reflects the hypocritical approach to addressing sustainability and environmental protection initiatives. These observations reinforce the disconnection from policy and implementation as observed in the interactions with the DEA. Respondents confirmed that the DTI and DEA also have a troubled relationship- the economic focus is

given preference over any environmental concerns. The resultant effect is that DEA exists but generally operates without a voice in environmental matters. The end result is the promotion and fostering of profitability at the expense of the ability for future generations to derive comparative gain from the use of undiminished natural resources upon which to base their own development. Ultimately business receives favourable treatment over environmental concerns. In spite of the global regulatory challenges, national regulations, business interference in environmental matters, unattained targets, companies announce they produce sustainably and have sustainability recognitions awarded to them.

## 5.7 Green Practice Adoption in the Value Chain to Ensure Green Production

Vehicle manufacturers allude to the importance of sparing and efficient use of resources over the entire product life cycle and this approach is seen as contributing positively towards sustainable development. This ensures that sustainability extends to suppliers as well as all business partners. Priority areas have been flagged as water, energy, materials use, emissions reductions and waste to cite a few. Vehicles' future environmental impact is decided on during the developmental phase which explains the need to account for the complete life cycle from the developmental phase. BMW for example has a vision of a green energy supply that is $CO_2$ free but concedes that this position is desirable and possible but not economical. The financial imperative always clouds over and supersedes the environmental considerations even in the value chain. Use of coal, oil and gas to supply the energy required is therefore preferred over wind or solar that is good for the environment but does not make economic sense. The adjustments made in the paint shop given as an example by BMW are commendable but the energy used is drawn from fossil fuel powered energy.

Vehicle production will inevitably draw resources from the environment regardless of the way in which the materials are utilised (Kehbila, 2009). Production ordinarily would not be possible in the absence of raw materials. Water is scarce within South Africa, but vehicle manufacturing processes require water. The plants use water taking this fact into consideration and the water is recycled whenever possible but freshwater is always drawn for use in the plants. Another aspect that determines raw materials use in vehicles is customer preferences that result in custom made vehicles. Vehicle manufacturers will seek to satisfy the customer as custom made cars are sold at a premium meaning manufacturers benefit from the financial returns. BMW attributes the fuel consumption in the BMW 3 series to customer

preference as this affords the customers the speed and power the car offers. Daimler also acknowledges that it makes vehicles that are adapted to the special requirements stipulated by its customers. This customer oriented focus is undoubtedly linked to the returns that are yielded as a result.

Figure 4.22 gives a general overview of some of the factors that influence choice of car purchase within the country. Highly ranked was the price of the car, model and make followed by engine capacity and fuel consumption. Interestingly aspects such as direct effect on any aspect of the environment and the materials used in the car were loosely considered. This can partly be as a result of the level of consideration given to environmental issues in the country as a whole and the importance placed on manufacturing and the livelihoods of people. Fuel consumption, although linked to environmental aspects such as emissions, can also be viewed as ranked higher due to the actual cost of the fuel and not necessarily the impact it has on the environment. Vehicle manufacturers highlight that the global south presents a huge market with great potential for sales given the population and increased overall vehicle demand (Death, 2014). The global south can also be viewed as a lucrative market due to the type of market it offers that is more concerned about the price and not necessarily the vehicles' impacts on the environment. Customers influence the types of materials used, dictate what fuels the cars and manufacturers are inclined to listen as customer preferences in spite of environmental stipulations dictate the returns vehicle manufacturers eventually get.

Figures 4.23 and 4.24 show two types of approaches to life cycle assessments adopted by Daimler and BMW to incorporate sustainability from inputs, development, production, utilisation, recycling and the resultant emissions and waste. The idea behind life cycle assessments is to design vehicles that have minimal impacts on the environment (DfE) and that can be recycled at the end of life (design for recycling). The argument lies in that a car's environmental impact is determined in its initial stages of development thereby making it essential to account for the entire life cycle in its development (DfE). Design for recycling on the other hand ensures cars can be recycled or reused at the end of life as 'waste is often a valuable resource'. Reducing primary raw materials and reusing or recycling components is an attempt at reducing negative impacts on the environment. The emphasis on recycling, reusing seems to be placed more in the European contexts as most of the vehicle manufacturers allude to meeting the required recycling rate of 85%. The reports also give in detail the extensive network that exists in the European context, the recycling model set out

by the EU as well as the numbers of recyclers available. No figures are given for the African context and this might be a reflection of the regulatory environment that does not enforce certain environmental aspects.

Even with extensive methods for designing for the environment and recycling, waste is still generated and is disposed in a number of ways such as landfills or incineration. In 2012 for example BMW disposed of an average of 6.11kg of waste per vehicle produced and for the smallest plant to have produced over tonnes of waste shows the levels of waste generation in vehicle manufacturing. VW managed to reduce $CO_2$ emissions by 129kg per vehicle produced, metallic waste by 28 kg per vehicle produced and wastewater 440 litres per vehicle produced. These figures are high and they give a glimpse into the actual amount of waste produced and generated in this particular period under study. Table 4.6 shows the actual figures for the 2010,11 and 2012 period. Non-hazardous waste for disposal was at 11.74kg in 2011 and 10.62kg in 2012 almost double what BMW produced, hazardous waste was 9.86kg in 2011 and 10.37kg in 2012. Although some of the emissions or waste produced decreased, the table still shows that manufacturing releases harmful emissions and introduces waste into the environment. Vehicle manufactures justify that 'the improvements seem small but represent an important lever for improving sustainable production when multiplied by the number of cars made'. The reverse can also equally apply that the amounts of waste produced per vehicle for example the 10.37kg in isolation appears insignificant but when multiplied by the actual number of cars made in the year becomes very significant as it yields tonnes of waste that finds its way into the environment.

