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The Indirect Impact of Road Freight Transport
Case Study: N3 Johannesburg to Durban Road
Freight Corridor

Thesis in partial fulfilment of the requirements for the degree of MSc Eng. Transportation

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ABSTRACT

“The performance of the logistics industry, specifically the cost of logistics, affects the global competitiveness of South African industries. Logistics costs as a percentage of transportable GDP have grown significantly over the past four years. To change the trends in underlying cost drivers or significantly mitigate their impact requires more than just operational efficiency enhancements, it requires bold steps in addressing the ingrained issues that stifle the economy as well as new directions in how supply chains operate” (10th Annual State of Logistics Survey, CSIR, 2014).

South Africa’s unique spatial challenges require more corridor transport relative to the size of the economy than most countries in the world. The overall aim of this investigation is to determine the estimated cost of the indirect impacts of road freight on the N3 corridor between Johannesburg and Durban. This corridor, approximately 600 kilometres in length, forms the link between the country’s industrial hub (Johannesburg) and its key Port (Durban). The following research questions are posed:

- What is the status quo of freight transport in a global, South African and Johannesburg to Durban Freight Corridor context?
- What are the future growth forecasts for freight on the Johannesburg to Durban corridor?
- What is the significance of freight transport in South Africa?
- Does the reported total cost of road freight transport take into account a holistic approach when determining the costs?
- How are direct and indirect impacts of road freight transport defined, and how do they differ?
- What are the direct and indirect impacts of road freight transport?
- What method can be used to assess the total indirect costs of all associated impacts?
- What are the estimated costs of the indirect impacts of road freight transport on the Johannesburg to Durban Freight Corridor?
- What are possible mitigation measures for the indirect impacts of road freight transport?
- What will the estimated costs of the indirect impacts of road freight transport on the Johannesburg to Durban Freight Corridor be in over a 30-year horizon, when considering future projections and possible mitigation measures?
- What are the alternative modes to road freight transport on the Johannesburg to Durban corridor?

At a high-level, the impacts of road freight can be split into two broad categories, namely; direct and indirect. Direct impacts refer to costs borne by the owner or operator of the freight companies, whereas indirect impacts arise when the social or economic activities of one group of persons (i.e. freight companies) have an impact on another group and when that impact is not fully accounted, or compensated for, by the first group (European Commission Community Research, 2003). The direct impacts of road freight consist of the following elements (Havenga, 2010):

- Transport costs (vehicle, fuel, driver, toll fees and vehicle maintenance),
- Storage and port handling costs, and
- Management and administration costs.

An increasing amount of research into the indirect impacts of transport has been conducted over the last decade, with numerous impacts identified in the literature (OECD, 1997, Jorgensen, 2009). The following indirect impacts were identified in this research:

- Accidents,
- Congestion,
- Energy efficiency and resource consumption,

- Exhaust emissions and air pollution,
- Noise pollution,
- Traffic enforcement, and
- Uptake of land.
- Overloading,

- Social, and
- Decline in rail infrastructure.

Table 1 summarises the total costs of the various indirect impacts of road freight in South African cents per ton kilometre, with a base year of 2012.

Table 1: Summary of road freight costs in South African cents per ton kilometre

Indirect Impact	Cost (ZAR cents per ton-kilometre)
Accidents	8.60
Congestion	1.92
Energy efficiency and resource consumption	2.75
Exhaust emissions and air pollution	12.78
Noise pollution	3.92
Traffic enforcement	2.99
Uptake of land	1.00
Overloading	11.43
Social	0.00
Decline in rail infrastructure	0.22
Total	45.61

The total additional cost per ton kilometre for road freight transport has been determined as 45.61 South African cents. This is the cost which is currently not borne directly by road freight operators. Figure 1 provides an indication of the percentage contribution of each cost factor to additional road freight transport costs.

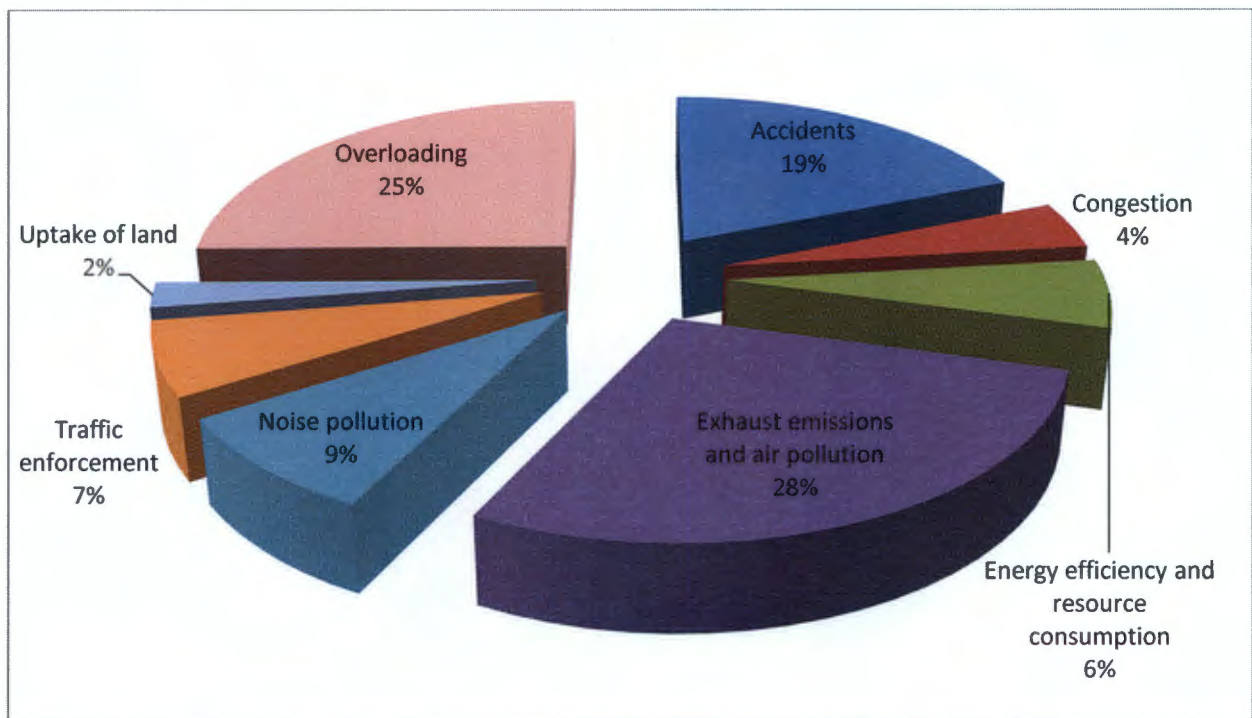


Figure 1: Estimated percentage contribution of each cost factor to additional road freight transport costs

Transnet (2014) state that a total of 21.3 billion ton-km were transported by road in 2012 along the Johannesburg to Durban Freight Corridor. At a cost of 45.61 cents per ton-km, this equates to R 9.72 billion in unaccounted costs that the road freight sector along the corridor is responsible for on an annual basis. When compared to the estimated direct costs of R 11.9 billion along the corridor, the indirect costs are significant at 82% of the direct costs. Furthermore, the cost of the indirect impacts equate to 0.3% of South Africa's GDP.

The 10th Annual State of Logistics Survey noted that externality costs amounted to a total of R40 billion in 2012 for the entire Country. Based on the research undertaken, this is deemed to be a very conservative estimate as the road freight transported on the corridor is 4.4% of the Country's total ton kilometres, yet is accountable for 24.3% of the Country's external transport costs.

The main differences between the value estimated in the 10th Annual State of Logistics Survey and this study, is that more indirect impacts have been considered (i.e. overloading and decline in rail infrastructure), and the cost per ton kilometre of exhaust emissions and air pollution has been increased to be more in line with European literature, as it is assumed that South Africa will begin to value this indirect impact higher in future.

These are merely the estimated costs of indirect impacts at present (2012), and it is imperative to consider what effect future growth scenarios will have on the costs associated with the indirect impacts. To demonstrate the significant financial impact of indirect costs of road freight on the corridor, six future scenarios are presented in the research, the results analysis is provided in Table 2.

Table 2: The current and future costs and percentages of GDP for the corridor's indirect impacts based on growth scenarios

Scenario name	Indirect cost in 2043 (R billion in 2012 prices)	Percentage of projected GDP in 2043
1). Business as usual	22.6	0.36%
2). Mitigate against impacts	17.6	0.28%
3). Increase in road freight modal share	27.5	0.43%
4). Transnet vision	14.3	0.15%
5). Improved economic growth, investment in rail and policy amendments	13.6	0.19%
6). Economic growth in line with NDP targets (5%), investment in rail and policy amendments	37.5	0.26%

The following findings are noted:

- **Scenario 1:** It is clear that a do-nothing/business as usual approach will only see the current scenario worsen in terms of the ability to transport goods effectively and efficiently. The indirect costs increase by 12.9 billion over the 31 year horizon at a compound annual growth rate (CAGR) of 2.8%, while the percentage of GDP increases at a CAGR of 0.5%.
- **Scenario 2:** The mitigation of impacts results in a lesser increase, in comparison to Scenario 1, of the indirect costs at a CAGR of 1.9%.
- **Scenario 3:** The increase in road freight modal share has a significantly worse impact on the indirect costs, with an increase to R 27.5 billion in 2043, at a CAGR of 3.4%.
- **Scenario 4:** The Transnet vision results in a lesser increase of R 4.6 billion over the 31 year horizon, at a much lower CAGR of 1.3%. This scenario also has the lowest share of GDP at 0.15%.
- **Scenario 5:** This scenario results in an increase of R 3.9 billion in indirect costs, the lowest of all scenarios, at a CAGR of 1.1%.
- **Scenario 6:** This scenario results in the highest increase in indirect costs; R 27.8 billion at a CAGR of 4.5%. However, the percentage of GDP reduces to 0.26%.

It is apparent when comparing the scenarios that the mitigation of impacts will reduce the indirect costs, as identified by Scenario 2. The biggest mitigating factor of all is the modal shift from road to rail, as modelled in Scenarios 4 and 5. However, it is imperative to note that Scenario 4, which is based on the SIP 2 Demand Book, is unconstrained and therefore assumes that sufficient products and infrastructure exist to achieve this scenario. Furthermore, the large increase in indirect costs in Scenario 6 can be attributed to the NDP's higher economic growth rate target of 5% for GDP, and the reliance on increased freight movements to achieve this target. However, the indirect costs as a percentage of GDP decrease, and this is due to investment in rail as well as policy amendments.

The output of the various scenarios varies significantly over the time period (2012 – 2043) and is provided in Figure 2.

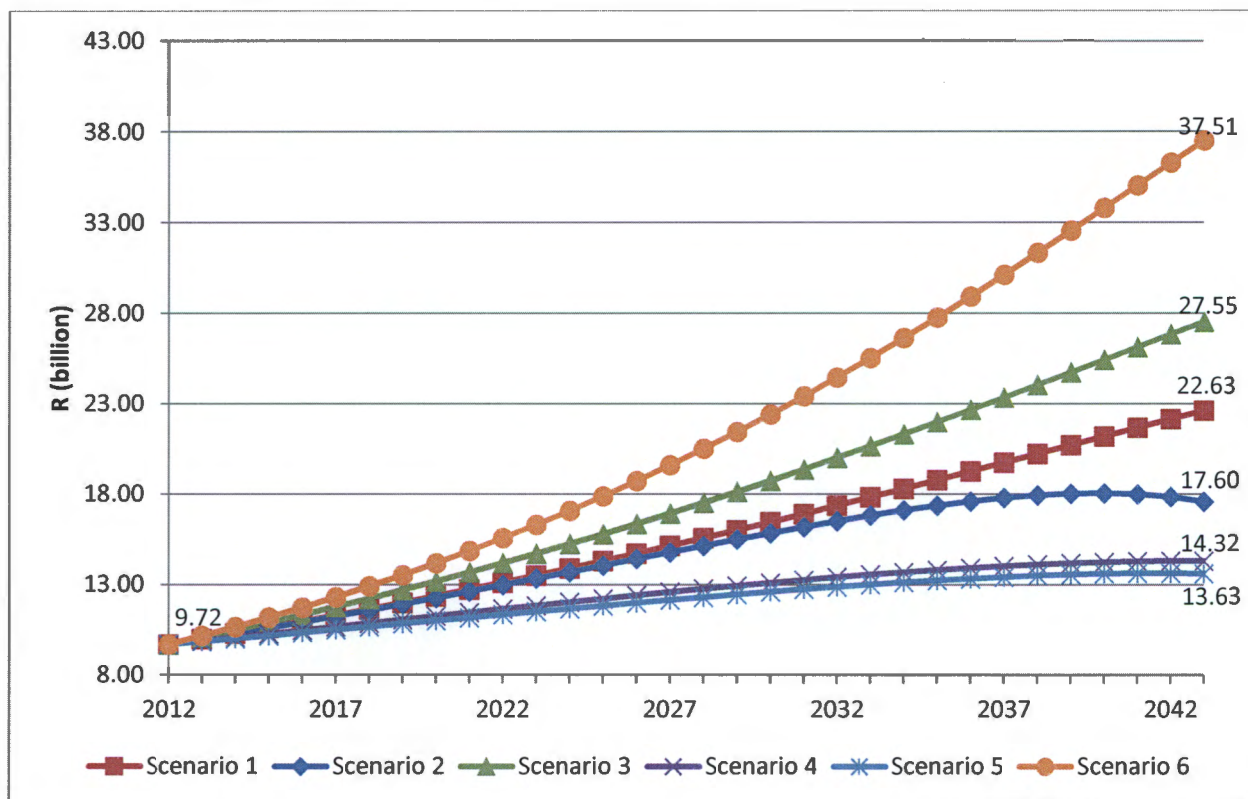


Figure 2: Projected costs (R billion at 2012 prices) of indirect impacts of road freight on the Johannesburg to Durban corridor for various scenarios

From a base year cost of R 9.72 billion in 2012, the indirect impacts of road freight transport on the Johannesburg to Durban corridor are estimated to range between R 13.63 billion up to R 37.51 billion in 2043 depending on which scenario is followed.

The importance of road freight to the South African economy cannot be understated, however, solutions to current road freight transport methods are required in order to develop and maintain a sustainable freight transport industry. In order to be competitive in international trade, the economy (and therefore also the freight transport industry) should be as effective as possible. In view of this, the following is proposed for the way forward:

- A review of National transport policy and legislation in order to determine the most efficient and effective way to ring fence and appropriately charge heavy vehicles in order to recover the costs resulting from externalities.
- Develop a funding model which uses the money recovered by road freight externalities to finance infrastructure investment.
- Consensus should be reached on what portion of the road budget should be paid for by road users. Part of the existing fuel levy or additional fuel tax can then be acknowledged as a road user charge, which should be viewed as the price for road usage. This can be agreed upon by industry and the government, and can even avoid the need for additional toll roads.

With the commonly accepted notion that there will always be a need for road freight transportation on the Johannesburg to Durban corridor due to the topography and type of goods transported, it is recommended that mitigation measures be further investigated and implemented in order to reduce the indirect costs.

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1 INTRODUCTION

1.1 Background to the Investigation

The benefit of freight transportation to any economy has the potential to be enormous. Freight transportation stimulates demand for goods and services and the sector therefore employs a significant number of people. However, the costs of transporting freight are continuously increasing. These increasing costs place additional burden on the operators, producers and consumers of freight – how much longer can these additional costs be sustained?

“The performance of the logistics industry, specifically the cost of logistics, affects the global competitiveness of South African industries. Logistics costs as a percentage of transportable GDP have grown significantly over the past four years. A deeper investigation of individual cost components and cost drivers shows that the increase in logistics costs is perhaps not so much the result of deteriorating efficiency in the industry but the disproportionate growth in cost drivers – especially fuel. To change the trends in underlying cost drivers or significantly mitigate their impact requires more than just operational efficiency enhancements, it requires bold steps in addressing the ingrained issues that stifle the economy as well as new directions in how supply chains operate. The rising trend of logistics costs poses a real challenge to all concerned in South Africa. Innovative and bold thinking with potentially far-reaching consequences is now required” (10th Annual State of Logistics Survey, CSIR, 2014).

The efficiencies of logistics systems often rely upon the ability to utilise intermodal freight solutions. The status-quo of the mode structure of South Africa's freight transport market is not sustainable, and forecasts indicate that freight transport demand will continue to grow well into the future. In 2008, South Africa generated 0.4% of the global GDP, but consumed 2.2% of the world's ton-kilometres and 6% of maritime ton-miles (CSIR Built Environment, 2008).

“Improving logistics performance is at the core of the economic growth and competitiveness agenda. Policymakers globally recognise the logistics sector as one of their key pillars for development. Trade powerhouses in Europe like the Netherlands or in developing countries like Vietnam or Indonesia see seamless and sustainable logistics as an engine of growth and of integration with global value chains. Indeed, inefficient logistics raises the costs of trading and reduces the potential for global integration. This is a hefty burden for developing countries trying to compete in the global marketplace” (World Bank, 2014).

South Africa's unique spatial challenges require more corridor transport relative to the size of the economy than most countries in the world. The primary or National road network in South Africa is maintained and operated by the South African National Roads Agency Limited (SANRAL) or appointed concessionaires. The SANRAL network is extensive and as displayed in Figure 3 caters for the road link or corridor between many significant city centres and more importantly trade ports/nodes.