In some instances vehicle manufacturers recondition and reuse some vehicle components such as engines or transmissions. Remanufactured parts are good on the environment and VW has made annual savings of 7,000 tonnes of steel through engine remanufacturing. The benefit however also extends to cost savings in that remanufactured parts cost 40% less than new parts and the cost is not transferred to customers meaning the vehicles become more affordable ultimately resulting in increased sales. Environmental benefits tend to be viewed more favourably in instances where they produce associated significant economic benefits. VW produces more than 16,000 components and Daimler has more than 12,000 components.

Toyota has developed the 3R's to address environmental ills in the value chain and under this initiative it recycles tungsten as shown in figure 4.25. Vehicle dealers explain that they have used vehicles departments in dealerships to sell used cars as part of the 'reusing' initiative.

BMW's life cycle assessments involve applying holistic accounting methods to assess vehicle impacts across the entire life cycle and sustainability targets have the same significance attached to cost in the development process. Cost implications infiltrate every aspect taken into consideration within vehicle manufacturing even in life cycle assessments. Toyota acknowledges that ensuring environmental impacts are taken into consideration across the entire life cycle of the vehicle is not easy or straightforward but is a complex task.

There are various examples given by vehicle manufacturers such as the weight reduction of 100kg in the golf that has resulted in a fuel consumption reduction of 23%. This was attained by the use of warm formed steel that uses significant amounts of energy to make. VW in 2012 won the greenest manufacturer title in South Africa in spite of the energy complex in the country, the materials derived from mining, the freshwater use to cite a few. Toyota points out that manufacturing competes with other sectors such as agriculture for water, waste continues to increase, is dumped wrongly and there are shortages of treatment plants. There is rampant illegal dumping as well amidst the greening buzz. A number of strides have been made in ensuring the value chain is made greener but a number of these initiatives are explained under the banner of cost effectiveness, economical relevance and not necessarily as solely beneficial to the environment or geared towards environmental preservation.

## 5.8 Vehicle Manufacturers' Interaction with Suppliers and Contribution to Sustainability

Vehicle manufacturers have an expansive network of suppliers and in order to retain control vehicle manufacturers have a criteria of expectations suppliers are expected to adhere to. Figure 4.26 gives an illustration of a seat supplier based in China showing that the supplier network is not only vast but global in nature. Figure 4.28 shows the distribution of BMW group suppliers with almost half of the suppliers located in the originating/parent country. The power that manufacturers have is mostly brought about by their financial muscle and this is used to push suppliers into delivering. Vehicle manufacturers have come up with supplier management platforms to verify suppliers as well as their levels of sustainability. They have set up special guidelines and expectations to control the sustainability activities of their suppliers and these are binding contractual agreements. Toyota is guided by respect and works with suppliers based on their strengths. Suppliers working with vehicle manufacturers are expected to adapt their sustainability initiatives in line with the manufacturers and also extend the same sustainability criteria to their own suppliers. Figure 4.27 illustrates the

manufacturer-supplier relationship in practice in line with the Toyota goals and vision. Overall this shows that in the vehicle-manufacturer relationship, vehicle manufacturers wield the power to dictate what sustainability entails across the entire supply chain.

Manufacturers train purchasers, suppliers and auditors to ensure supplier compliance and BMW trained 46 suppliers in South Africa in 2015. The numbers of suppliers trained in relation to the vast network of suppliers available is very small (46 suppliers trained with a reach of over 13,000 suppliers). The group highlights that it uses transparency and dialogue to maintain lasting relations with its suppliers. Daimler in South Africa runs annual in-house courses to keep staff informed of developments or changes in legislation. BMW has a channel that allows returning faulty supplies. Daimler hosted a supplier forum in East London in 2012 to help local suppliers to compete globally. Vehicle manufacturers require suppliers to fill in sustainability questionnaires to supply information on how they fulfil the sustainability criteria of the company in question. The response rate of the suppliers is also limited to an extent considering BMW has over 13,000 suppliers and in 2013, 3,000 submitted requested information whilst in 2015, 1,900 submitted.

Vehicle manufacturers admit that the expansive supplier network is burdened with increased $CO_2$ emissions and costly transport logistics. In addition, ensuring supplier environmental sustainability given that there are first tier suppliers and second tier as well as various sub-suppliers is complex and laborious. The differences in legislation and conditions in countries in Eastern Europe or Asia further challenges the environmental sustainability effectiveness. Non-compliance has also been cited in countries such as Brazil, Mexico, Russia, India and China. BMW concedes that tracing the raw materials back to their origin in as much as they are indispensable to manufacturing is very complex and near impossible. As a result it becomes challenging to trace a raw material to the raw material extraction stage. Manufacturers have resorted to carrying out random checks at first tier level twice or thrice a year to ensure compliance. Defaulting suppliers are dealt with in line with set criteria and audits are conducted. Monitoring sustainability standards within the supply chain is explained in line with minimising risk, preventing supply shortages, guarding against reputational damage, ensuring quality and maintaining consistent services. All these aspects have a direct bearing on the product quality, customer satisfaction and ultimately returns. The suppliers and group in turn profit from the relationship.

The supplier-manufacturer relationship is not without problems in spite of the extensive

measures that have been put in place to ensure compliance to set sustainability standards. VW gives examples of violations it had to deal with and address in 2011 as well as 2013 and it cites non-compliance in environmental protection initiatives as one of the areas of violations. Figure 4.29 explains the reasons behind the violations that are experienced in vehicle manufacturing as it shows the various small components that go into a car thereby representing the various levels of suppliers that contribute to making a car. VW and Toyota have moved towards localisation as a solution towards offsetting the complexities that global supply chains introduce. The advantages of localisation though extending into the ecological and social realm are largely explained leaning towards the economical aspect as localisation offers reduced logistical costs, local market aligned prices, currency risks reductions and customs duty removal. The measures that vehicle manufacturers have put in to ensure supply chains are green are difficult to enforce on all suppliers as they are many, located under widely differing legislative backgrounds and are equally driven by a profit mandate. The drive to yield greater return on investment within vehicle manufacturing industries has adverse effects on the levels at which environmental initiatives are taken into consideration within manufacturing.

## 5.9 Conclusion

The purpose of the study was to analyse the ways in which vehicle manufacturers within South Africa have adapted and adjusted to sustainability demands in their operations in line with adjusting to the green economy imperative in their search for profit. The analysis of the data shows that there are a number of strides that have been made to adjust to sustainability demands but the basis of these adjustments lies heavily on cost reduction and ultimately profitability. This is reflected mostly in the definitions of sustainability informing the operations of the vehicle manufacturing companies, the sources of raw materials utilised, adjustments made to increased awareness, response to sustainability questions, interaction with suppliers, EMS adoption, navigation of regulatory environment and green practices along the value chain. Zhu et al. (2007), highlight that all stages of a product life cycle will influence a supply chain's environmental burden. The premise upon which vehicle manufacturers approach environmental sustainability ultimately skews their approach in favour of the economic benefits as they have created a dominant narrative of what sustainability entails to suit business parameters (Ahi and Searcy, 2013).

Figge and Hahn (2012) are of the opinion that in order for development to be sustainable the

economic imperatives should not dominate above societal and environmental concerns. This opinion invariably lies at odds with the essence of business that is still steeped in the traditional approach that views resources as a means to maximise on returns. The complexity also lies in that sustainability and green economy principles are open to various definitions that are manipulated to suit the needs of the user. Business also argues that the environment, society and economic aspects can operate in harmony but from the analysis, business and governments tend to favour the economic aspect as it addresses various challenges readily at the expense of the environment. Business tends to be unwilling to invest in greener practices as the argument is that these are at odds with the profitability mandate. Contentions and conundrums therefore still exist within the vehicle manufacturing setting that need to be addressed to make meaningful progress.

The study findings reflect that to attain sustainability more engagement is needed to devise solutions that address the conflicting interests that exist amongst various stakeholders and the environment. This will ensure future generations can derive the same value from the environment similar to the one current generations derive. In South Africa, concerted effort is required from a political perspective to ensure environmental regulations can be enforceable as well as a genuine commitment to greening the economy in a practical way. Corporations thrive in environments that reflect a half-hearted approach towards dealing with the environment.

# CHAPTER SIX

# CONCLUSIONS AND RECOMMENDATIONS

## 6.0 Introduction

This chapter brings together the key findings and lessons that were learnt from vehicle manufacturing in the context of a green economy in South Africa, in the search for profits. The section is divided into three segments, the first segment recaps the key findings as they relate to the research aims, the second segment proposes recommendations and the last section proposes future research focus areas.

## 6.1 Recapping Key Findings

This study sought out to establish a number of aspects such as the ways in which the vehicle manufacturing industry has aligned with sustainability demands, the ways in which the environment is taken into consideration as vehicles are manufactured, the interaction that occurs with suppliers, the regulatory environment governing manufacturers, the green practices adopted in the value chain, alignment with EMS and the impact of increased environmental awareness on vehicle manufacturers. The South African economy is heavily reliant on coal powered energy yet at the same time seeks to adopt green economy imperatives. This presents a myriad of challenges as the goals and reality are at odds. Another complexity is the involvement of corporations in an already complex relationship. Corporations seek profits whilst governments seek employment creation and poverty alleviation and all these activities are supported by the environment. A balance or favourable situation becomes difficult to realise under such conditions as there are many vested interests operating within the given locality.

The vehicle manufacturers have to some extent implemented pragmatic efforts towards preserving the environment albeit being motivated by profit. Such efforts include the use of green energy that is generated from wind or refuse although this is still very minute compared to that used from non-green sources. Other attempts include recycling, adoption of EMSs to guide production, water saving and use of alternative materials where applicable. The major challenge within this industry lies in that there is a hypocritical approach towards addressing sustainability aspects vis-à-vis manufacturing goals. This raises many areas of conflict and

complexity in that manufacturers appear defensive particularly in the sustainability reports and the way they interact with the public. Another major challenge is the lack of fair platforms to chart solutions as manufacturers use power and financial influence to dictate positions to governments, environment, suppliers and customers.

The legal environment within the country and political will to change and enforce certain beneficial practices has also been lacking and this perpetuates unsustainable behaviours. Vehicle manufacturers are global in nature hence some of the solutions proposed are top down (from mother country to host country) and this relationship is also fraught with complexities particularly brought about by power and financial muscle that mother countries have over host locations. Manufacturers tend not to address the real environmental challenges but give out information to comply and maintain reputations. The real challenges experienced in the relationship between manufacturing and the environment are largely located within the profit drive that manufacturers push more than the other agendas. This has led to the manipulation that occurs as a result of the power corporates have in environmental decisions, the use of raw materials, corporate reporting as well as supplier relations. Manufacturing considers every aspect through the lens of the potential savings/cost reductions, competitive advantage and profitability.