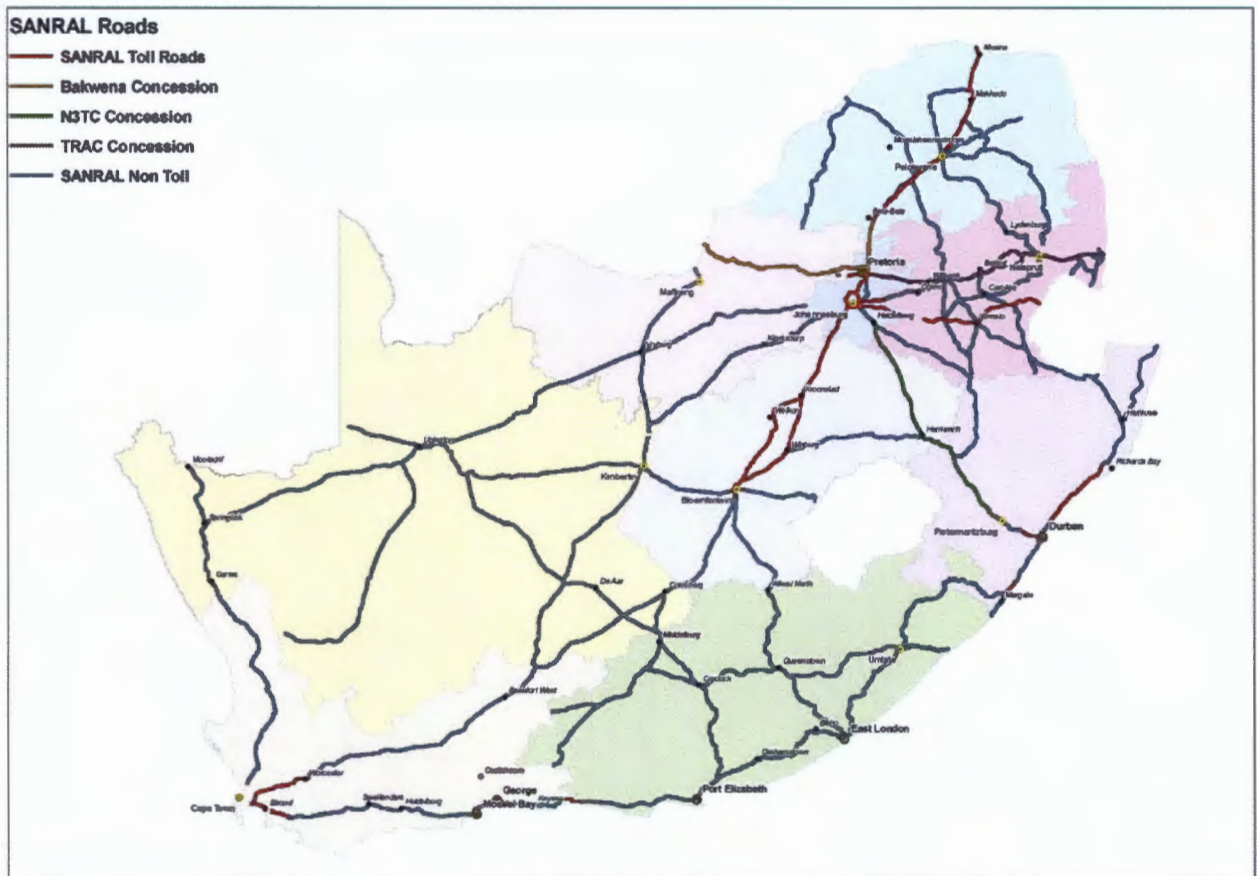


Figure 3: The extent of the SANRAL road network in South Africa
 Source: SANRAL

A main route or corridor used for freight transport is National Route 3 or the N3, which links landlocked Johannesburg (South Africa’s economic powerhouse) to Durban (Southern Africa’s busiest port in terms of tonnage). The N3 corridor is displayed in Figure 4 and is approximately 600 km in length, and the volume of freight moved on the South African transportation system has grown significantly over the past few years. As demand for freight service grows, concerns about capacity shortfalls, congestion and even safety and security issues have intensified.



Figure 4: The N3 road corridor linking Johannesburg to Durban
 Source: N3TC

Durban is the port through which Johannesburg imports and exports the majority of its goods. The N3 is therefore a very busy route, with high traffic volumes and a relatively high proportion of heavy vehicles when compared with most other routes.

In a presentation by the Council for Scientific and Industrial Research (CSIR, 2009) transport costs were summarised as a percentage of GDP and Logistics costs, which is displayed in Figure 5.

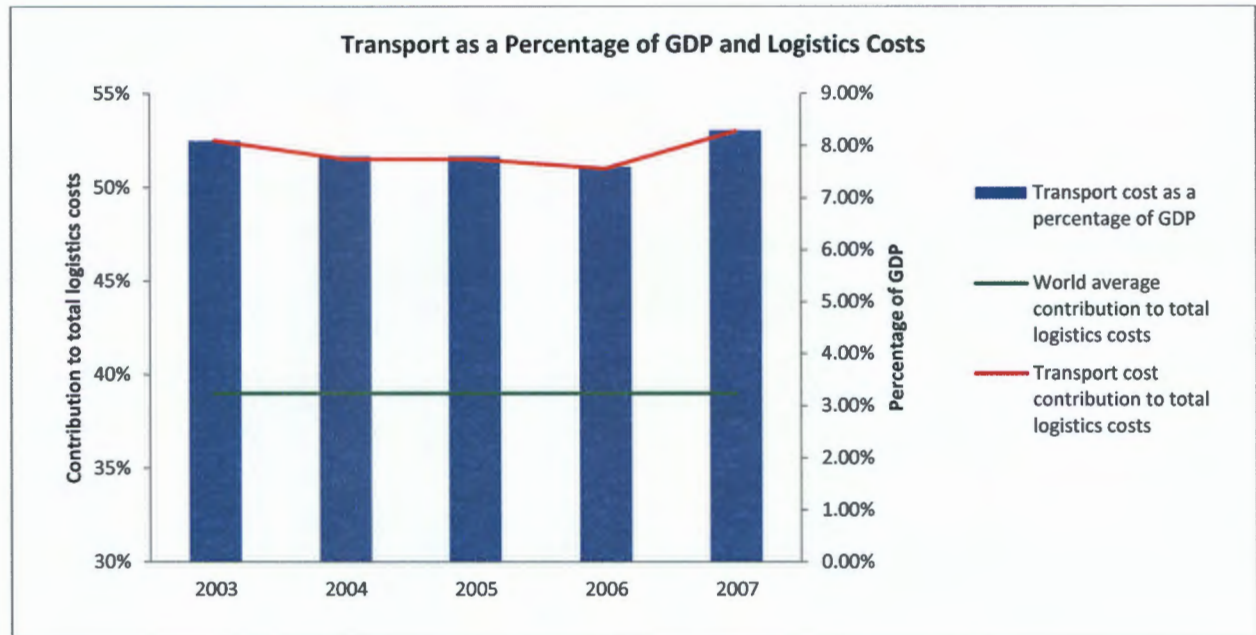


Figure 5: Transport costs as a percentage of GDP and Logistics costs

Source: CSIR, 2009

Figure 5 indicates that transport costs accounted for 8.3% of GDP in 2007, and for almost 54% of the total logistics costs in the same year. In comparison, the world average transport cost contribution to total logistics costs was 39% in the equivalent year. It was stated that the main reason for this discrepancy is that too much freight is transported by road in South Africa when compared with other countries, and furthermore that the wrong freight is transported by road (CSIR, 2009).

Freight transport enables the growth of the economy by providing critical goods in the right location at the right time. However, the 'impact' of freight transport as discussed implies that in order to ensure the sustainable growth of the South African economy, investigations into better or improved and therefore, more economical freight strategies are required.

At a high-level, the impacts of road freight can be split into two broad categories, namely: direct and indirect impacts. Direct impacts refer to costs borne by the owner or operator of the freight companies, whereas indirect impacts arise when the social or economic activities of one group of persons (i.e. freight companies) have an impact on another group and when that impact is not fully accounted, or compensated for, by the first group (European Commission Community Research, 2003).

South Africa has comparatively high transportation costs, much of which is due to road freight. These costs are however, due to direct costs. The total cost of transportation – inclusive of indirect costs – could be significantly greater than the 'known' direct costs. The determination of these costs is not always faultless and therefore the reliability of this information should be considered, and where possible, a range of costs evaluated. Not all of the indirect impacts are measured by a monetary value, and as a result, a conversion of these costs into a monetary value is required. This is facilitated through the application of shadow pricing. Shadow pricing has a number of different definitions depending on the application. For the purpose of this investigation, shadow pricing is defined as the method whereby monetary costs are associated with the indirect impacts of road freight transport.

1.2 Problem Statement

"Freight transport is likely to consume an increasing amount of energy and land, and it contributes to a wide range of problems, such as air and noise emissions, congestion and traffic fatalities" (Hesse and Rodrigue, 2004).

The 10th Annual State of Logistics Survey (CSIR, 2014) noted that in 2012, the cost of the abovementioned 'wide range of problems' amounted to a total of R40 billion (0.3% of GDP) for all freight transport in South Africa. In particular, the cost of the 'wide range of problems', or indirect impacts, of road freight along the Johannesburg to Durban Freight Corridor is unknown.

1.3 Overall Aim of the Investigation

The overall aim of this investigation is to determine the estimated cost of the indirect impacts, or externalities, of road freight on the Johannesburg to Durban Freight Corridor.

1.4 Objectives

The objectives of this investigation are to:

- Describe the indirect impacts of transporting freight via road,
- Calculate the cost of these indirect impacts on the Johannesburg to Durban corridor,
- Determine what these costs will be over a 30-year horizon considering numerous growth scenarios, and
- Recommend possible solutions to reduce the indirect impacts of road freight, and hence the associated indirect costs.

Having identified the objectives of the investigation, the following research questions are posed:

- What is the status quo of freight transport in a global, South African and Johannesburg to Durban Freight Corridor context?
- What are the future growth forecasts for freight on the Johannesburg to Durban corridor?
- What is the significance of freight transport in South Africa?
- Does the reported total cost of road freight transport take into account a holistic approach when determining the costs?
- How are direct and indirect impacts of road freight transport defined, and how do they differ?
- What are the direct and indirect impacts of road freight transport?
- What method can be used to assess the total indirect costs of all associated impacts?
- What are the estimated costs of the indirect impacts of road freight transport on the Johannesburg to Durban Freight Corridor?
- What are possible mitigation measures for the indirect impacts of road freight transport?
- What will the estimated costs of the indirect impacts of road freight transport on the Johannesburg to Durban Freight Corridor be in over a 30-year horizon, when considering future projections and possible mitigation measures?
- What are the alternative modes to road freight transport on the Johannesburg to Durban corridor?

Previous local and international research will be used to determine the internal and external costs caused by road freight. The costs will be summarised as a rate in terms of South African cents per ton kilometre (cents/ton-km) travelled. Alternative methods to transport freight on this corridor will be considered in an

attempt to identify the most sustainable solution. Road freight plays a pivotal role in the South African economy and a sustainable solution will need to meet the objectives of the freight logistics, which is illustrated in Figure 6.



Figure 6: Objectives of the freight logistics industry
 Source: CSIR Built Environment, 2009

1.5 Limitations and Scope of Investigation

The scope of this investigation is limited based on the following criteria:

- Extent of study area – this investigation is focussed on a case study of the N3 freight transport corridor between Johannesburg (South Africa's economic powerhouse) and Durban (Southern Africa's busiest port).
- Extensiveness of existing research – this investigation aims to review and combine existing specialist research studies which consider the specific indirect impacts of road freight. When doing so, local research and data will be considered and where this is either not available or sufficient, international data will be utilised.
- Access to data – the topic being researched is currently under discussion at a National level in South Africa. As a result there are a number of studies currently underway that are considering, for example, the Durban – Gauteng Corridor. Access to this information is therefore not always possible due to these studies not being completed. In addition, a large amount of information will be obtained from journals, papers and other widely available material.

1.6 Major Assumptions

The following major assumptions have been made in this investigation:

- All international currencies have been converted into South African Rands, with the applicable exchange rate.
- For the purpose of comparison and consistency, 2012 has been set as the base year for analysis purposes.
- Unless otherwise stated, all Rand values provided are at 2012 prices.
- Growth in total freight transported on the Johannesburg to Durban corridor is as postulated in the Analysis section, and is based on an understanding of local trends coupled with a desire to achieve certain economic growth targets for the country.

1.7 Outline of the Report

The process flow illustrated in Chapter Two outlines the approach to the research. This approach has been used to formulate the overall layout of this document, which will now be described.

Chapter Three considers a broad overview of the role of freight transport in a global context, discusses the current status quo of the South African freight industry, and describes how it has evolved into the present condition and where it is likely to go in the future. The Johannesburg to Durban freight corridor and its characteristics are also introduced in this section.

Chapter Four provides an understanding of the importance of freight transport in a South African context, and includes the costs of the logistics industry in relation to South African GDP.

Chapter Five identifies the negative impacts of road freight with specific emphasis on the indirect impacts.

Chapter Six determines the cost of each of these impacts using existing local, and where required, international studies. As far as possible, all known impacts will be taken into consideration and the costs determined based on a South African cents per ton kilometre (cent/ton-km).

Chapter Seven identifies possible solutions to mitigate the impacts of road freight and proposes alternative strategies that could be introduced to create a sustainable freight solution.

Chapter Eight includes an analysis of the calculated indirect cost per ton kilometre according to six scenarios. Each scenario is assessed from a base year of 2012 up to a horizon year of 2043 which is in line with Transnet's projected freight growth models. This analysis is specific to the Johannesburg to Durban corridor.

Chapter Nine presents and discusses the findings of the research.

Chapter Ten discusses conclusions and recommendations of the study. The initial research questions as identified in Chapter One are first discussed. Concluding remarks on the research are then provided, together with recommendations on the application of this investigation. Further research areas are also identified.

2 METHODOLOGY

In order to clearly explain the methodology undertaken during the investigation, a Study Overview is illustrated in Figure 7. Each step in this sequence is discussed briefly in this chapter.

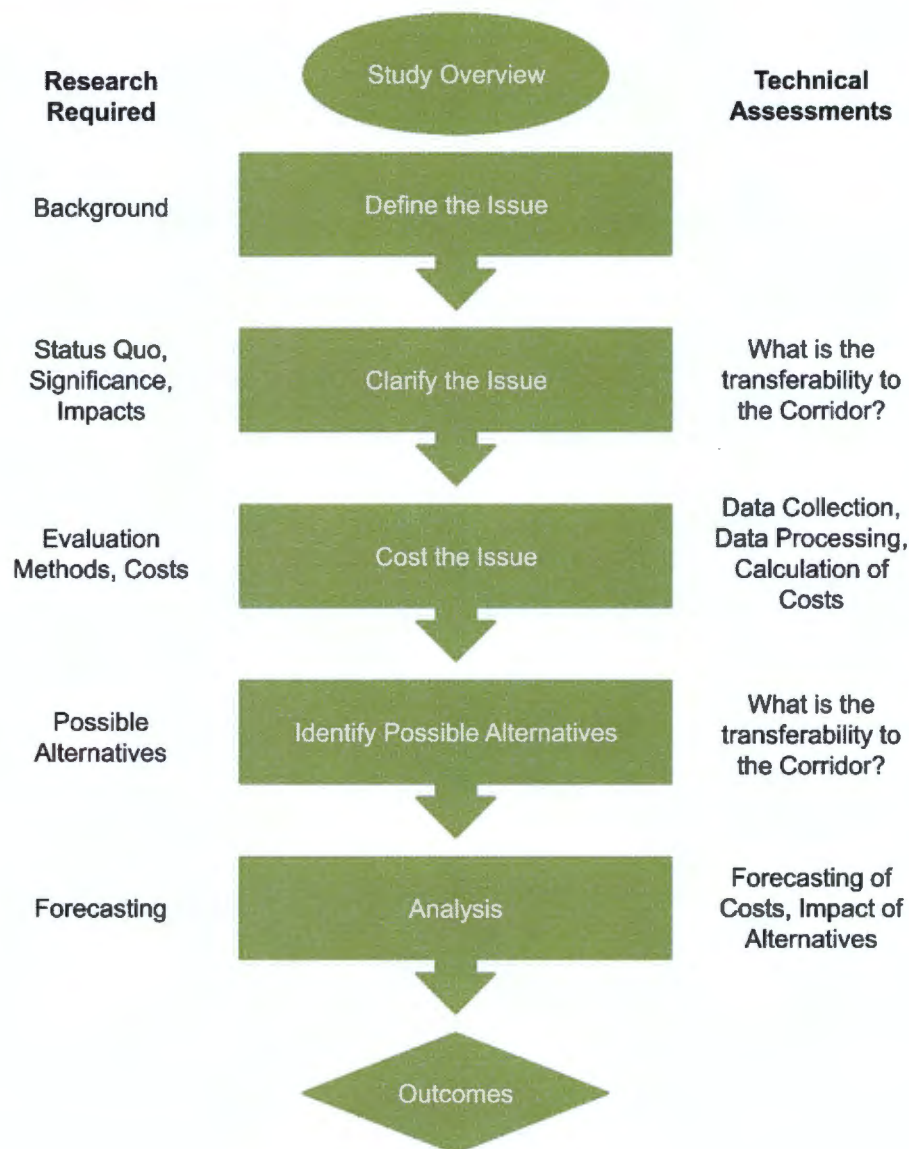


Figure 7: The overview of the study

- (1) **Define the Issue:** Background to the problem will be researched to determine the problem statement.
- (2) **Clarify the Issue:** The status quo of freight transport will be established, looking at the Global, South African, and Johannesburg to Durban Corridor context. The significance of freight transport will be investigated, highlighting its critical role in the South African economy. The numerous impacts of freight transport will be identified, with direct and indirect impacts being defined, and a distinction made between the two.
- (3) **Cost the Issue:** The method used to assign costs to the indirect impacts will be researched and presented, followed by a review and discussion on the available literature of the costs associated with indirect impacts. The required data will then be collected and where applicable, processed to ensure that all costs are being reported using the same base. The cost per ton kilometre will then be determined for each impact.