## 6.2 Recommendations

Based on the above findings the researcher recommends the following:

- A review of sustainability approaches in manufacturing that does not accord the three arms of sustainability the same weight but that views sustainability from an environmental perspective as all activities within manufacturing are heavily anchored on the environment. This will entail genuine environmental preservation measures that are not anchored on the business case for sustainability but that consider the non-renewable resource scarcity looming.

- Vehicle manufacturers should also consider the total effects raw materials sourcing has on the environment as they tend to focus more on the production sites. Manufacturing draws raw materials form mining for example that has created countless environmental ills, therefore, manufacturers also need to take responsibility for environmental ills at the sources of their raw materials.

- Vehicle manufacturers need to rethink the way sustainability is reported as well as letting other actors decide on the best approaches to environmental preservation. They currently interfere extensively in these processes and they have a lot at stake meaning they steer decisions in their favour.

- The political environment needs to restructure the approaches towards the environment and not just focus on growth, job creation and financial earnings. The government needs to think through greener energy sources as well as getting various actors to participate in sustainability debates at various levels.

- Corporates can think through corporate social responsibility and give more back into the environment from which they derive resources and not just investing into the social arena as advertising strategies to boost sales.

- A critical revisiting of the green economy paradigm particularly in emerging/developing economy context to determine whether this concept is applicable or at odds with developmental goals within the contexts.

- Analysing the feasibility of placing manufacturing at the forefront as key solutions to unemployment and development challenges.

## 6.3 Future Research Focus

The link between vehicle manufacturing and sustainability in the context of the green economy is an area that still has scope for expansion. Studies that look at the motor vehicle manufacturing industry in the country tend to focus on the government policies that have favoured vehicle manufacturing. In light of the increased environmental awareness further research can look at the complexities that arise in setting up manufacturing as an area to address green growth given that the two are at odds with each other. Further work can be done to unearth the dynamics that prevent adoption of green economies such as the various vested interests that exists in countries and the interrelationships amongst global companies, local hosts and environment. More work can be done to trace raw materials' sources and the accumulative wastes generated as the raw material passes through the supply chain until it reaches its final destination (production plant) through to the disposal stage.

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# APPENDICES

## Appendix A- Interview Schedule For In-Depth Interviews With Management From Vehicle Manufacturing Companies

1. **Background information**

   i. Can you tell me about yourself (work history and professional background)

   ii. How did you join this organisation?

   iii. What is your role in the organisation?

2. **Study area**

   a) Which factors influenced the location of this company on this particular site?

   b) Can you explain briefly how sustainability concerns have impacted upon production in this company over time?

   c) What does this production process entail? Does the company practice sustainable production?

   d) Can you describe the company's value chain stages and any green practices that are adopted in each stage to ensure environmentally friendly production?

   e) Does this company make use of any of the ISO standards in carrying out any tasks in vehicle production?

   f) If it does may you please highlight which ones are used and how they impact on production?

   g) How do you ensure environmental sustainability in a practical way as you carry out production?

h) How do you interact with your suppliers? - Are there any sustainability measures that are used to govern this interaction?

i) How has increased global environmental awareness impacted upon vehicle manufacturing?

j) How do you adhere to and apply i) local,
ii) National and
iii) International environmental regulations in your operations?

k) What impact if any do these regulations have on the operations of the company?

l) How do you deal with aspects of waste disposal and end of life re-cycling?

m) How do you measure and record environmental profitability/ sustainability as a company and how is this reported in your financials?

n) How have your consumers responded to the green initiative/sustainability drive and has this in any way affected, altered or enhanced sales?

## Appendix B -Interview Questions with Vehicle Manufacturers

1. May you please i) give a brief description of the work you do/position you hold? ii) Give any suggestions on what drives vehicle manufacturers to produce cars.

2. What influences the location of car dealers?

Proximity to vehicle manufacturers
The target market cars will be sold to
The prices of the car models
Availability of space
Other (please specify)

3. How are cars transported to car dealers?

Road

Rail

Other (please specify)

4. In the event that customers request spare parts for service or repair work where do car dealers source these?

Vehicle manufacturers in South Africa

Specified spare part suppliers (from Database) in South Africa

Suppliers outside of South Africa but within the continent

Suppliers in other continents

Other (please specify)

5. Do car dealers interact directly or indirectly with vehicle manufacturers? Explain the nature of the relationship dealers have with vehicle manufacturers?

6. Are you aware of any laws in South Africa and globally that i) regulate the relationship between car dealers and vehicle manufacturers or with the customers? ii) Affect vehicle production and sales?

7. On a scale of 1-10 (1 very low and 10 very high) please rank the materials listed below in order of the proportion they contribute in the model you sell?

Steel

Plastic

Leather

Rubber

Glass

Paint

Aluminium

Iron

Fibreglass

Other (specify)

8. Where are the materials you selected in question 7 sourced from?

Locally-within South Africa

From other African countries

European countries

North American Countries

South American Countries

Asian countries

Australia

I don't know

9. What do customers mostly take into consideration when buying cars? Rank 1-5 (1 as the least considered aspect and 5 as the most considered).

Materials used

Price of the car

Make of the car

Model of the car

Engine capacity

Fuel Consumption

Colour

Direct effect on any aspect of the environment, e.g. Noise, fumes etc

Other (specify)

10. Do you have any policy in place to help with the disposal of used vehicles? If yes please elaborate on what it is?

## Appendix C-Data used to derive Figure 4.15

24 Dealers Ranking on Materials used in vehicle manufacturing

| Material used | Ranking-Scale of 1-10(1 as the least used and 10 most used | Number of dealers who ranked each material |
|---|---|---|
| Steel | 8 | 20 |
| Aluminium | 7 | 19 |
| Rubber | 7 | 17 |
| Paint | 7 | 18 |
| Iron | 5.5 | 16 |
| Glass | 5.5 | 12 |
| Plastic | 5 | 14 |
| Leather | 5 | 14 |
| Fibreglass | 3 | 10 |

## Appendix D – Participant Information Sheet

School of Geography, Archaeology and Environmental Studies
Private Bag 3, Wits 2050, South Africa Enquiries: GEOGRAPHY: TEL: +27 11 717-6503 •
ARCHAEOLOGY: TEL: +27 11 717-6045 •
http://www.wits.ac.za/geography/

### PARTICIPANT INFORMATION SHEET

Hello,

My name is Prue Mutumi and I am a PhD student at WITS University. As part of my studies I am doing a research project entitled- *For profit or the environment? An analysis of the relationship between the motor vehicle manufacturing industry and the green economy in South Africa.* The study is focusing on the motor vehicle manufacturing industry in South Africa. This study examines how the motor vehicle manufacturing industry in South Africa negotiates sustainability demands in the search for profit. This extends to operations from the way raw materials are sourced, production locations, interactions with suppliers, actual production chain, movement of finished products and the negotiation of environmental regulations (local, national and international regulations). The study will focus on how global manufacturing companies adopt and adapt to sustainability demands in their operations in line with adjusting to the green economy imperative.

My target participants include managers in varying units within motor vehicle manufacturing companies as they are directly responsible for strategic decisions and directions taken within the company. I am interested in talking to managers responsible for the production, purchasing and supply units, disposal and recycling as well as units linked to environmental responsibility. I am also interested in talking to those managers who have been in the company for a relatively long time as they will be able to give a background and progress towards greening the production process within the company. If you fall into this category I would like to kindly invite you to participate in this study.

Your participation will entail that I interview you. The interview will be conducted at a place you deem private and where you feel comfortable sharing the nature of your work given the position you hold in the company with me. The interview will take between 1 and 2 hours. I am interested in talking to you about your work, the sustainability measures adopted by your company, the use of standards such as those developed by the ISO (International Organization for Standardization) and how these impact on production as well as any future

sustainability plans that may be adopted to ensure that production takes the environment into consideration. Other insights may come out of these conversations and you may share any other additional information you so wish to share.

There will not be any personal benefits arising from your participation in the study but the information you share with me will help us better understand vehicle manufacturing industries, their sustainability efforts, the impact greening operations might have on profits, and how industries negotiate and operate under set environmental regulations on a global, national and local scale. This information can be used to better understand the intricate relationships that exist between the search for profit and the environment thus resulting in long-term benefits for individuals, corporations and the environment.

Your participation in this study is entirely voluntary. You are free to decide whether you want to take part or not. There will be no negative consequences if you decide not to participate. You are free to withdraw from the study at any time you feel like doing so. In the event that we are recording an interview, you are also free to stop the recording at any time.

The information you share with me will remain confidential. In the event that you agree to the recording of the interviews the contents of these recordings will be locked in a cabin where I only have access. The information you provide will also be grouped with information from other participants such that it can never be traced back to you. While I will know your name and possibly the names of other participants in this study, I will not document your name in interview reports (transcripts) and in the study report. In the research report I will also use pseudonyms (not your real name) to conceal and protect your identity and that of other participants.

For any further information regarding this project please feel free to contact me on 078 294 4274. You may also contact me on email at 500948@students.wits.ac.za Thank you for taking time to consider participating in the study.

## Appendix E- Informed Consent Form

**School of Geography, Archaeology and Environmental Studies**

Private Bag 3, Wits 2050, South Africa Enquiries **GEOGRAPHY:** TEL: +27 11 717-6503 •
**ARCHAEOLOGY:** TEL: +27 11 717-6045 •
http://www.wits.ac.za/geography/

**Informed consent for participating in an interview**

Thank you for agreeing to participate in this study. Do you have any questions concerning the study? Please read and sign the following.

I hereby confirm that I have been informed about the nature and conduct of the study. I have also read and understood the Participant Information Sheet. I may not benefit personally from participating in the interview.

I may, at any stage withdraw my consent and participation in the study, without facing any negative consequences. I have been made aware that my name will not be used in the research report and only a pseudonym will be used instead. The information that I give will be treated as confidential and will not in any way be identified with me and can only be used for the purposes of this study and for any other related academic activity such as publication of the findings in a scholarly journal.

I have also been afforded the opportunity to ask questions about the study.

I declare that I am prepared to participate in this study.

**Name of Participant:** _____

**Date of birth:** _____

**Signature:** _____

**Date:** _____

I, Prue P J Mutumi, hereby confirm that the above participant has been fully informed about the nature and conduct of the study.

**Signature:** _____

**Date:** _____

***If verbal consent is given, the interviewer must sign below in the presence of the participant.***

_____ _____

(Signature of interviewer certifying that informed Consent has been given verbally by respondent) Date

# Appendix F- Ethics Application

## University of the Witwatersrand, Johannesburg

***Ethics Application Form* for *Human Research Ethics Committee (HREC Non-Medical)***

(Revised December 2012)