- (4) **Identify Possible Alternatives:** Possible alternatives and improvements will be researched and discussed.
- (5) **Analysis:** Having calculated the cost of the indirect impacts per ton kilometre, the current estimated cost of the indirect impacts of road freight on the Johannesburg to Durban Freight Corridor will be determined. Various growth scenarios for freight along the corridor will be researched, presented and discussed, taking into account possible scenarios which include the researched alternatives and improvements. The total cost of the indirect impacts for each scenario will be calculated.
- (6) **Outcome:** At the end of the investigation, the findings will be written up. Conclusions will be drawn based on the findings in order for recommendations to be made.

3 STATUS QUO OF FREIGHT TRANSPORT

“Globalisation of production and trade is among the defining characteristics of our era. The scale of economic activity is just as impressive as the speed of technological development. Lower production costs and higher productivity have contributed to the creation of greater wealth today than ever before. Without a doubt, transport is an indispensable part of this process. It provides vital distribution for production, as well as essential personal mobility, directly interconnecting businesses to worldwide markets. Transport is a key element of economic growth and competitiveness” (Yildirim, 2009).

An effective and reliable transfer of goods is vital in contributing to the economic growth and stability of a country. When looking to define the role of the freight sector, it is important to understand its origins and the role it currently plays in both a global and local context. In order to understand how the freight transport sector has developed in South Africa, it is important to first consider the global role that freight transport plays. Thereafter, a history of freight in South Africa will be introduced which will enable the introduction of the Johannesburg to Durban freight corridor. The intention of this Chapter is to:

- Introduce the role of freight transport in a global context (note that the majority of the research has been conducted by the US Department of Transport, however it still refers to countries worldwide),
- Discuss the current status quo of the South African transport network,
- Provide an understanding of how freight transport originated in South Africa and identify the circumstances that led to the current status quo,
- Determine the importance of road freight in a South African context, and
- Introduce the Johannesburg to Durban freight corridor and its characteristics.

3.1 Global Freight Transport

“The movement of international freight among nations relies on a complex array of long-distance transportation services. The process involves many participants, including shippers, commercial for-hire carriers, third-party logistics providers, and consignees. Moreover, global trade depends on seaport and airport services to move large volumes of merchandise over long distances via a variety of transportation modes. The interaction of these services and participants is vital to successful global trade” (US Department of Transportation, 2010).

3.1.1 Modal Choice

The US Department of Transport produces Freight Facts and Figures periodically, with the latest available document being published in 2012. Included in the information is a breakdown per mode in terms of weight, value and ton-miles. This information is illustrated in Figure 8, Figure 9 and Figure 10 (respectively) and is presented according to a distance band, thereby enabling a comparison of which modes are preferred over different distances (US Department of Transportation, 2012).

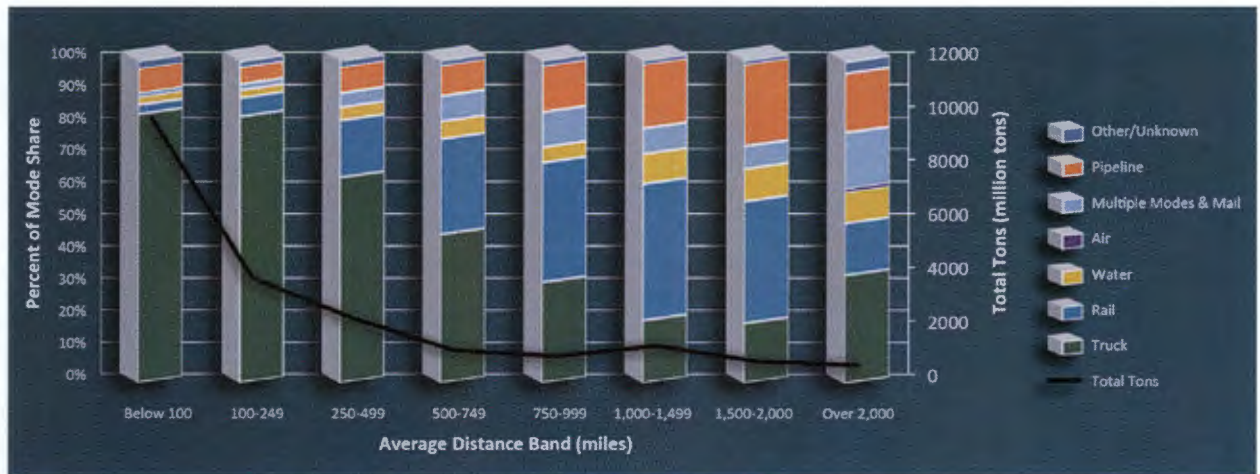


Figure 8: Mode Share of Tonnage and Total Tonnage by Distance Band: 2007
 Source: US Department of Transportation, 2012

Trucks transport the largest share of goods by weight for distances less than 750 miles (1200 kilometres) and more than 2,000 miles (3200 kilometres). Rail is the dominant mode for goods moved between distances of 750 and 2,000 miles (US Department of Transportation, 2012).

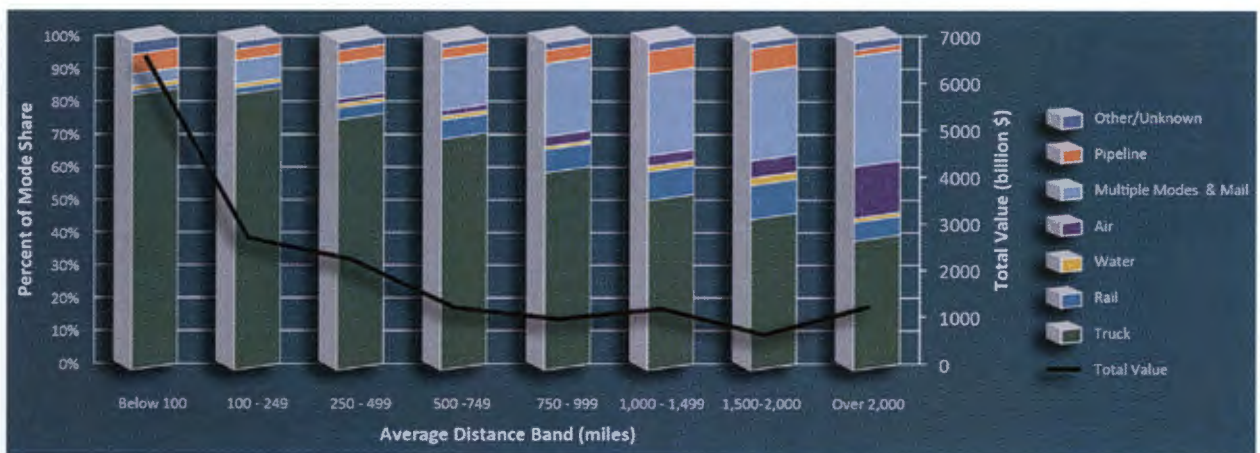


Figure 9: Mode Share of Value and Total Value by Distance Band: 2007
 Source: US Department of Transportation, 2012

Trucks transported the largest percentage of goods by value across all distance bands. For distances less than 250 miles (400 kilometres), trucks are responsible for transporting approximately 84% of the value of all goods transported (US Department of Transportation, 2012).

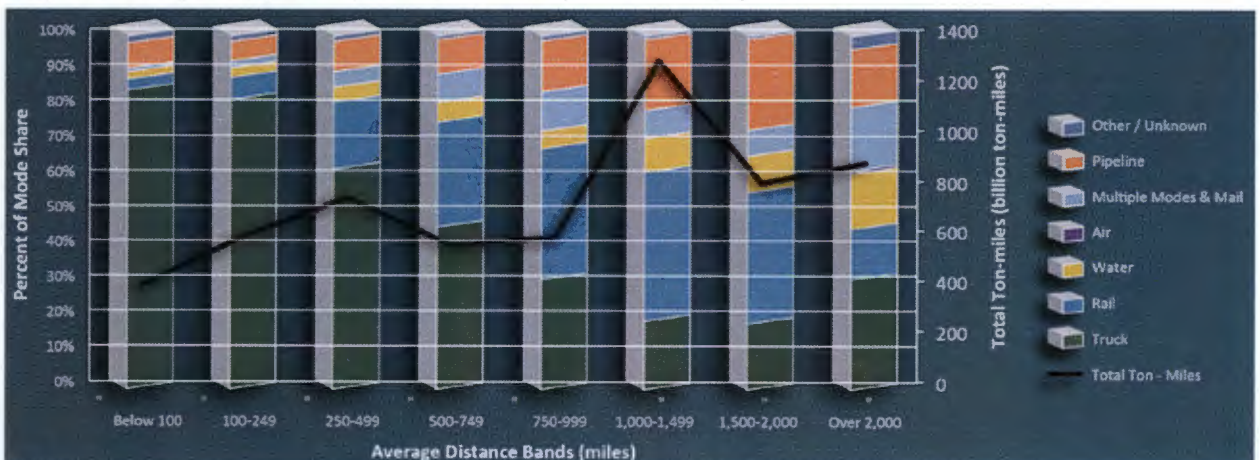


Figure 10: Mode Share of Ton Miles and Total Ton Miles by Distance Band: 2007
 Source: US Department of Transportation, 2012

The modal distribution for ton miles is similar to that for tons. Trucks are the most dominant for distances less than 750 miles and over 2,000 miles. Rail is preferred for distances between 750 and 2,000 miles (US Department of Transportation, 2012).

Nearly all shipments require the use of more than one mode of transportation to reach their final destination. For example, a shipment of imported goods arriving at a maritime port is transferred to rail or truck to continue its journey. Railroads tend to carry commodities over long distances at low prices, while trucks often carry commodities over shorter distances and with shorter travel time. Figure 11 illustrates the percentage share of various transport modes by both value and weight for the US in 2007. It should be noted that land includes truck, rail and pipeline modes (US Department of Transportation, 2010).

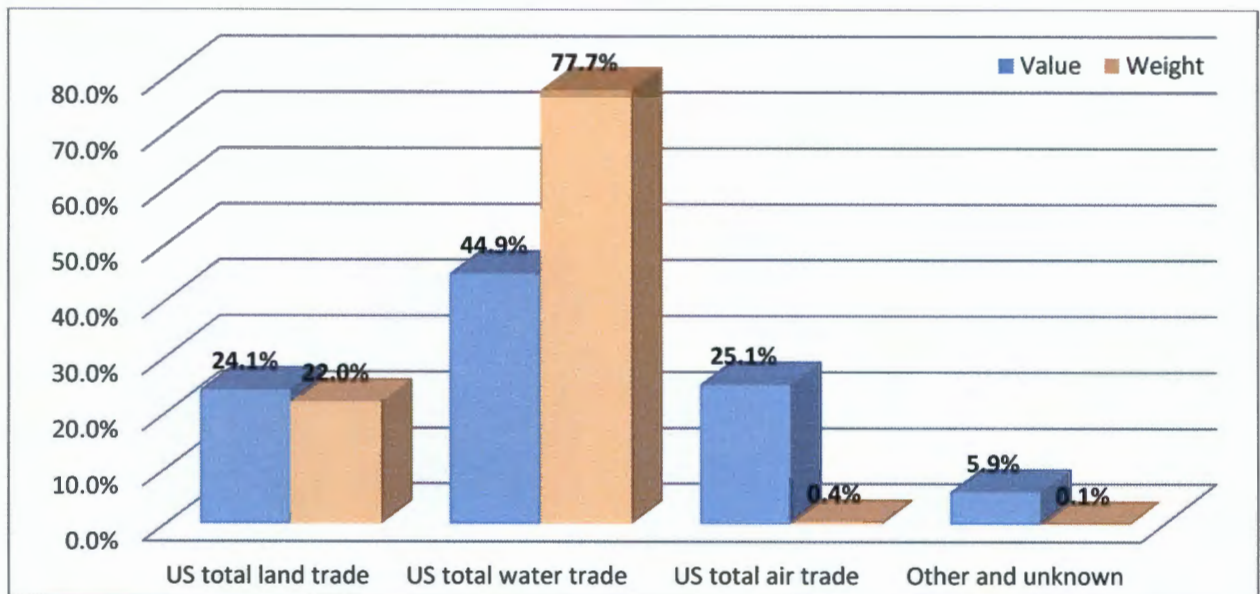


Figure 11: Modal Shares of US Trade Handled by Land, Water, and Air Gateways by Value and Weight: 2007
 Source: United States Department of Transportation, 2010

In 2007, waterborne vessels accounted for more US international trade, both in terms of tonnage (78%) and value (45%), than any other mode. Water transportation is less dominant in terms of value because high value-per-ton commodities often move by air and truck, particularly in US trade with Canada and Mexico.

The information above outlined modal share for trade movements. On the other hand, the domestic modal share in the US is understandably different. The US Department of Transportation produced the 2007 Commodity Flow Survey in 2009; the outcome of this survey includes a summary of the freight distribution among modes by tons, ton-kilometres and value in 2007 (illustrated in Figure 12, Figure 13 and Figure 14 respectively). The Commodity Flow Survey is for domestic shipments only; it does not include movements for imported intermodal transfers – such as ship-to-land transfers – and is therefore not comparable to the results displayed in Figure 11.

As illustrated by Figure 12 (weight) and Figure 14 (value), most goods are moved via truck. The amount of freight moved by rail, however, is comparable when one considers the amount (weight) multiplied by distance as measured in ton-kilometres. It should be noted that the multimodal category includes the traditional intermodal combination of truck and rail plus truck and water; rail and water; postal and courier service; and other multiple modes for the same shipment (US Department of Transportation, 2009).

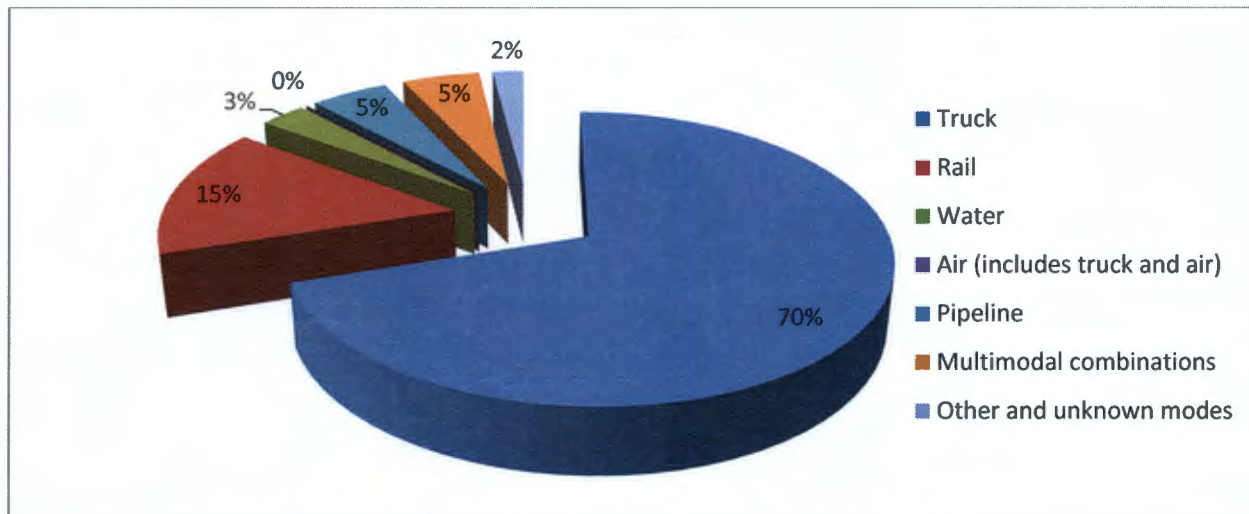


Figure 12: Freight distribution among modes by tons in 2007
 Source: United States Department of Transportation, 2009

For weight of goods transported, Figure 12 shows that road freight is dominant (70%), followed by rail (15%), with the remaining modes making up the other 15%.

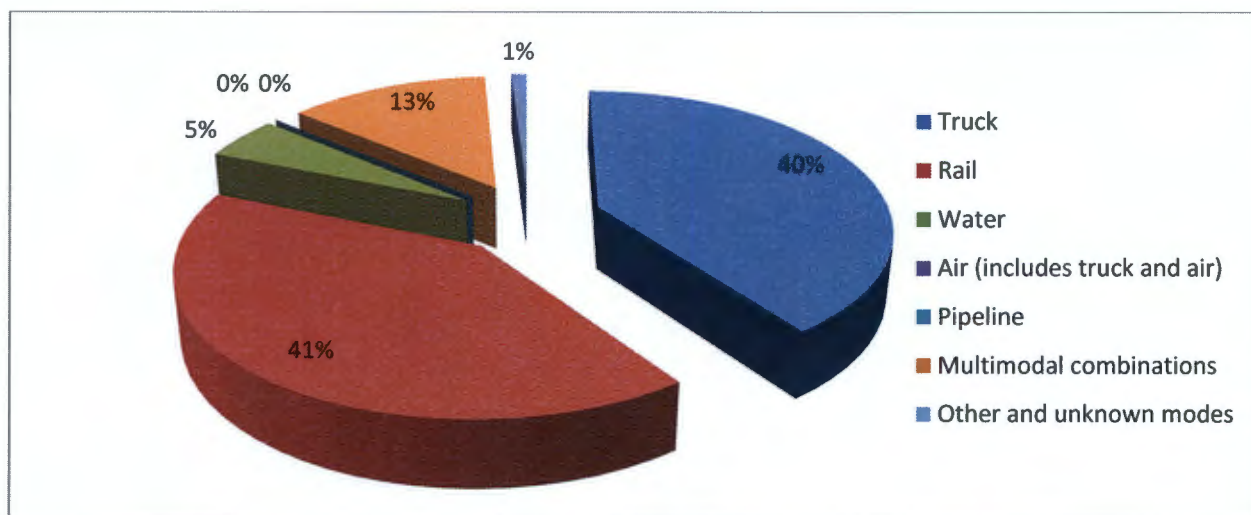


Figure 13: Freight distribution among modes by ton-kilometres in 2007
 Source: United States Department of Transportation, 2009

As shown in Figure 13, when taking the distance travelled into account in addition to the volume transported, rail (41%) and road (40%) freight transport are decidedly comparable in the US; this is due to the longer average travel distances by rail combined with the suitability of rail to transport bulk (heavy) goods, thereby translating into high ton-kilometres.