Use this form in applying for clearance of research involving human participants

Instructions

1. Completed applications must be submitted to the Research Office approximately three weeks before each of the monthly meetings. The deadlines are available on the Wits Research website http://www.wits.ac.za/academic/research/ethics.htm/7075/ethics.html
2. Applications must be submitted as hard copies, one of which must be an original (see checklist below for numbers of copies required). Electronic submissions will not be accepted.
3. All submissions and materials must be typed. Handwritten submissions are **NOT** acceptable.
4. Incomplete applications will **NOT** be considered.
5. Applications will **NOT** be processed if signatures from applicant or supervisor are missing.
6. Photocopying should be done 'back-to-back' to save paper.
7. Glossy and fancy binding is **NOT** necessary.
8. Necessary supporting documents (e.g. *Participant Information Sheet, Consent Form*, copies of instruments), must be stapled to the *Ethics Application Form.*

**Complete this checklist to show what documents you have submitted.**

| ☑ | **Check list** | **No. of copies required** |
|---|---|---|
| **For all research:** | | |
| | Completed *Ethics Application Form* | **15** |
| | Copies of the research proposal | **4** |
| | Copies of proposed research instruments (e.g. questionnaires/interview schedules) | **4** |
| | *Participant Information Sheet* (for each different sample group) | **4** |
| | *Consent Form* [*Assent Form* for under 18s] (for participant's signature) (for each different sample group) | **4** |
| **Where applicable (Attach to this form):** | | |
| | Relevant permissions (from, e.g. company's HR department, National authorities such as Education, Correctional Services, etc.) or other legally required consent | **4** |
| | Any other appropriate consent forms (e.g. consent forms for members of focus groups, consent forms (for video or photography), etc. | **4** |
| | Guardian *Consent Form* (for participants under the age of 18) | **4** |
| | Other (please specify) | **4** |

Declaration

I recognise that it is my responsibility to conduct my research in an ethical manner according to Guidelines of the University of the Witwatersrand, according to any laws and/or legal frameworks that may apply, and according to the norms and expectations of my discipline.

In preparing this Application for Ethics Clearance form, I have consulted the ***Guidelines for Human Research Ethics Clearance Application /non-medical*** (available on this web site

http://web.wits.ac.za/Academic/Research/Applications.htm) and have familiarised myself with the ethical guidelines specific to my discipline.

Signature _____

Name of researcher/applicant: Prue P. J. Mutumi

## 1. Researcher's personal data

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Surname: Mutumi | | | | | Name: Prue Portia Jacqueline | | | | | |
| Title: | | Prof | | Dr | | Mr | * | Ms | | Mrs | | Other: |
| School: GAES (Geography Archaeology and Environmental Studies) | | | | | | | | | | |
| Student number: 500948 | * | Full time | | Part time | | Staff | | | | |
| Your telephone(s): 078294 4274 | | | | | | | | | | |
| Your Email: 500948@students.wits.ac.za | | | | | | | | | | |
| Name of Supervisor (if applicable): | Dr. D. Simatele | | | | | | | | | |
| Supervisor's email address: | Danny.Simatele@wits.ac.za | | | | | | | | | |
| Supervisor's tel. number(s): | 011 717 6515 | | | | | | | | | |

## 2. Specifics about the research project

**Title of research project**

For profit or the environment? An analysis of the relationship between the motor vehicle manufacturing industry and the green economy in South Africa.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Is this research for degree purposes?** | * | **Yes** | | **No** | | | |
| **If so, for what degree?** | | **Honours** | | **Masters (dissertation)** | | **Masters (research report)** | |
| | * | **PhD** | | **Other (specify):** | | | |
| **Has it been approved by the relevant higher degrees committee or other relevant unit?** | * | **Yes** | | **No** | | **Submitted & pending** | |

**List the names and affiliations of any *additional* researchers who will be covered by this ethics protocol**

**Where will the research be carried out?**

In Eastern London , 7 Settlers Way Gately Industrial Township, 103 Algoa Road Uitenhage, and 15 Prospecton Road, Prospecton.

**What are the aims and objectives of the research?** (Please list; be brief)

The aim of the research is to understand how the motor vehicle manufacturing industries in South Africa have adapted their operations to align with sustainable production practices such as stipulated by the ISO 14000.

The research seeks:

1. To establish whether the motor vehicle manufacturing industry has aligned to sustainability imperatives.
2. To assess whether corporations take the environment into consideration as they carry out their operations.
3. To examine the way in which motor vehicle manufacturing industries interact with their suppliers and the immediate environment.
4. To generate knowledge on the way the motor vehicle industry operates within South Africa in the context of a green economy.

**Do you have any financial or material interest associated with your research participants or with the organisations that you will work with during your research?**

| | | | | | |
|---|---|---|---|---|---|
| ☐ | Yes | ☐ | No | ☐ | Potential conflicts of interest may exist |

Please **explain how you will manage any existing or potential conflicts of interest, if applicable.**
**N/A**

| INFORMATION RELATING TO ETHICAL MATTERS |
|---|
| *Protocols submitted to the Committee must have sufficient information to enable the committee to judge the ethical implications of the proposed research. Please be brief and concise but also as specific and informative as possible* |

**3. Formal permission**

**Has appropriate formal permission been obtained, if required (e.g. employer, government department, land owner, etc.)?**

| | | | | | |
|---|---|---|---|---|---|
| | Yes (attached) | * | Not required | | Pending (must be supplied before permission is granted) |

Obtaining permission is necessary when conducting research *within the premises* of a particular site such as an ethnography of the functioning of a supermarket or a school, or the way staff interact with clients in a clinic, or of how the HIV Unit in the City of Johannesburg functions. Please read the detailed guidelines on the Ethics website http://web.wits.ac.za/Academic/Research/Applications.htm