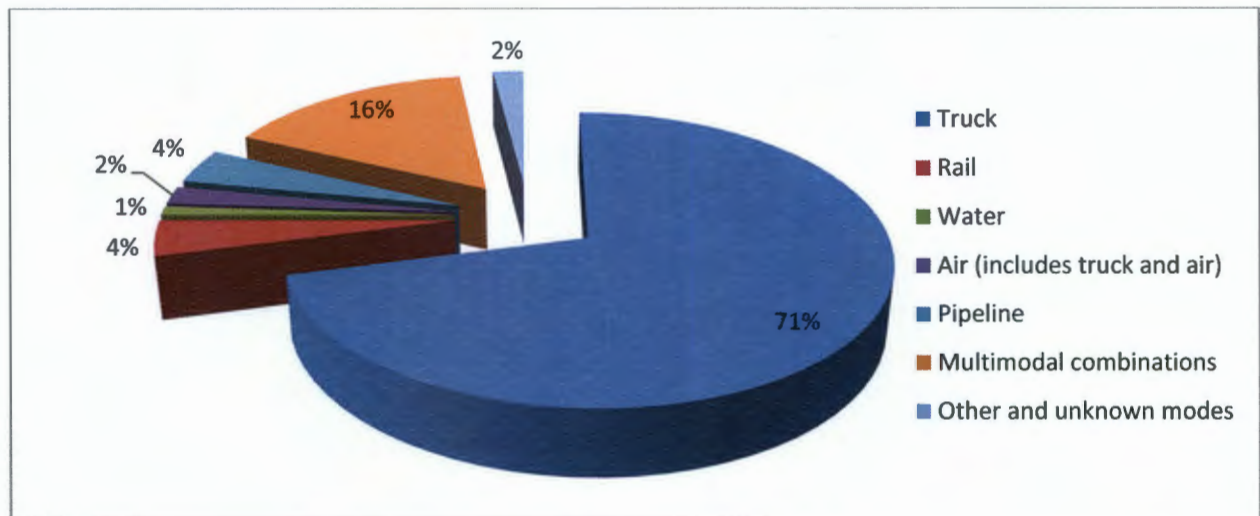
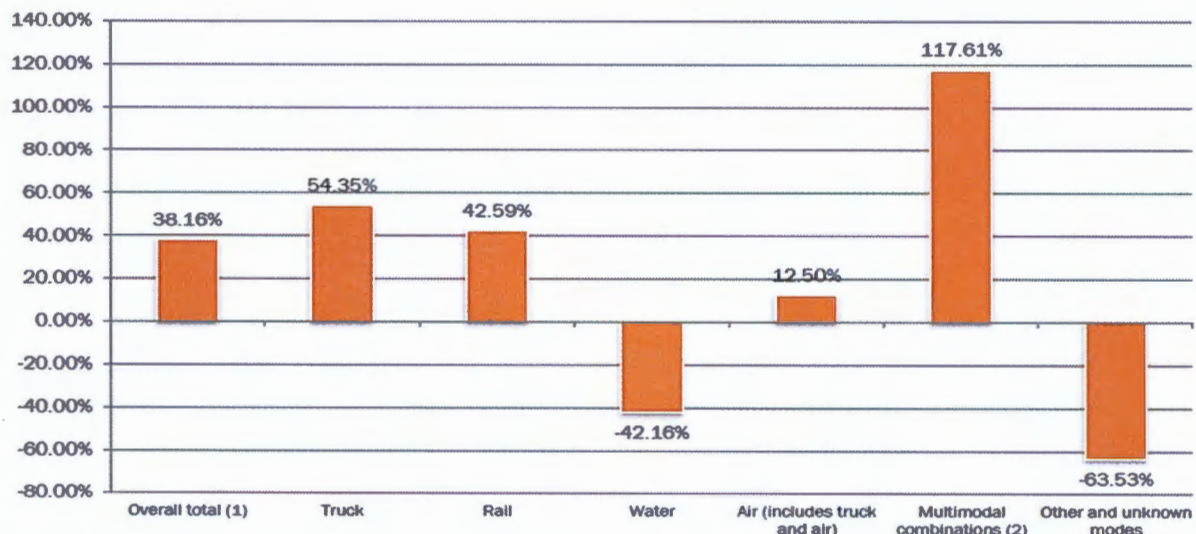


Figure 14: Freight distribution among modes by value in 2007
 Source: United States Department of Transportation, 2009

Due to the freight transportation industry being highly competitive, the private sector chooses the most cost-effective mode for transportation. For instance, intermodal transport (using more than one mode) handled less than 11% of goods by value in 2007, likely due to the cost of transferring goods between modes. There is, however, evidence that some of these transfer costs are offset by low-cost, long-distance hauls. The Federal Highway Administration (FHWA) estimates intermodal transport’s share of goods will increase to over 21% by 2035 (US Department of Transportation, 2009).

3.1.2 Trends

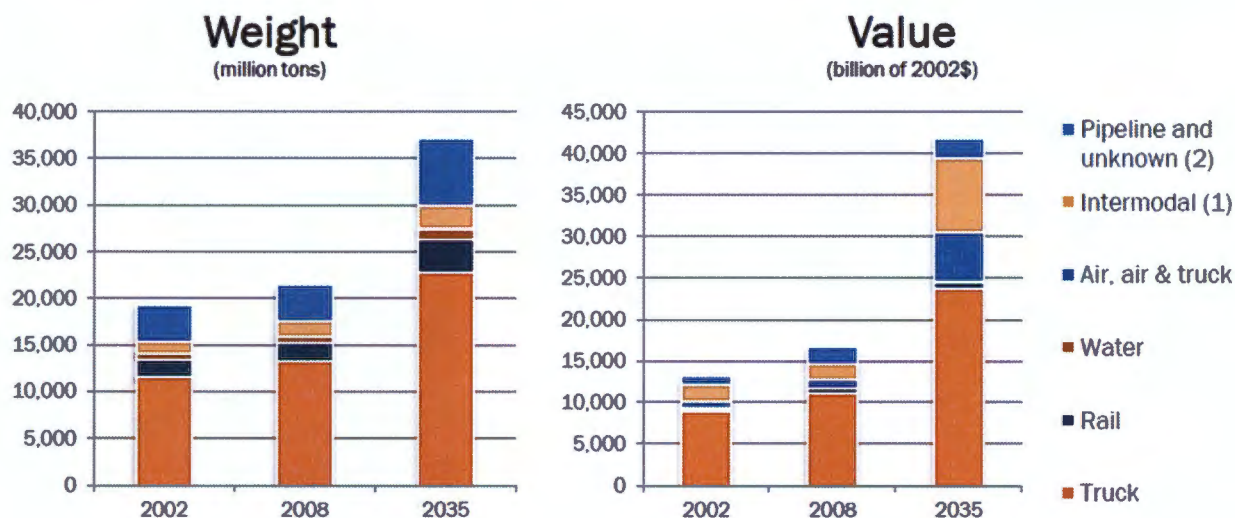
Between 1993 and 2007, freight transportation (total ton-miles) in the US grew by over 38% (see Figure 15). A significant amount of this was due to the increase in truck ton-miles. The increase in road freight is due to cost competitiveness and the advent of just-in-time (JIT) inventory management.



(1) CFS plus out-of-scope estimates. (2) Multimodal includes the traditional intermodal combination of truck and rail plus truck and water; rail and water; parcel, postal, and courier service; and other multiple modes for the same shipment.

Figure 15: Percent change in ton-miles per mode between 1993 and 2007
 Source: Centre for Climate and Energy Solutions, 2010

Figure 16 provides a breakdown of the modal share of goods transported by weight and value for 2002 and 2008. Also included is a projection of the modal share in terms of value and weight in 2035. The US DOT estimates that trucks will continue to increase their share of freight transportation.



(1) Intermodal includes U.S. Postal Service and courier shipments and all intermodal combinations, except air and truck. Intermodal also includes oceangoing exports and imports that move between ports and interior domestic locations by modes other than water. (2) Pipeline and unknown shipments are combined because data on region-to-region flows by pipeline are statistically uncertain.

Figure 16: Trends for freight transportation by weight and value in the US

Source: U.S. Department of Transportation, 2009

The United States Department of Transportation prepared a document entitled *Freight Transportation: Global Highlights (2010)*, which provides a broad overview of trends in the movement of international freight among the top 25 world economies as measured by 2008 Gross Domestic Product (GDP).

As the largest freight transport system in the world, the United States transportation network serves more than 300 million people and 7.5 million businesses across almost 10 million square kilometres of land. The freight network enables the movement of raw materials and finished product between production and consumption centres and is a vital component of commerce in the United States. Between 1998 and 2008, world merchandise freight exports nearly tripled in value from \$5.4 trillion to \$16 trillion. During the same period, US freight exports almost doubled from \$682 billion to \$1.3 trillion (US Department of Transportation, 2010).

The rising trend in world exports indicates the strong connectivity among countries and the increased globalisation of economic activities that generate freight movements. Almost all countries export goods, and the United States receives exports from more than 200 countries; however, the overwhelming majority of global exports are concentrated in only a few countries. In 2008, the concentration of world exports among the top trading nations was significant (US Department of Transportation, 2010):

- More than half (51%) of the exports were from 10 countries,
- Three-quarters (76%) were from 25 countries, and
- Approximately 91% were from the top 50 countries.

In 2008, the global economic downturn had a significant impact on freight. This can be justified as freight is generated by economic activity and therefore responds to global financial market fluctuations. Prior to 2008, the main challenge experienced by the freight sector was the significant growth in trade that resulted

in capacity constraints within the freight system. From 2009 onwards the challenge has been to manage the excess capacity as a result of freight businesses contracting in tough financial times due to reduced trade volumes. By the end of September 2009, there were an estimated 548 container vessels with a carrying capacity of 1.3 million 20-foot equivalent units (TEUs) that were idle at seaports worldwide due to the decline in global demand for containership services (US Department of Transportation, 2010).

The global freight transportation infrastructure handles large volumes of cargo. In 2008, more than \$16 trillion of exported freight was transported worldwide. Maritime vessels, airplanes, trucks, and trains transported these goods from production centers to various consumption markets. In 2008, the top three global merchandise exporters were China, Germany, and the United States. Together they accounted for 26% of the value of total worldwide freight exports (US Department of Transportation, 2010). The value of goods exported by country is represented graphically in Figure 17.

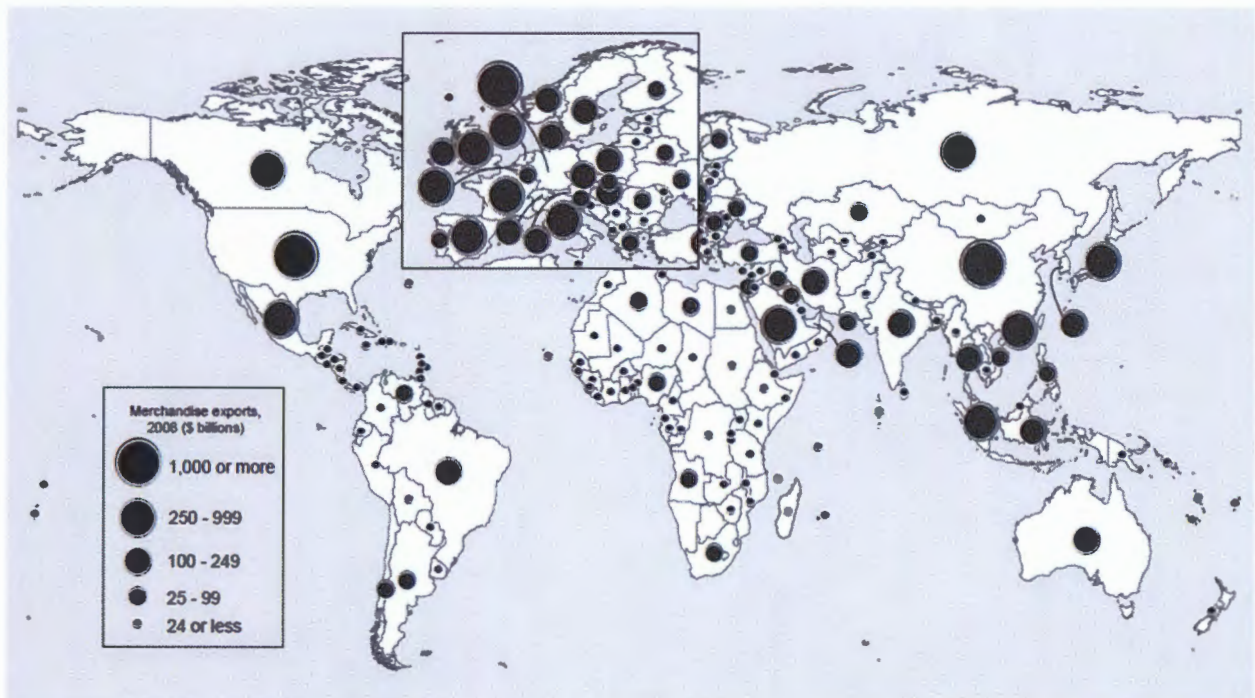


Figure 17: Value of World Goods Exports by Country: 2008
Source: United States Department of Transportation, 2010

A significant proportion of global freight originates from the world's leading economies. In 2008, the world's top five economies by Gross Domestic Product (GDP), namely the United States, Japan, China, Germany, and France together accounted for (US Department of Transportation, 2010):

- 35% of global goods exports (\$5.6 trillion out of \$16 trillion),
- 50% of global GDP (\$30.1 trillion out of \$60.9 trillion), and
- 28% of world population (1.9 billion out of 6.8 billion people).

3.1.3 Overview of Leading Economies

Table 3 provides an overview of ten countries (ranked according to total roadway kilometres) that fall within the top 20 leading economies in 2008 in terms of GDP. The United States has the highest total of roadways, railways, pipelines and airports in comparison to other countries. The US was ranked as the leading economy in 2008 (US\$ 14.3 trillion) with a share of 23.4% of global GDP (US Department of Transportation, 2010).

Table 3: Extent of Physical Transportation Systems in World's Top Economies

Source: United States Department of Transportation, 2010

Country (Ranked by total roadways)	Roadways		Railways (km)	Waterways (km)	Pipelines (km)	Airports (No.)	2008 GDP of leading economies		
	Total (km)	Paved roads (km)					Rank in terms of 2008 GDP	Value (Billions of US \$)	Share of Global GDP (%)
United States	6 465 799	4 209 835	226 427	41 009	793 285	5 146	1	14 265	23.4
India	3 316 452	1 517 077	63 327	14 500	22 773	251	12	1 210	2.0
China	1 930 544	1 575 571	77 834	110 000	58 082	413	3	4 402	7.2
Brazil	1 751 868	96 353	28 857	50 000	19 289	734	10	1 573	2.6
Japan	1 196 999	949 101	23 506	1 770	4 082	144	2	4 924	8.1
Canada	1 042 300	415 600	46 688	636	98 544	514	11	1 511	2.5
France	951 500	951 500	29 213	8 501	22 804	295	5	2 866	4.7
Russia	933 000	754 984	87 157	102 000	246 855	596	8	1 677	2.8
Australia	812 972	341 448	37 855	2 000	30 604	462	14	1 011	1.7
Spain	681 224	681 224	15 288	1 000	11 743	154	9	1 612	2.6
Total	19 082 658	11 492 693	636 152	331 416	1 308 061	8 709	N/A	35 051	57.6

In comparison with the US, Japan has a considerably smaller transport system; it is, however, ranked second in terms of GDP (US\$ 4.9 trillion) with an 8.1% share of global GDP. A further notable point is the minute percentage (6%) of paved roads in comparison to the total road network in Brazil. The total area of a country as well as total population should, however, be considered when examining total transport system size. When road networks are viewed in relation to total land area, countries such as Japan and France have at least twice as many kilometres of roadways per square kilometre of land area as the United States. On the other hand, if road networks are viewed in relation to population, these two countries have fewer roadway kilometres per person than the United States. This may be attributed to the lower population density and vast geographic expanse of the United States (US Department of Transportation, 2010).

3.1.4 Logistics Performance

“Improving logistics performance is at the core of the economic growth and competitiveness agenda. Policymakers globally recognise the logistics sector as one of their key pillars for development. Trade powerhouses in Europe like the Netherlands or in developing countries like Vietnam or Indonesia see seamless and sustainable logistics as an engine of growth and of integration with global value chains. Indeed, inefficient logistics raises the costs of trading and reduces the potential for global integration. This is a hefty burden for developing countries trying to compete in the global marketplace” (World Bank, 2014).

In 2014, the World Bank prepared the Logistics Performance Index (LPI), which has been produced bi-annually since 2007. The LPI measures the on-the-ground efficiency of trade supply chains or logistics performance and is based on a worldwide survey of global freight forwarders and express carriers. The top 15 countries only are pictured alongside; South Africa is ranked at number 34 with a score of 3.43 at 77.9% of the highest performer. The index is graphically represented in Figure 18, and shows that South Africa performs well in comparison to many developed countries.

Economy	2014 LPI		
	Rank	Score	% of highest performer
Germany	1	4.12	100.0
Netherlands	2	4.05	97.6
Belgium	3	4.04	97.5
United Kingdom	4	4.01	96.6
Singapore	5	4.00	96.2
Sweden	6	3.96	94.9
Norway	7	3.96	94.8
Luxembourg	8	3.95	94.4
United States	9	3.92	93.5
Japan	10	3.91	93.4
Ireland	11	3.87	91.9
Canada	12	3.86	91.5
France	13	3.85	91.2
Switzerland	14	3.84	91.1
Hong Kong SAR, China	15	3.83	90.5

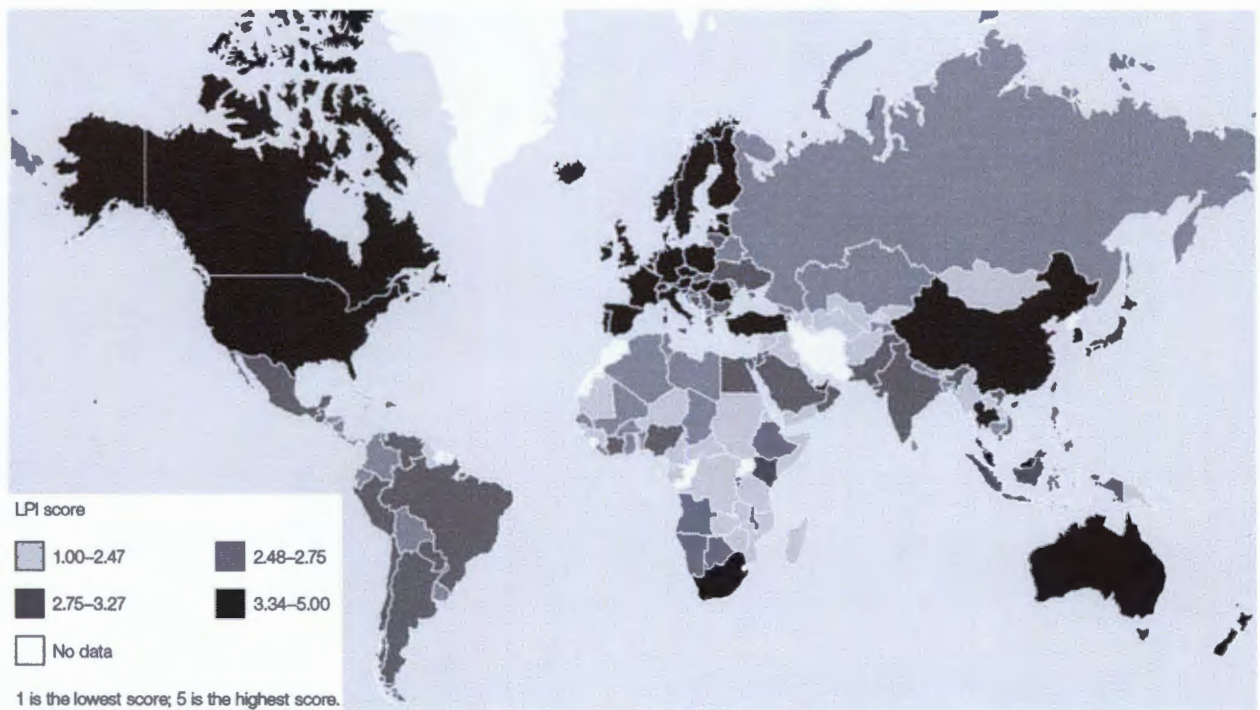


Figure 18: Global Logistics Performance Index
 Source: World Bank, 2014

International trade and commerce relies on global supply chains. The logistics sector of global supply chains includes freight transportation, warehousing, border clearance, payment systems, and increasingly more functions outsourced by producers and merchants to dedicated logistics service providers. As a result, the importance of good logistics performance for economic growth, diversification, and poverty reduction is firmly established (World Bank, 2014).

Also included in the LPI survey are factors deemed important to the logistics sector moving forward. These include infrastructure, ICT, regional connectivity, availability of data and green logistics to name a few. Figure 19 provides a summary of the components which respondents felt were the most important.

LPI component	Bottom quintile	Third and fourth quintiles	Second quintile	Top quintile
Transport infrastructure	✓	✓	✓✓	✓
ICT	✓	✓		
Logistics facilities			✓	✓✓
Customs	✓✓✓	✓✓	✓	
Integration of border management	✓	✓✓✓	✓✓✓	✓
Services reforms	✓✓	✓✓✓	✓✓✓	
Regional facilitation and corridors	✓✓✓	✓✓	✓✓	
National data tools	✓	✓	✓✓✓	✓✓✓
Green logistics			✓✓	✓✓✓

✓✓✓ is very important; ✓✓ is important; ✓ is fairly important.

ICT is information and communications technology.

Figure 19: Trade logistics reform matrix

Source: World Bank, 2014

The top 25% (No. 1 – 40) of countries on the LPI placed the greatest importance collectively on national data tools and green logistics. This demonstrates the importance of the availability of information through websites, satellite tracking, etc, which enables logistics firms to be more efficient and effective as well as to integrate all aspects of the supply chain. In addition, the highest ranked logistics countries value the environment and hence place significant importance on any initiatives that could decrease the impact of logistics on the environment.

The LPI shows that the quality of services is driving logistics performance in emerging and richer economies. Logistics performance is strongly associated with the reliability of supply chains and the predictability of service delivery for producers and exporters. Supply chains – only as strong as their weakest links – are becoming more and more complex, often spanning many countries while remaining critical to national competitiveness. Comprehensive reforms and long-term commitments from policymakers and private stakeholders will be essential (World Bank, 2014).

3.2 South African Freight Transport

3.2.1 Status Quo of South African Transport

The previous section introduced freight in a global context. This section will now provide an overview of the transport network and consider the role that freight transport plays in South Africa.

3.2.1.1 Road Infrastructure

In total, South Africa has a road network of over 750 000 kilometres (DoT, 2005). This infrastructure network comprises surfaced, gravel and earth roads which vary in condition from very good to very poor. The composition of the South African road network is displayed in Figure 20.

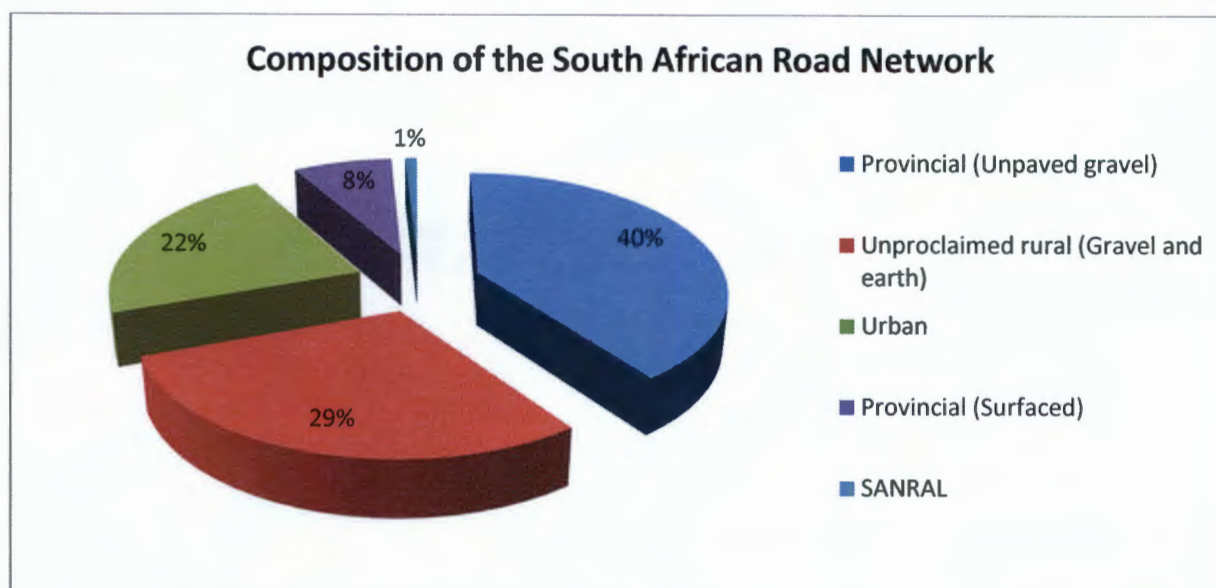


Figure 20: The composition of the South African road network

Source: DoT, 2005

The Department of Transport (2005) reported that a road condition assessment identified that more sections of the national network are in very good, good, or fair condition than is the case for provincial roads. The condition of provincial roads is decreasing as the number of heavy vehicles utilising these roads increases and as a result of unscrupulous operators overloading their vehicles.

The Gauteng - Durban corridor carries 29 million tons (2005) of cargo annually and is the busiest freight corridor in South Africa in terms of tonnage transported. The primary road infrastructure is of very good quality; however, when combined with the secondary provincial road network, a reported index of 38% of roads fall into the poor to very poor condition – compared to an international benchmark of 5 – 10%. Whilst transport of freight via road has a number of advantages, the road system has been reported by (DoT, 2005) as “*facing gradual degradation due to underlying shortcomings of the system.*” This is primarily, due to two reasons (DoT, 2005):

- Investment levels in the road network are estimated to be half of what they should be, and
- The significant increase in heavy vehicle traffic volumes is shortening the required maintenance and rehabilitation cycles.

3.2.1.2 Road Freight Operations

South African road freight operators move approximately 647 million tons of freight per annum, with an estimated 30% moved for reward and 70% for in-house requirements. Whilst the flexibility afforded by the road system plays a large role in the increase in road freight traffic, it is also apparent that the real prices within the road freight industry have declined since 1992 (DoT, 2005). An example of the decline in real prices in Rand per ton-kilometre is provided in Figure 21 for two of the largest road freight companies in South Africa. This is a consequence of the competitive environment and technological advances in the industry, including improved fuel efficiency, increased fleet utilisation and the use of information management techniques. DoT (2005) also reports that the service levels for road freight are good and comparable to those of European operators.

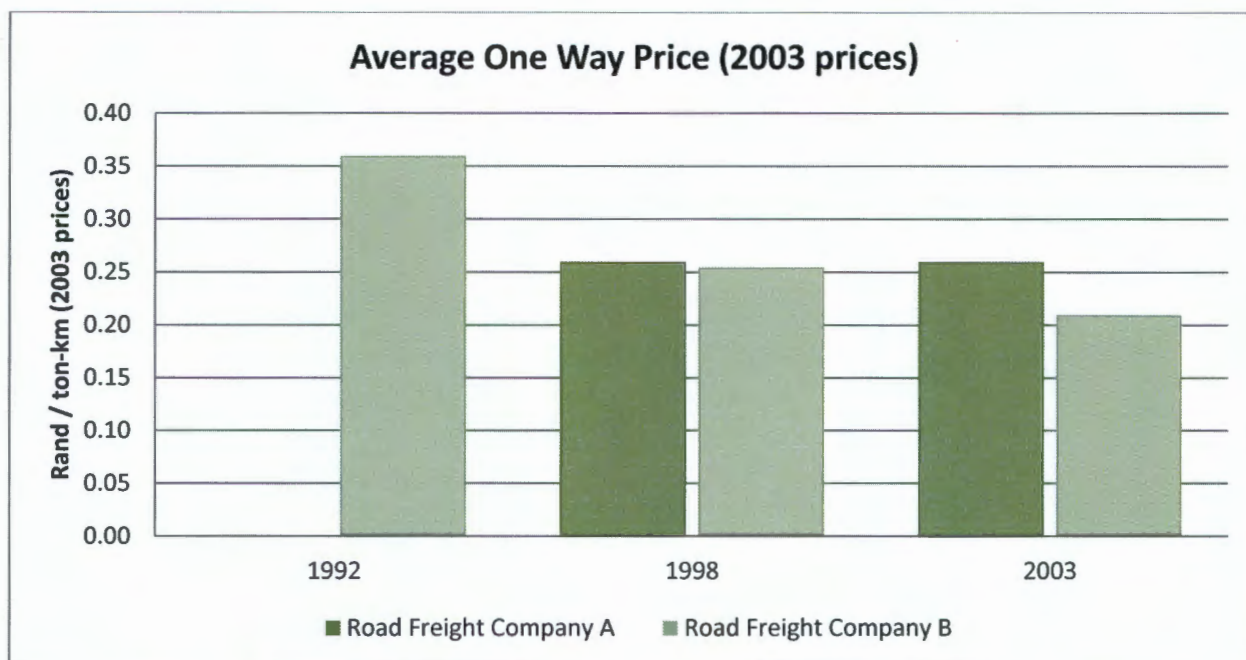


Figure 21: The decline of real prices for two large road freight companies in South Africa
Source: DoT, 2005

A consequence of this competitive environment is long working hours for drivers, particularly for smaller operators. Long working hours result in driver fatigue and can lead to an increased number of accidents involving heavy vehicles. The fatal accident rate for trucks increased from 8 to 10 fatalities per 100 million vehicle kilometres travelled from 1991 to 2000, and from 10 to 13 fatalities per 100 million vehicle kilometres travelled from 2001 to 2003 (DoT, 2005).

Another concern to those in the freight industry is the prevalence of HIV/AIDS which is reported to be significantly higher among long distance truck drivers than among any other group (DoT, 2005), which increases the cost of transport, as a result of extended sick leave and benefit costs, to the operator.

3.2.1.3 Road Maintenance

The shift from rail to road transport that has occurred over the last few decades has naturally resulted in higher volumes of heavy traffic on the South African road network. This is in addition to the increasing number of private vehicle owners who commute on the network daily. Private vehicles only have a minimal effect on road maintenance requirements; on the other hand, the impact of the increase in the number of heavy vehicle sales can be seen on the road network. Van der Mescht (2006) suggests that the majority of the national road network, managed by SANRAL, is in a serviceable condition and receives regular maintenance. Many provincial roads by comparison have not, however, been maintained adequately and are in a 'state of disrepair' (Van der Mescht, 2006). Figure 22 displays the road network for each authority in comparison to the maintenance cost allocation per kilometre of road.

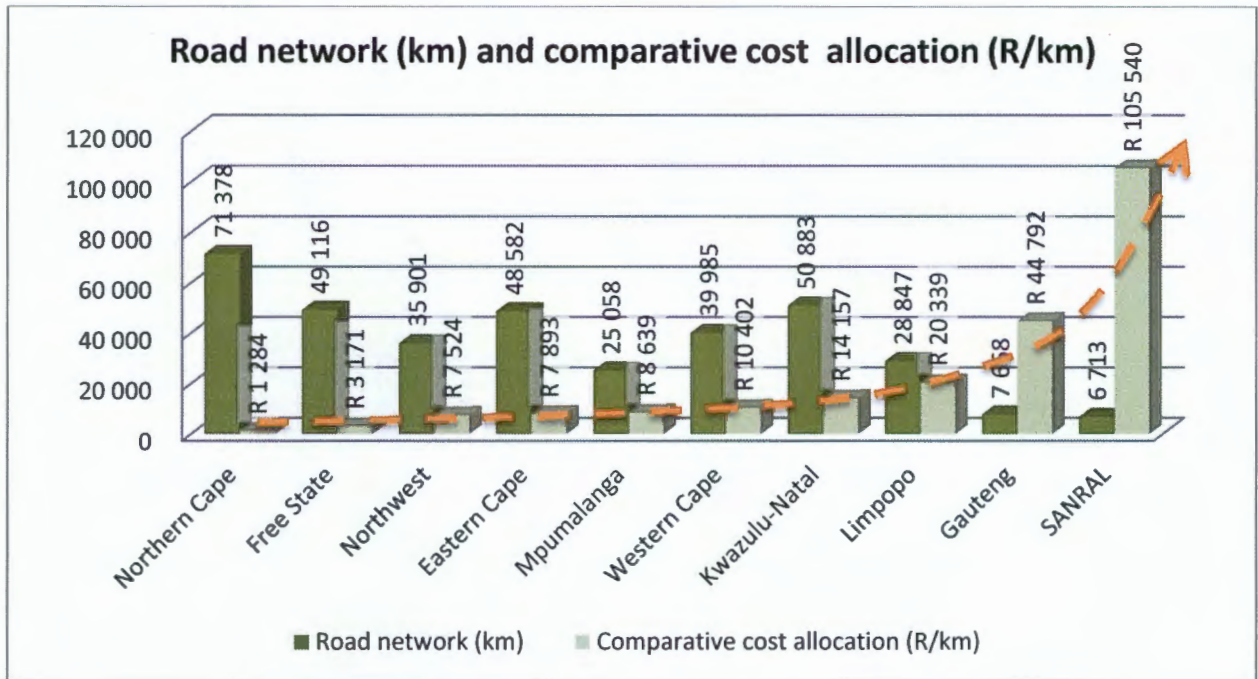


Figure 22: Road maintenance expenditure in 2001

Source: Annual Transport Statistics, 2002

The information in Figure 22 displays the disparity between the equivalent expenditure per kilometre on maintenance for different road authorities. The dashed line indicates the increasing comparative cost allocation (R/km) across the different road authorities. The expenditure on maintenance in the Western Cape (R 10 402/km) represents the average when total costs are divided by the entire road network (Annual Transport Statistics, 2002).

The Northern Cape has the largest road network (71 378 km) to maintain, yet the allocation for maintenance in this province is the lowest at an estimate R 1 284/km. This is in contrast to a province like Gauteng which has a 7 668 km road network and an allocation for maintenance of R 44 792/km. SANRAL has the largest allocation on a R/km basis, with R 105 540/km spent on the National road network (6 713 km) for maintenance (Annual Transport Statistics, 2002).

Stander and Pienaar (2002) note that road users contribute 5% of total government revenue through revenue generated from the fuel levy alone, whilst expenditure on transport and communication amounts to 4% of total government spending.

3.2.1.4 Rail Infrastructure

The competition between road and rail transport for market share in the freight industry varies according to the type of commodity and area. Rail is almost exclusively responsible for the haulage of export coal and iron ore traffic, while road freight is the dominant mode of transport in urban areas and in particular of consumer goods. The competition between these two modes for the conveyance of general freight is therefore restricted to major transport corridors and rural areas (CSIR Built Environment, 2008).

When railway lines were built in SA, attempts were made to limit initial construction costs by selecting routes which avoided high mountain ranges and deep river basins. The result is considerably longer rail links compared to the equivalent distance by road. Hence, rail is at a disadvantage when looking to transport perishables and time sensitive goods (Van der Mescht, 2006).