**4. How will data on human research participants be collected (instruments, methods, procedures)? (Attach instruments as an appendix)**

| | |
|---|---|
| | In written format (e.g. questionnaires, diagnostic tests, etc.) |
| | Completion of on-line instruments (e.g. questionnaires) |
| * | Individual interviews (e.g. structured, semi-structured, etc.) |
| | Group interviews (e.g. seminar/discussion groups, focus groups, etc.) |
| | Ethnographic observation, participant observation, other informal descriptive, and/ or interactive methods |
| | Community-based methods or techniques such as drama workshops, community theatre, training workshops, participant rural appraisal (PRA), rapid rural appraisal (RRA), etc. |
| | Research on/in therapeutic or counselling contexts |
| | Observation of public performance, and/or public behaviour observation |
| * | Photography, video and/or audio recording (**specific separate consent forms may be required**) |
| | Other research methods or techniques (specify in this line). |

**Brief details of instruments to be used** (attach instrument or draft to this application)

Qualitative data will be gathered in the project. Information will be gathered through in –depth interviews with staff from the organisations. I have attached a schedule containing the general guiding questions to be posed in the interviews- See Appendix A.

**5. Who will the research participants be?**

Brief description of human participants, including age range and sample size, for each sample:

Participants in this study will mainly be management in the different production units in the chosen motor vehicle manufacturing industries. I envisage interviewing 8 managers in each company. This group of managers will be comprised of people aged between 30 and 60.

| | | | | |
|---|---|---|---|---|
| Does this research expose either the participant or the researcher to any potential risks or harm that they would not otherwise be exposed to? | | Yes | * | No |

If 'yes', explain:
N/A

| Will research involve vulnerable categories? | ☐ Yes | * No |
|---|---|---|
| If so, state which ones:<br><br>N/A | | |
| How will any existing vulnerabilities among research participants be addressed?<br><br>N/A | | |

**NB:** The term 'vulnerable categories' includes, among others, children under 18, orphans, prisoners, persons with cognitive or communication disorders, people who are traumatised or currently in traumatic situations.

Where necessary, include details of steps to be taken to facilitate data collection across language barriers (e.g. interpretation or translation).

**6. How will informed consent be obtained?**

**How will potential participants be identified / selected / recruited?**

Participants will be drawn from management in the motor vehicle manufacturing industries using simple random sampling and systemic sampling. This selection is strategic in that top management is active in the strategic decisions companies make hence this group will be key in providing information related to the greening of the production processes in the different corporations.

**What will participants be told about the research (including the promises to be made)?**

Participants will be told that this research is looking at the motor vehicle manufacturing industry in South Africa in the context of the green economy. They will also be told that this research looks at how vehicle manufacturers within the country have adjusted and adapted to the demands of sustainable production demands and environmental management systems such as ISO 14000. Management in the organisations will be told that the researcher is interested in how the companies balance the South African environmental regulations against the parent company country regulations in their search for profit. Participants will be told about the interviews, duration and specific areas of interest pertinent to the study such as the production process as well as the sourcing of raw materials. Participants will be made aware that there will be no personal benefits to be derived from participating in the study. The information derived from the study will lead to a better understanding of the green movement within manufacturing in South Africa, and the way in which global influences play a part within the production processes thus offering an insight into the way corporations take the environment into consideration as they operate. The participants will be told that taking part in the study is optional with no repercussions on those who choose not to participate or terminate participation in the middle of the interviews. All participants will be made aware that confidentiality will be guaranteed in the written work.

**How will informed consent be obtained?**

| | | | | | |
|---|---|---|---|---|---|
| [*] | Formal (Signed form) | [ ] | Informal (e.g. verbal) | [ ] | Other |

**Briefly explain your strategy for ensuring informed consent**

The researcher will provide an information sheet detailing the research project to potential participants. Potential participants will be invited to take part in the study and those who agree to take part will be asked to sign an informed consent form. This form will contain the rights of the participant such as the right to terminate the interview when the participant chooses to and the right not to respond to questions participants find uncomfortable answering. Consent will also be sought for recording interviews using a voice recorder and participants will be asked to sign the informed consent form if they are in agreement with voice recording.

**Attach *Participant Information Sheets* and *Consent Forms* for each sample group, and/or other related materials**

**NB**: ***Consent*** in social science and humanities research involving human participants: Where informal ethnographic or participant observation methods are used, or where signed *Consent Forms* are not possible, or for research involving group contexts (focus group, Participant Rapid Assessment, Rapid Rural Appraisal, public performance, workshops) **state how the quality of informed consent will be assured**. It is essential that participants in research be fully informed and agree, on this basis, to participate in the research.

**7. Protecting participant identities**

| | | | | |
|---|---|---|---|---|
| Can **confidentiality** be guaranteed? | [*] | Yes | [ ] | No |
| Can **anonymity** be guaranteed in resulting reports, theses and/or | [*] | Yes | [ ] | No |

| publications? | | |
|---|---|---|

**Explain** how this will be done? (What will participants be told in this regard?)

Participants will be told that their real names will not be used in presenting data. The option that will be used is to give pseudo names for each of the participants. The researcher will ensure that interviews will be carried out away from other participants so that any information they provide and personal views are kept confidential in a way that all information supplied will not be traced back to the participant.

**NB**: While confidentiality may be desirable, it cannot be guaranteed in, for example, focus groups, or ethnographic observation. Similarly anonymity should be preserved in questionnaires, but cannot be offered in workshop methodologies, focus group research, etc. Participants should have the right to remain anonymous in the final report, and this must be respected in handling of all data relating to them. Participants need to be informed about these issues.

**8. Protection of data during and after the research**

How will the data be protected while the research is in progress? (This includes how the identities of participants will be protected).

A cataloguing system will be used to conceal participant names in the field notes and transcripts. Data will also be stored in a password protected computer.