The South African railway network predominantly uses a rail gauge of 1067 mm, with the exception of a few narrow gauge branch lines. This is less than the international standard gauge of 1435 mm. Horizontal and vertical clearances along the railway lines are also below international standards. These affect the maximum allowable width and height of rail vehicles, and one such disadvantage is that this system is unable to accommodate modern double-stack container wagons or 'piggy-back' operations (Van der Mescht, 2006).

In attempts to cut costs, Spoornet (now Transnet Freight Rail) has terminated unprofitable rail services and the infrastructure currently lies unmaintained and underutilised. The company is, however, reluctant to lease / sell these underutilised lines to the private sector (Van der Mescht, 2006).

3.2.1.5 Rail Freight Operations

Van der Mescht (2006) reports that since 1990 there have been many press reports regarding poor service delivery from Spoornet (now Transnet Freight Rail), including threats from prominent export companies stating that they will switch to road transport if the utility does not improve on service delivery. Van der Mescht (2006) also cites Bailey and Thomas (2004), who state that the decline in the market share for the conveyance of general freight by rail is due to "*South Africa's apparent rail strategy, which is to marginalise rail and focus on minimising perceived losses by cutting expenses – rather than developing an integrated transport model for the country*" (Van der Mescht, 2006). This is an important deduction as it once again notes that every mode has its time and place and an integrated approach to freight transport is required in order to ensure sustainability. This will, however, come at an initial large capital cost (such as upgrading rail infrastructure) which will need to be borne by someone. This begs the question as to whether the rail network in South Africa has effectively become redundant.

3.2.1.6 Does South Africa have a redundant rail network?

A number of transportation professionals have questioned the Government's decision to invest further in rail infrastructure. Van der Mescht (2006) lists a number of authors who are sceptical for the following reasons:

- Rail has become a technologically redundant mode of transport in comparison to road (Marsay, 2005), and
- Rail freight movement appears to be less effective, at least from an infrastructure investment perspective (Stander and Pienaar, 2005).

Road transport, undoubtedly, has greater flexibility and adaptability in comparison to rail and this makes it possible for a transport operator to cater for any customer requirements. These could range from different size loads to unexpected urgent deliveries, which can be processed immediately. Van der Mescht (2006) notes that the points listed by Marsay (2005) and Stander and Pienaar (2005) are valid and cannot be disputed.

With this being said, the abovementioned authors do acknowledge that there are some disadvantages to road transport in comparison with rail. Road freight haulers are subsidised by motorists for the use of the road network, and a more equitable distribution of road user charge is required for heavy vehicles. Additionally, the current comparison drawn between road and rail is based on an inefficient, unreliable and unprofitable rail service (Van der Mescht, 2006).

3.2.2 History of Freight in South Africa

The road network initially acted as a feeder service to the railways which had expanded rapidly during the 19th and 20th centuries in order to provide a means of low cost transport over long distances and to add capacity along busy corridors and arterial routes. At the beginning of the twentieth century, the road system was in its infancy and little competition between road and rail existed (Jorgensen, 2009).

Rail lines and services were built and provided to boost economic growth particularly at the onset of the 20th century. Not much consideration was given to the financial viability and these operations were subsidised by the tax payers of South Africa (Stander and Pienaar, 2002).

Road freight transport was tightly controlled for approximately six decades (1930 – 1990), but the gradual deregulation thereof, which has occurred since the late 1970s has caused a gradual shift of general freight from rail to road (Stander and Pienaar, 2002). Since the 1920's, a marked improvement in road construction techniques and vehicle technology, coupled with the tariff structures of the then South African Railways (SAR), resulted in road transport becoming an alternative to rail. A number of Commissions into road freight transport ensued between 1929 and 1977. The first of these (Le Roux Commission, 1929) recommended a fair degree of economic control over road transportation, which led to the Motor Carrier Transportation Act (Act 39 of 1930) that governed all transportation of persons and goods for reward. The Marais Commission (1965) and Van Breda Commission (1977) both concluded that control and regulation of road freight must remain, although the latter brought in the concept of gradual deregulation (Stander and Pienaar, 2002).

A major shift in thinking regarding policies governing road transport took place in 1977 when the Road Transportation Act (Act 74 of 1977) made concessions to achieve open competition. The National Transport Policy Study (NTPS) of 1986 proposed new methods which could stimulate competition. These included (Stander and Pienaar, 2002):

- Easier entry into the road transport market,
- More scope for private initiative,
- Encouragement of small business, and
- Creation of a more efficient and a less costly transport system for South Africa.

The recommendations of the NTPS led to the Transport Deregulation Act (Act 80 of 1988) which, together with the Road Traffic Act (Act 29 of 1989), abolished economic regulation of the freight transport industry and replaced it with technical and safety regulation of operators and vehicles. Motivation for this deregulation included the gradual movement in the South African economy to more industrial/manufacturing activities versus the production of basic agricultural and primary commodities (minerals, ore, etc.). Road freight transport, which in comparison with rail freight transport, could offer higher reliability, flexibility, accessibility, security, as well as a shorter transit time, was preferred by the industrial sector (Stander and Pienaar, 2002).

The deregulation of the road freight industry and the economic shift towards industrial activities resulted in a significant growth of road freight haulage. The continuous growth in road freight transport between 1957 and 2006 is displayed in Figure 23 (CSIR, 2008). What is most noticeable is that between 1993 and 2006 rail freight haulage remained fairly static.

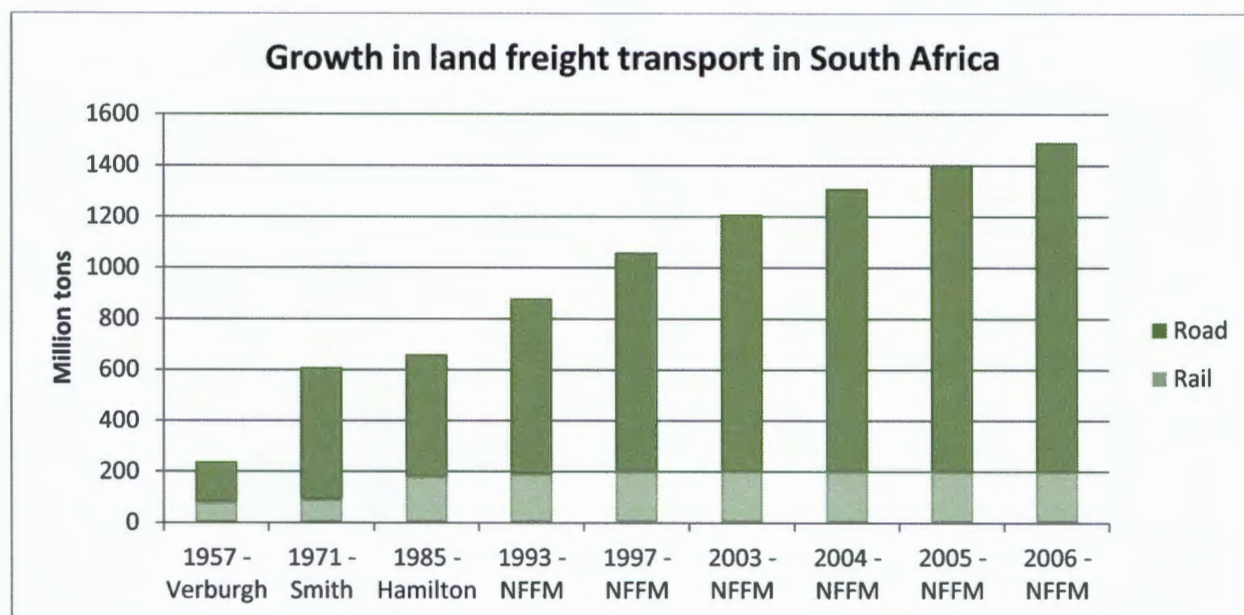


Figure 23: The growth in road freight transport experienced from 1957 to 2006
 Source: CSIR, 2008

Stander and Pienaar (2002) reported significant changes in total annual freight movement. The change in road and rail freight movement between 1985 and 2000 is illustrated in Figure 24.

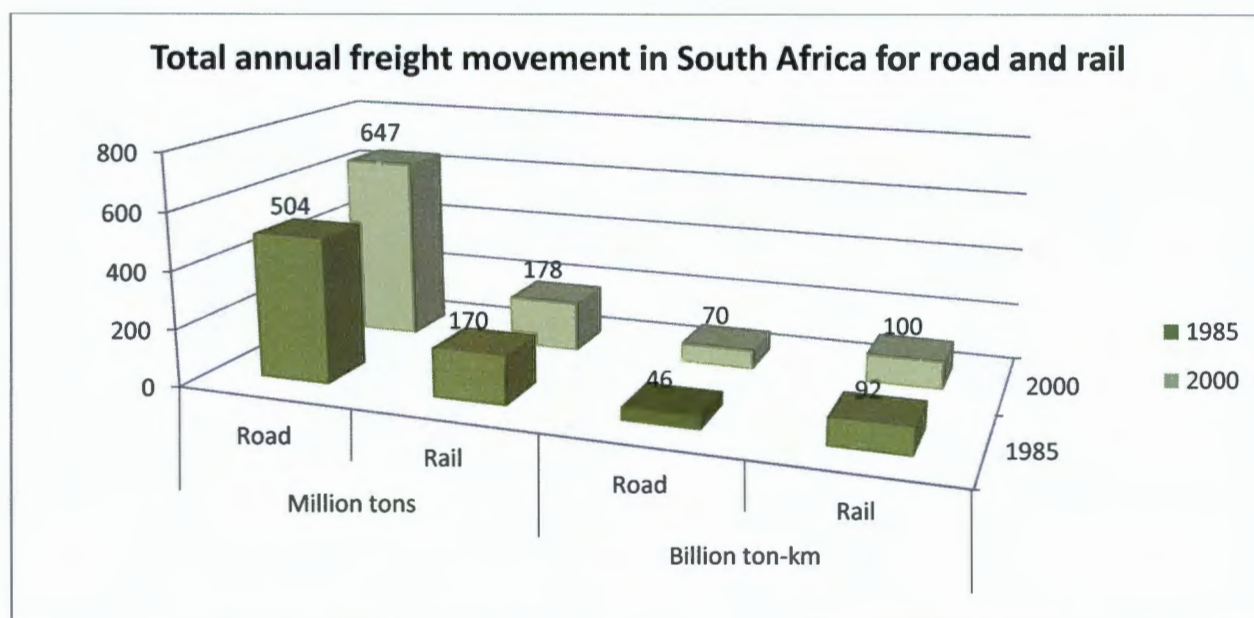


Figure 24: Total annual freight movement in South Africa for road and rail
 Source: Stander and Pienaar, 2002

From Figure 24, it can be seen that annual freight movement via road increased by 143 million tons (28%) or 24 billion ton-kilometre (52%) between 1985 and 2000. On the other hand, annual freight movement via rail increased by only 8 million tons (5%) or 8 billion ton-kilometre (9%) over the same 15 year period. This is a clear indication of the significant growth in the road freight industry over the 15 year period between 1985 and 2000.

Stander and Pienaar (2002) noted that it is the movement of general freight (versus haulage of minerals and ore) where the biggest changes in freight carried by rail (Spoornet) are evident. Figure 25 illustrates how this reduced by 25% between 1988/89 and 2000/01.

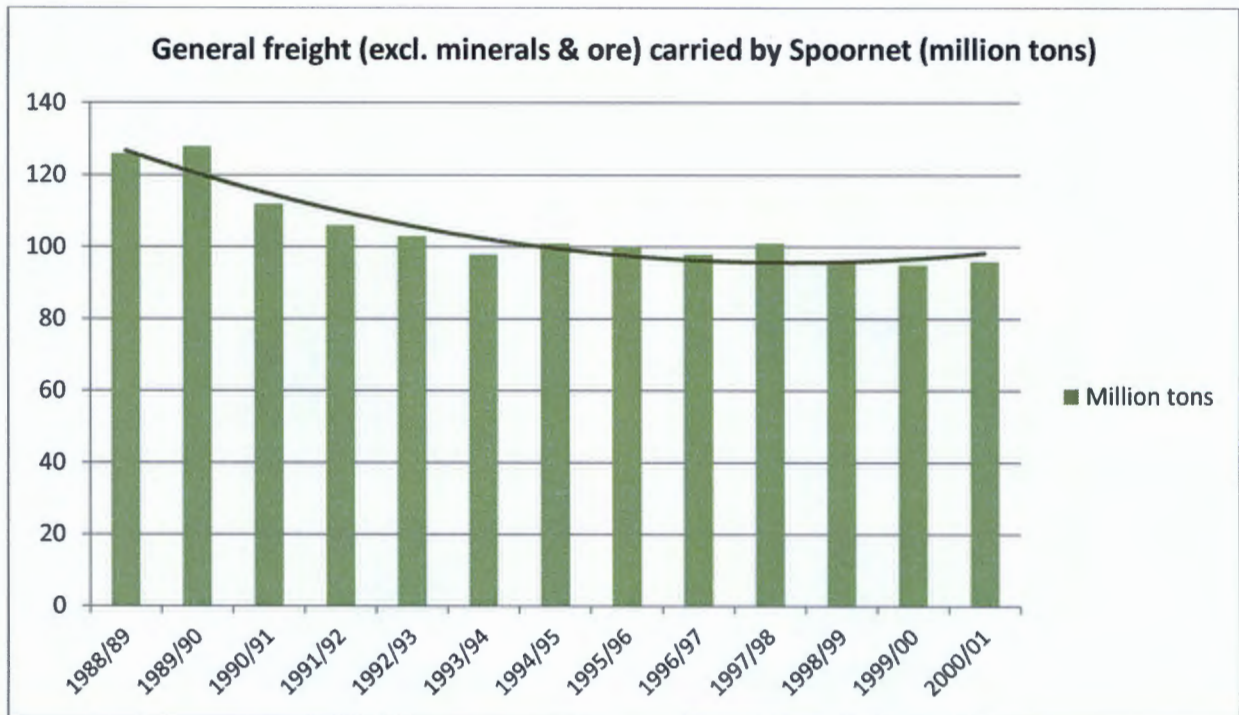


Figure 25: General freight carried by Spoornet between 1988 and 2001

Source: Stander and Pienaar, 2002

Figure 25 displays the general downward trend in million tons of general freight carried by Transnet (excluding minerals and ore). The significance of this information is twofold:

- The low average growth of total freight movement by rail versus the higher growth of road freight indicates the precarious position of the rail operator (Transnet) in the South African freight market, and
- If land freight transport strategy remains unchanged, road freight volumes will continue to grow as the gap between road and rail is amplified, and the resulting negative impacts will prevent a sustainable growth in the economy.

3.2.3 Modal Share of Freight Transport in South Africa

The status-quo of the mode structure of South Africa's freight transport market is not sustainable, and forecasts indicate that freight transport demand will continue to grow well into the future. In 2008 it was reported that South Africa generates 0.4% of the global GDP, but consumes 2.2% of the world's ton-kilometre and 6% of maritime ton-miles (CSIR Built Environment, 2008). A more sustainable modal share is, therefore, vital.

The current status of freight transport in South Africa has been attributed to the geographical conditions. The possible freight choices in South Africa are still largely dependent on the topology, which will continue to impact on the future strategies for freight transport. Current freight modes include road, rail, sea, pipeline and air.

South Africa's sea routes are not well developed for domestic shipping; this is due to relatively high terminal costs, limited vessel and terminal capacity and inclement weather conditions. Air transport is more prevalent in economies that are more advanced, but this is not yet the case in South Africa. Pipeline transport is increasing with the replacement and expansion in capacity of Transnet's Durban to Johannesburg Pipeline (DJP) which transports refined petroleum products (petrol, diesel and jet fuel) from refineries in Durban, as

well as imports of refined petroleum products from the storage facilities at Island View, in the Port of Durban (CSIR Built Environment, 2008).

The primary alternatives for freight transport in South Africa are therefore road and rail, contributing 99% to all logistics costs. According to the CSIR Built Environment (2008), the remaining 1% of costs are associated with other modes (0.08% with air, 0.29% with coastal shipping and 0.69% with pipelines). Road and rail freight transport will be investigated further, due to their significant share in the South African freight industry.

Close to 1.6 billion tons of freight was observed in the four different categories (corridor, rural, metropolitan and bulk mining) in South Africa in 2007 (CSIR Built Environment, 2008). A comparison of the road and rail categories for tonnage and ton-kilometre in 2007 are displayed in Figure 26 and Figure 27.

Almost 1.4 billion tons was observed on road at an Average Transport Distance (ATD) of 178 km, delivering 245 billion ton-kilometre. Rail only contributed 205 million tons at an average transport distance of 629 km, delivering 129 billion ton-kilometre (CSIR Built Environment, 2008). The market share split for road and rail by tons transported thus stands at 87/13. This is an unsustainable situation, and alternative viable intermodal solutions are required.

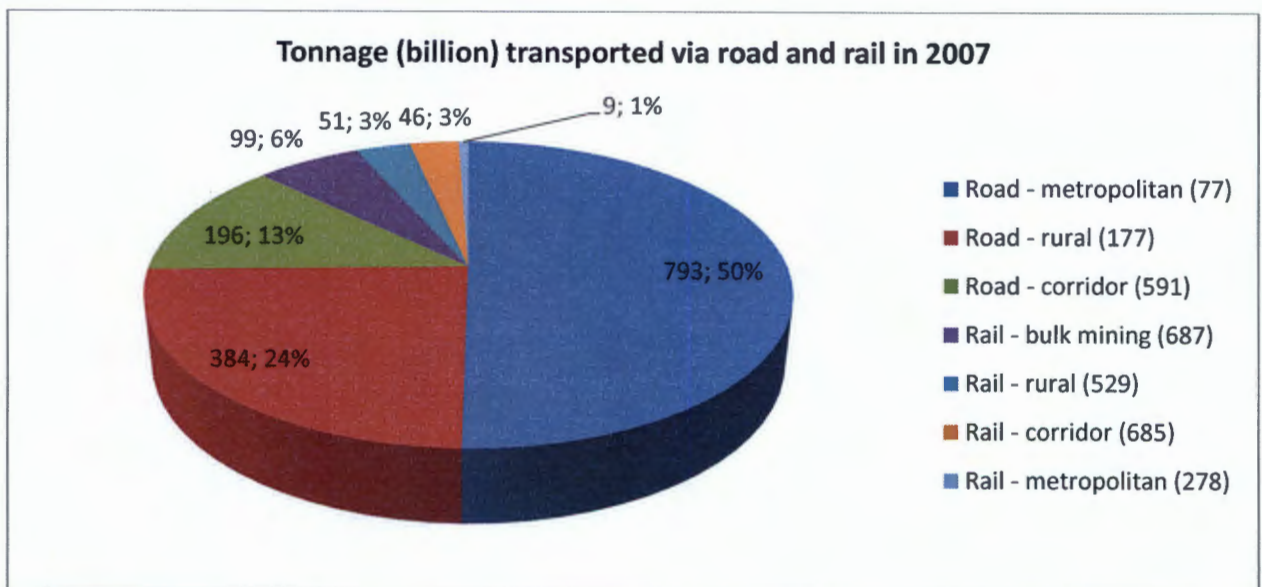


Figure 26: Tonnage (billion) transported via road and rail in 2007, (*) indicate average transport distance (km)
 Source: CSIR Built Environment, 2008

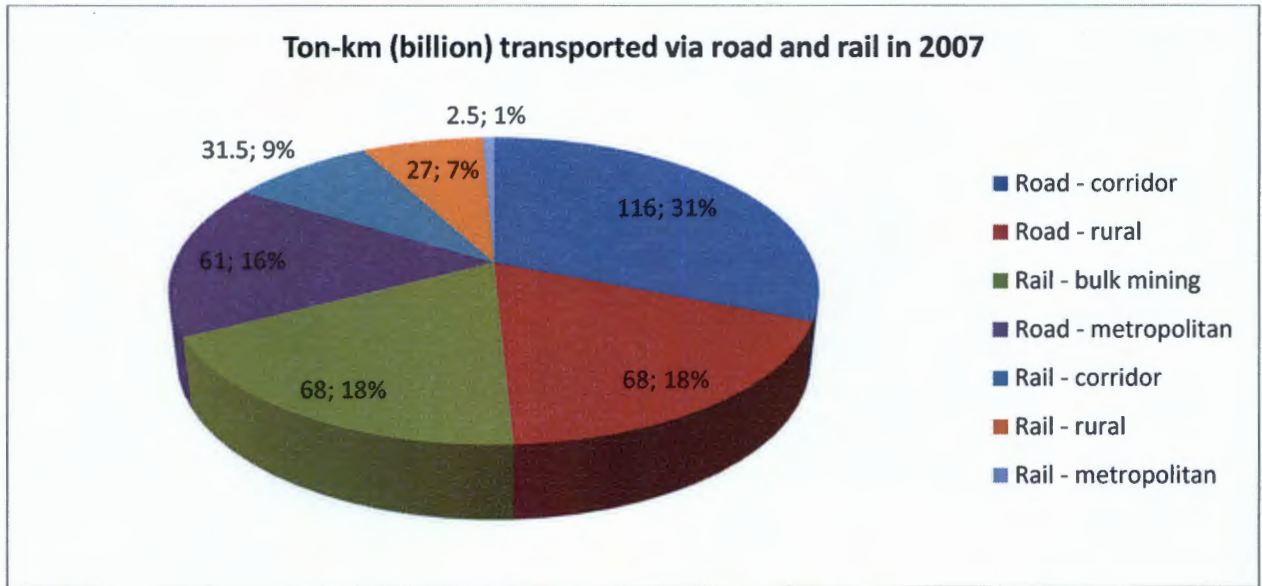


Figure 27: Ton-km (billion) transported via road and rail in 2007
 Source: CSIR Built Environment, 2008

3.2.3.1 Overall market share

The percentage split between road and rail indicates modal shift on a macro-scale and supports the possibility that competitiveness could be improved through modal reconfiguration. The overall ton-kilometre and costs or income are displayed in Figure 28.

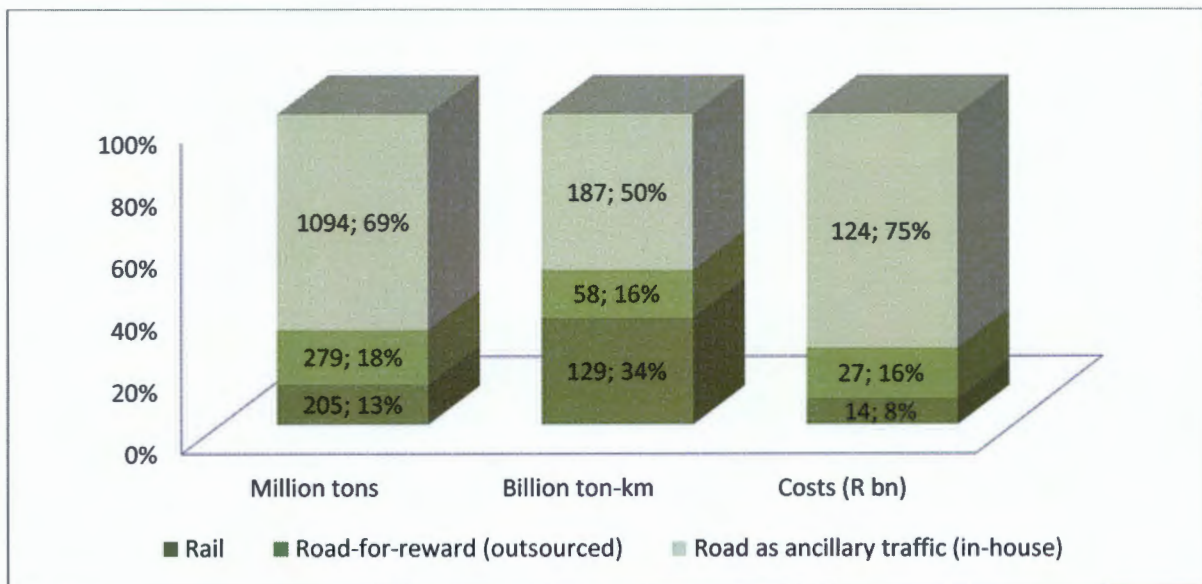


Figure 28: Road and rail market share in terms of ton, ton-km and costs
 Source CSIR Built Environment, 2008

Although rail provides 34% of transport output (ton-kilometre), only 13% of tons shipped are by rail and rail receives only 8% of the proceeds available for transport in South Africa. This also means that road-for-reward accounts for only 16% of all road transport costs and that rail's market share of outsourced traffic is around 36% (CSIR Built Environment, 2008).

Another approach to market share is to consider the traffic that could travel via either road or rail. This type of traffic (contestable traffic) is the most important as it is not feasible to shift traffic onto road or rail that could not travel effectively on the other mode. In this approach, it would mean that:

- 'Captured rail' traffic (i.e. bulk mining) is excluded,
- 'Captured road' traffic (i.e. metropolitan and to some extent rural traffic) is excluded, and
- It is assumed that even ancillary road transport on corridors should be a target for modal shift to railroad.

This means that for contestable traffic, only corridor market share should be considered (including road ancillary traffic) and this is reflected in Figure 29.

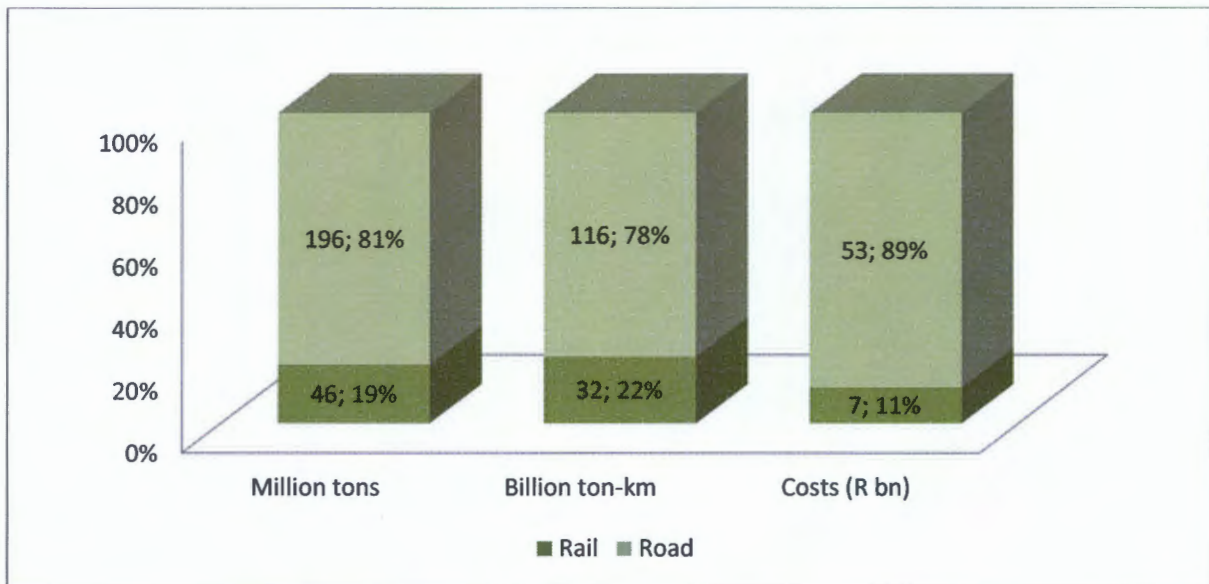


Figure 29: Corridor market share analysis for road and rail

Source CSIR Built Environment, 2008

In terms of contestable traffic, road is the dominant mode both in terms of million tons transported (81%) and billion ton-kilometre (78%). Intermodal transport as a 'mode' is not depicted, as no domestic intermodal solutions exist for South Africa at present (CSIR Built Environment, 2008).

3.2.3.2 Capacity assessment

Capacity challenges are a reality for all modes of transport, with some experiencing over capacity and others experiencing low utilisation. These challenges can sometimes be linked to different modes utilising a corridor. For example, Lane (2009) cites the Department of Transport (2005), which stated that the Durban to Johannesburg rail corridor is approximately operating at 20% of the installed capacity. In addition to this, poor renewal practices and narrow gauge railway lines limit the efficient carrying capacity of the rolling stock (Hendler et al., 2008, as cited by Lane, 2009). These physical factors of the rail fleet contribute to the current situation, in which road transport is more competitive than rail (Lane, 2009).

3.2.3.3 Labour productivity

Freight transport labour productivity can be analysed by looking at road and rail freight ton-kilometre produced per employee as displayed in Figure 30.

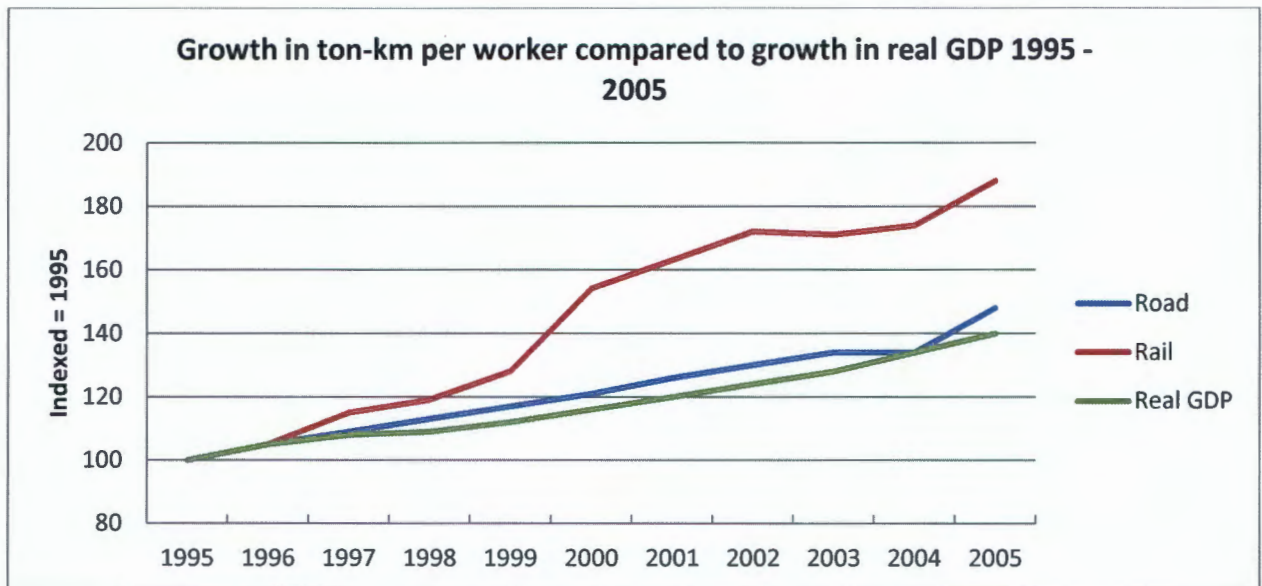


Figure 30: Growth in ton-km per worker compared to growth in real GDP between 1995 and 2005
 Source CSIR Built Environment, 2008

When it is considered that rail freight input includes the infrastructure development and maintenance of the mode (which is not the case for road freight), rail freight employment productivity has improved the most and is currently probably greater than for road. Rail's capacity for automation is much higher than road, and as South Africa faces unique challenges over the next 50 years, this could have a unique skills set challenge. This means that South Africa's freight transport system is currently focused on a highly effective road transport system, but this is not sustainable and growth in railway traffic would eventually have to be engineered (CSIR Built Environment, 2008).

The best available benchmark for overall economic productivity would be GDP produced per formal worker in South Africa compared to ton-kilometre output for surface freight employment. In this regard, surface freight employment labour productivity outstrips overall economic productivity by far as is indicated in Figure 31.

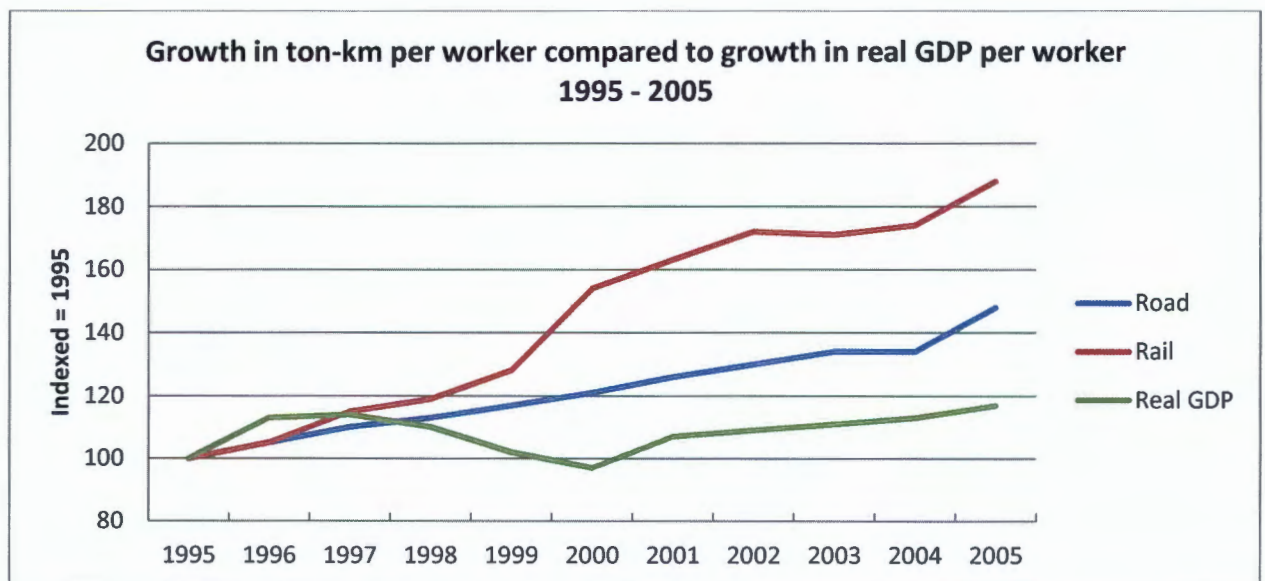


Figure 31: Growth in ton-km per worker compared to growth in real GDP per worker between 1995 and 2005
 Source CSIR Built Environment, 2008

Overall labour productivity in South Africa has declined (measured financially), whilst road freight transport employment output has traced real GDP and rail freight employment output has surpassed it.

3.2.3.4 Road freight

The road freight industry provides a flexible link in supply chain management logistics, and is an important job creator. Owner driven operators are becoming more and more common, medium size truck companies are consolidating and there are four major groups being – Bidvest, Imperial Holdings, Super Group and Unitrans (Rail Road Association, n.d.).

According to the most recent CSIR State of Logistics Survey for South Africa (2012), the road freight market in South Africa totals about 1 532 million tons of traffic per annum. Of this total, some 819 million tons were metropolitan, 465 million tons rural and 159 million tons of corridor traffic. South Africa has over 250 000 registered commercial vehicles and of this, some 50 000 are heavy freight vehicles owned by some 3 000 companies.

While road transport hauliers carry far higher tonnages of freight, the average line-haul distance (195 km) is shorter than that for rail (636 km) (Rail Road Association, n.d.). This is, due to the fact that the greater portion of road freight is of a local and short-haul delivery nature. Because of this, the rail balance of ton-kilometres is much higher but much of it is export coal and ores, while road freight operators handle a higher percentage of general freight traffic.