What is to be **done with the research data** after completion of the project?

| | | | |
|---|---|---|---|
| | Stored in archives (specify) | | Stored in on-line data base (specify) |
| * | Stored in password protected computer | | Stored in digital form with all identifying feature removed |
| | Destroyed after 5 years (insert numbers of years) | | |

Explain how the data will be securely stored during this time

The data will not hold the names of participants and will only be accessible to the researcher and supervisor.

**NB**: 'Raw' or unprocessed data, especially **where the identity or personal data of research participants is included, must be safeguarded** and preserved from unauthorised access. Data may be destroyed after use, but **preservation in an archive or personal collection** may also be appropriate, desirable or even essential. For instance, data sets that contain **historically important information** or information that relates to **national heritage** must be preserved and should be placed in a public archive where possible and appropriate.

All data should be preserved in a way that **respects the nature of the original participants' consent**. If you are unsure about the procedure of data management and storage, please contact Nina Lewin (ninalewin@gmail.com)

| 9. Access to the research results / reports |
|---|
| How will the results be **reported**?<br><br>Results will be used primarily to write up a PhD dissertation and to publish findings in scholarly journal articles. |
| Who will have access?<br><br>The thesis will be accessible on the University Library system and journal articles will be accessible as regulated by each specific journal. |
| Note: All Wits Masters and PhDs are stored in the main library as well being made available on the www. |

**SIGNATURES (REQUIRED)**

**In signing this form, the researcher and supervisor (if any) of this project undertake to ensure that any amendments to this project that are required by the Human Research Ethics Committee are made before the project commences.**

***Declaration: We, the signatories, declare that all information on this form is correct and that we will strive to maintain the highest ethical standards in this research at all times, according to disciplinary and university expectations, recognising that ethical practice in research is always a continuing process.***

| | Date | Name | Signature |
|---|---|---|---|
| **Applicant** | February 2015 | Prue P. J Mutumi | |
| **Supervisor** | February 2015 | Dr. D. Simatele | |

# Appendix G- Ethics Clearance Certificate

Research Office

**HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)**
R14/49 Mutumi

| | |
|---|---|
| **CLEARANCE CERTIFICATE** | **PROTOCOL NUMBER: H15/0313** |
| **PROJECT TITLE** | For profit or the environment? An analysis of the relationship between the motor vehicle manufacturing industry and the green economy in the RSA |
| **INVESTIGATOR(S)** | Ms PP Mutumi |
| **SCHOOL/DEPARTMENT** | GAES/Geography |
| **DATE CONSIDERED** | 20 March 2015 |
| **DECISION OF THE COMMITTEE** | Approved unconditionally |
| **EXPIRY DATE** | 01 April 2017 |

**DATE** 7 April 2015 **CHAIRPERSON** (Professor T Milani)

cc: Supervisor : Dr D Simatele

**DECLARATION OF INVESTIGATOR(S)**

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we 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. **I agree to completion of a yearly progress report.**

_____ _____/_____/_____

**Signature** **Date**

**PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES**

## Appendix H- Plagiarism Report

500948:PhDResearch_Prue.docx

ORIGINALITY REPORT

| 9% | 8% | 1% | 4% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

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# Appendix I-BMW Assessment for 2015 Production

**BMW Group input/output assessment for 2015 vehicle production** T 3.16

| Input | |
|---|---|
| Raw materials[1] | |
| Steel | 2,419,434 t |
| Plastics[2] | 544,618 t |
| Aluminium | 582,928 t |
| Magnesium | 6,992 t |
| Operating fluids[3] | 69,445 t |
| Water[4] | 4,819,684 m³ |
| Energy[5] | 5,054,722 MWh |

| Output | |
|---|---|
| Vehicles | |
| BMW Group vehicles produced[6] | 2,139,829 |
| Vehicles produced (contracted) | 139,674 |
| Total waste[4] | 754,747 t |
| of which recyclable | 745,986 t |
| of which waste for disposal | 8,761 t |
| Total waste water[4] | 3,108,587 m³ |
| $CO_2$ emissions[6] | 1,266,697 t |
| Volatile organic compounds (VOC)[5] | 2,618 t |
| $NO_x$[5] | 602 t |
| CO[5] | 367 t |
| $SO_2$[5] | 6 t |
| Particulates, dust[5] | 59 t |

1 Due to the fact that internal reporting has a different scope, this figure excludes BMW Brilliance (CH) but includes Magna Steyr AT.
2 Component weight.
3 Operating fluid for products (e.g. engine and gear oil, brake and cooling fluid, cooling agent, fuel for production refuelling). As the data is captured via the central purchasing system, the figure excludes BMW Brilliance (CH) and Magna Steyr AT.
4 Incl. BMW Brilliance (CH), excluding contract production.
5 BMW Group measurements; capture as well as calculations based on energy consumption (primarily heating oil and gas) with the aid of the VDA emission factors.
6 Calculated using updated emissions factors. If 2014 factors were used: 1,355,037 t $CO_2$.

The number of vehicles produced again showed a robust increase in the reporting period (+5.3%). On the input side, the shift from steel to aluminium reported in 2014 continued due to the increase in lightweight construction. Aluminium grew by 5.7%, a much faster rate than steel (0.9%). In addition, the efficiency indicators energy/water consumption, process waste water, waste for disposal, VOC and $CO_2$ emissions per vehicle improved by an average of 7.0% compared to 2014.

GRI G4-EN1, GRI G4-EN2, GRI G4-EN3, GRI G4-EN8, GRI G4-EN15, GRI G4-EN21, GRI G4-EN22, GRI G4-EN23