South Africa operates some of the largest road freight vehicles in the world, considering the fact that they have unlimited access to the highway system. The most common long-haul vehicle is the Interlink combination, generally, having seven or eight axles. The legal gross vehicle mass (GVM), which is the total mass including load, is 56 tons. A legal maximum axle load is 9 tons and together with the GVM, a 2 ½ % tolerance is allowed (Rail Road Association, n.d.).

Deregulation of road transport and the abolition of the restrictive road-permit system have led to intense competition within the road freight industry, since access has not been controlled (Rail Road Association, n.d.). As a result, heavy vehicle overloading has become an endemic problem, due to the fact that the road freight industry is currently overtraded. In addition to this, there are many other challenges currently facing the road freight sector some of which include vehicle roadworthiness, driver's working conditions and fuel taxation.

3.2.3.5 Rail freight

Transnet Freight Rail (TFR) operates over 22 000 route-kilometres of line of which about 6 000 km consists of main lines for general freight and long-distance passenger train services (Rail Road Association, n.d.). In addition to this there are a number of secondary arterial routes and approximately 70 branch lines in excess of 12 000 km in length. TFR also operates the 861 km Sishen – Saldanha ore line (OREX), and the 580 km Richards Bay coal line (COALink).

Rail traffic has been relatively static during the past ten years, but had declined from a high of about 182 million tons per annum to 179.9 million tons in the 2007 – 2008 financial year. Of this, over 85m tons of coal and ore traffic were routed over COALink and OREX, but the rail share of the general freight market has dropped significantly since transport deregulation (Rail Road Association, n.d.).

The development of better roads and modern road vehicles has led to intense modal competition, impacting negatively on most state-owned railways, which had become bureaucratic, inefficient and often a drain on the National fiscus.

Down-sizing of railways by closing marginal branch or parallel competing lines was a trend until recent times, when transport deregulation freed many railway administrations to restructure or outsource light traffic-density lines by concessioning or outright privatisation. Entire railways, such as those in Argentina, Peru, Côte d' Ivoire, Australia and New Zealand have been concessioned or privatised and this has been a major success. TFR is now in the mid-stage of restructuring in preparation for outsourcing services and concessioning various lines (Rail Road Association, n.d.).

Research shows that there has been a continuing decrease in general cargo carried by rail since the early 1980's, throughout South Africa. A comparison of road and rail tonnage shows that more than twice the rail tonnage is carried by road hauliers to and from eThekweni and the pattern is consistent regardless of whether the services are towards the west, north or south (eThekweni Transport Authority, 2005).

It is possible for rail to regain its importance as an energy efficient and environmentally friendly mode (assuming that electricity is produced in a sustainable way) of transport, thus saving vital foreign exchange on imported petroleum, since electricity is used for over 90% of requirements.

3.2.3.6 *Current outlook on road and rail in South Africa*

It should be noted that each freight mode has a purpose and in many cases is often better suited to transport certain commodities over others. For example, most bulk mining output in South Africa is transported by rail. The coal line between Mpumalanga and Richards Bay and the iron ore line between Sishen and Saldanha together contribute 99 million tons (6% of all tons observed) over an Average Travel Distance (ATD) of 687 km, producing 68 billion ton-kilometre (18% of all ton-kilometre produced by all modes). This form of transport is by far the highest contributor to rail market share and also the most lucrative rail transport in the country. It has no road alternative and is thus 'captured' rail traffic (CSIR Built Environment, 2008).

Van der Mescht (2006) cites The First State of Logistics Survey for South Africa (2004), which highlighted the following key road and rail issues in 2004:

- Whilst it is considered best practice to transport long-distance corridor freight by rail, with road providing the feeder and distribution services, 75% of long-haul tonnage in South Africa is conveyed by road,
- Conveyance of freight along dense long-haul corridors is on average more costly than a possible intermodal solution, and
- The commercialisation and corporatisation of the state-owned railways in 1990 has resulted in critical underinvestment in rail assets and the illogical fragmentation of assets, processes and systems.

Each country and, specifically, each geographical area have unique transport demands and requirements. Whilst international examples should be considered – the actual regional context of the modes under investigation must be judged. This, in turn, will facilitate an informed decision on the preferred approach to freight transport on the N3 corridor between Gauteng and Durban.

Stander and Pienaar (2002) note that the playing fields in the market for freight transport have tended to be unfairly weighted in favour of road transport. This is supported by the following observations:

- Laden heavy vehicles do not contribute proportionately to light motor vehicles for their use of roads and could be considered to be “subsidised” by light motor vehicles, should all fees and levies associated with road usage be considered.
- Spoornet (Transnet Freight Rail) is required to pay the same fuel levy as road vehicle operators for the diesel that they use. If this is considered as a fuel levy, which as discussed, is seen as a road user charge then this could be deemed to be unfair towards rail operators. However, if this cost is viewed as a general form of taxation, then it is similar to VAT or company tax that Spoornet has to pay.
- Increases in the legal axle limit for a truck has been disputed due to the fact that increased load will increase the potential damage to infrastructure, and in particular to road pavements. On the other hand, it has been argued that if infrastructure is upgraded to accommodate additional loads then there is likely to be a higher effectiveness and lower transport cost, which ultimately could benefit the economy. A similar argument can be directed at rail infrastructure, in terms of international gauge sizes, etc. The trade off in terms of total costs between upgrading infrastructure (rail or road) and the potential improved efficiency has not been calculated to date.

3.2.3.7 Strengths of road transport

Road transport has replaced rail carriage as the dominant form of long-distance freight transport. On long hauls, road freight carriers are able to transport certain primary products of an organic nature, such as timber, fish, and agricultural products (for example, live-stock, fresh and frozen meats, fruit, vegetables and dairy products); some semi-finished goods; and most finished goods (Stander and Pienaar, 2002).

Road freight transport is more flexible and versatile than other modes, because of the vast network of roads. It can, therefore, offer a point-to-point service between almost any origin and destination. It is this flexibility and versatility that has enabled road freight transport to become dominant in many countries. The strengths of road freight are listed by (Stander and Pienaar, 2002) as follows:

- *Door-to-door service:* Road transport is not limited to a fixed route or to fixed terminals. Consignments can be conveyed directly from a shipper to a receiver without the need for specially built terminals.
- *Accessibility:* Road carriers can deliver in every country or economically active region in the world. Deliveries are therefore usually prompt.
- *Freight protection:* As a result of the ability to supply a door-to-door service, little handling and few transshipments take place between origins and destinations. Separate feeding/collection and line-hauling are often not necessary, and neither are delivery or distribution activities.
- *Speed:* This mode maintains short door-to-door transit times, especially over short distances. When delays occur as a result of traffic congestion or other incidents, it is often possible to follow alternative routes.
- *Capacity:* The vehicle carrying capacity, although relatively small compared with other modes of transport, is adaptable and can be readily increased.
- *High frequency:* A high service frequency can be maintained as a result of the small carrying capacity and relatively high speed of road vehicles.

Road freight carriage offers the client reliable service with little damage or loss in transit. It, generally, provides much faster service than rail transport and compares favourably with air carriers on short hauls. Many road freight carriers, particularly those involved in “just in time” services, operate according to a

scheduled timetable (Stander and Pienaar, 2002). This results in reliable transit times. Road freight carriers are also flexible in terms of the size of freight they can transport and hence they can compete with air transport for small shipments and with rail transport for larger shipments.

3.2.3.8 Limitations of road transport

Whilst road freight transport has a number of strengths in comparison to other modes, it does have some limitations. Stander and Pienaar (2002) note the following limitations of road freight transport:

- *Limited carrying capacity:* The dimensions and gross mass of road vehicles are limited through legislation.
- *High environmental impact:* Road vehicles create noise and air pollution.
- *Vulnerability to external factors:* Inclement weather conditions and traffic congestion can impact on the reliability and punctuality of road transport operations – especially in countries with severe climatic conditions, such as heavy fog and snowfalls.
- *High energy consumption:* To convey one unit of freight, road vehicles consume more energy/fuel than other form of surface transport.
- *Shared right of way:* On public roads, the right of way is shared with other traffic, which increases safety and security risks and the occurrence of unexpected delays. An accident involving a truck with hazardous goods on board may result in a complete road closure lasting several hours. In addition to high accident risk, road vehicles are vulnerable to theft and hijacking.

Appropriate incentives (and/or disincentives) as well as market mechanisms need to be introduced in order to influence the behaviour of companies and their customers to achieve desired climate change outcomes (Stander and Pienaar, 2002).

3.2.4 Performance of South African Logistics Sector

The 2014 LPI includes a competency rating of the South African logistics sector. The results of this, both in terms of LPI score and global LPI rank are pictured in Figure 32. South Africa is ranked overall at number 34 with a score of 3.43 and at 77.9% of the highest performer (World Bank, 2014).

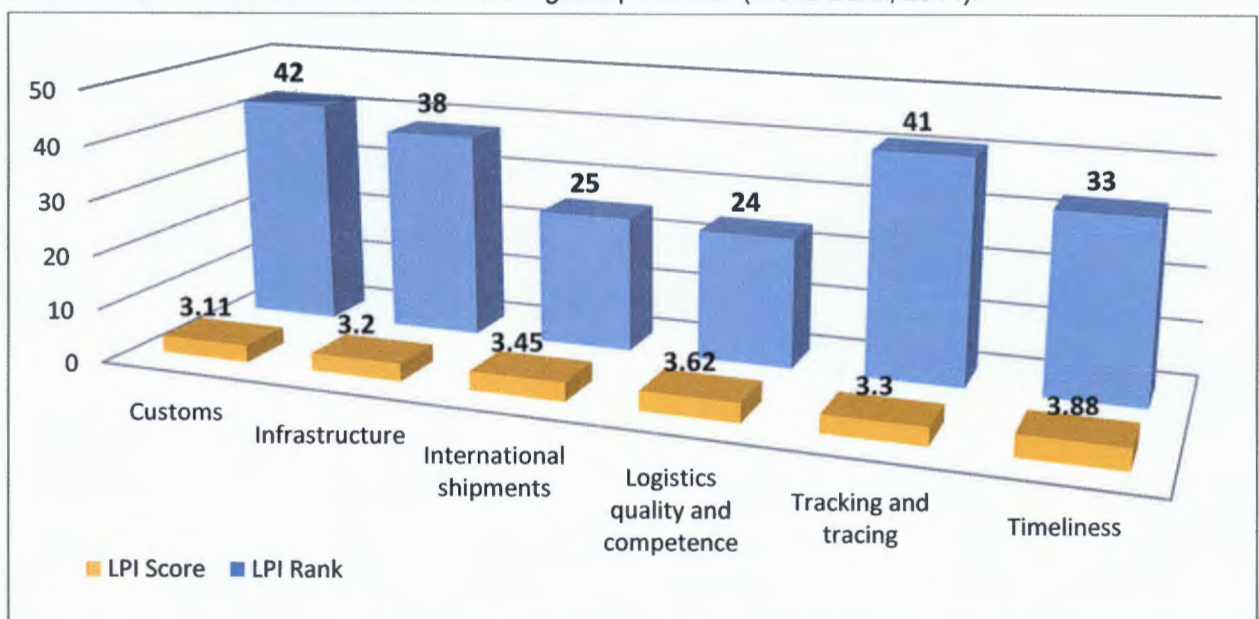


Figure 32: LPI score and rank per competency for South Africa
Source: World Bank, 2014

When considering South Africa's overall ranking is 34, international shipments (25) and logistics quality and competence (24) are considered top performing competencies. Customs (42) and tracking and tracing (41) are competencies which in comparison are the worst performing for South Africa.

The LPI also enables a comparison for 'like versus like' countries based on income. Figure 33 includes an assessment of over and underperforming countries which are categorised as non-high income. South Africa is deemed to be an over performer.

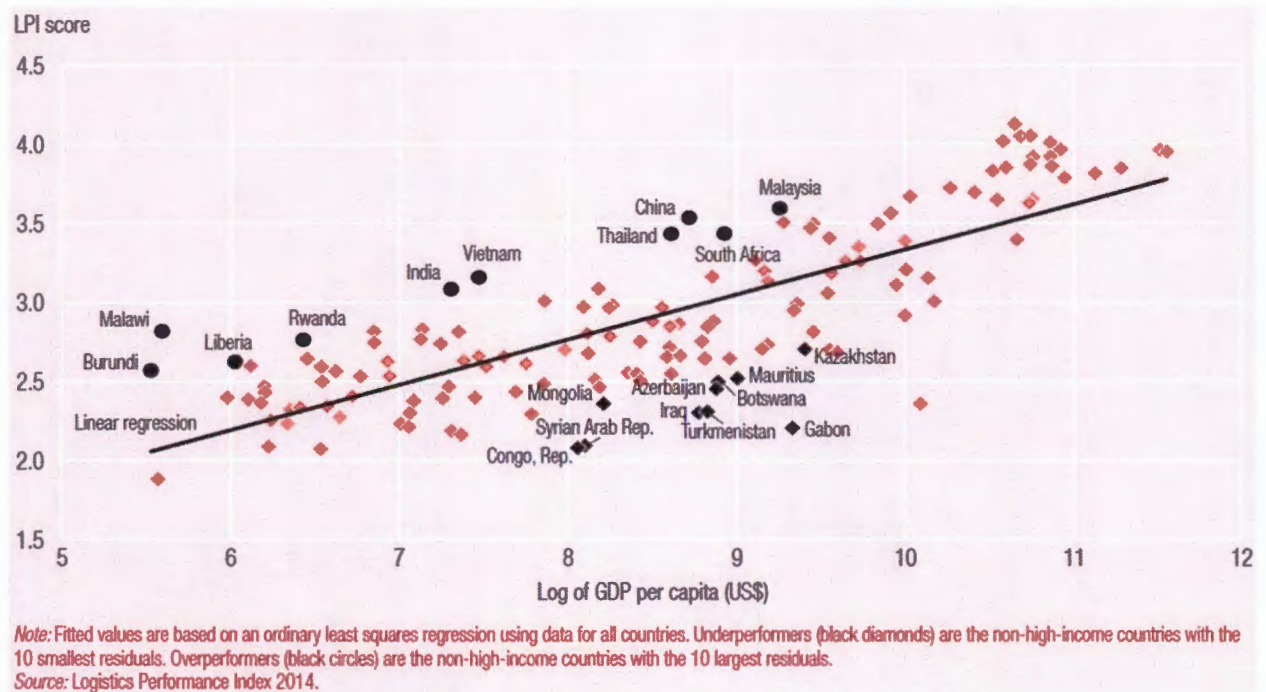


Figure 33: LPI Overperformers and Underperformers
Source: World Bank, 2014

The LPI has identified that income alone cannot explain why performance varies widely among countries in certain income groups. In particular the low and middle income groups are more dispersed indicating that some are performing well despite perceived possible financial constraints. India, China and South Africa (all part of the BRICS consortium) are considered to outperform countries within a similar income band. In comparison, a number of other African countries (Botswana, Mauritius, Republic of Congo and Gabon) are considered to be underperforming in relation to similar income groups (World Bank, 2014).

3.2.5 Future Trends in South African Freight Logistics

The National Freight Logistics Strategy (NFLS) was generated as "a response to the freight system's inability to fulfil the demand for cargo movement at prices, levels of service, quality of service, and at acceptable levels of reliability in a manner that supports the national development strategies." The NFLS outlines the "strategic framework for institutional reform and industrial structuring that will ensure a more efficient freight system ...". An extract from the NFLS problem statement suggests that "... there is a lack of integrated planning." A key focus of the NFLS implementation is on the approach to corridor development along certain defined critical freight corridors (DoT, 2005).

The apparent competitive advantage that road has over rail has been described by some as being unfair. Stander and Pienaar (2002) include an example with remarks made by the then Minister of Transport Jeff Radebe in November 2000, who referred to the "increase in the permitted Gross Vehicle Mass for trucks",

the “*weak policing system*” and the notion that trucks generate a range of negative externalities (damage to roads, pollution, road congestion and road accidents), for which they do not bear the direct cost, as being a system, which is biased towards road freight transport. He proposed that “*policy measures must be put in place to counteract the consequences of unregulated road haulage. This will serve to level the playing field which is currently tilted very heavily in favour of road transport*” (Stander and Pienaar, 2002).

Freight transport by road over long distances is expensive and it is clear that a shift from freight transport by road back onto rail could solve some of the high cost-related problems and provide opportunities for a more competitive position for South Africa as a whole. Long distance truck travel also contributes to socio-economic problems within the driver population as is evidenced by the prevalence of HIV/Aids and other social issues among truck drivers (CSIR Built Environment, 2008). There is also a call for driver education and improved working conditions within the road freight sector, and this will further pressurise the industry.

A shift is required back to the railway corridors, the need for rail-dedicated metropolitan solutions and more effective rural road infrastructure with intermodal nodes, cannot be disputed (CSIR Built Environment, 2008). These views are shared by the road freight industry, which have reported in interviews that the shift is possible and might become a reality as soon as the middle of the next decade.

The above-mentioned shift will require that the industry’s sector skills plan be aligned closely with a number of national plans in order to support a skills demand shift from long haul road to long haul rail. These plans include the Transnet national infrastructure plan, the Department of Transport’s (DoT) National Transport Master Plan (NATMAP) and the deployment of Moving South Africa, as well as the national freight logistics plan (CSIR Built Environment, 2008).

3.3 Johannesburg to Durban Freight Corridor

3.3.1 Background to Primary Road Network

Of the approximately 600km of national road between Durban and Johannesburg, 415 km comprises a toll route. The National Route 3 (N3) links South Africa’s largest economic and industrial hub in Gauteng with Durban in KwaZulu-Natal, which is the largest and busiest sea port in Africa. The N3 is thus of major strategic importance to the well-being of the economy of South Africa.

The annual average daily traffic in 2011 on the N3 toll route at the Mooi River Plaza was between 15 000 and 16 000 vehicles per day. On a normal 24-hour day, outside of special events, the daily traffic on the N3 is between 10 000 and 14 000 vehicles, of which a third are heavy vehicles, some 3000 to 5000 per day (N3TC, 2009).

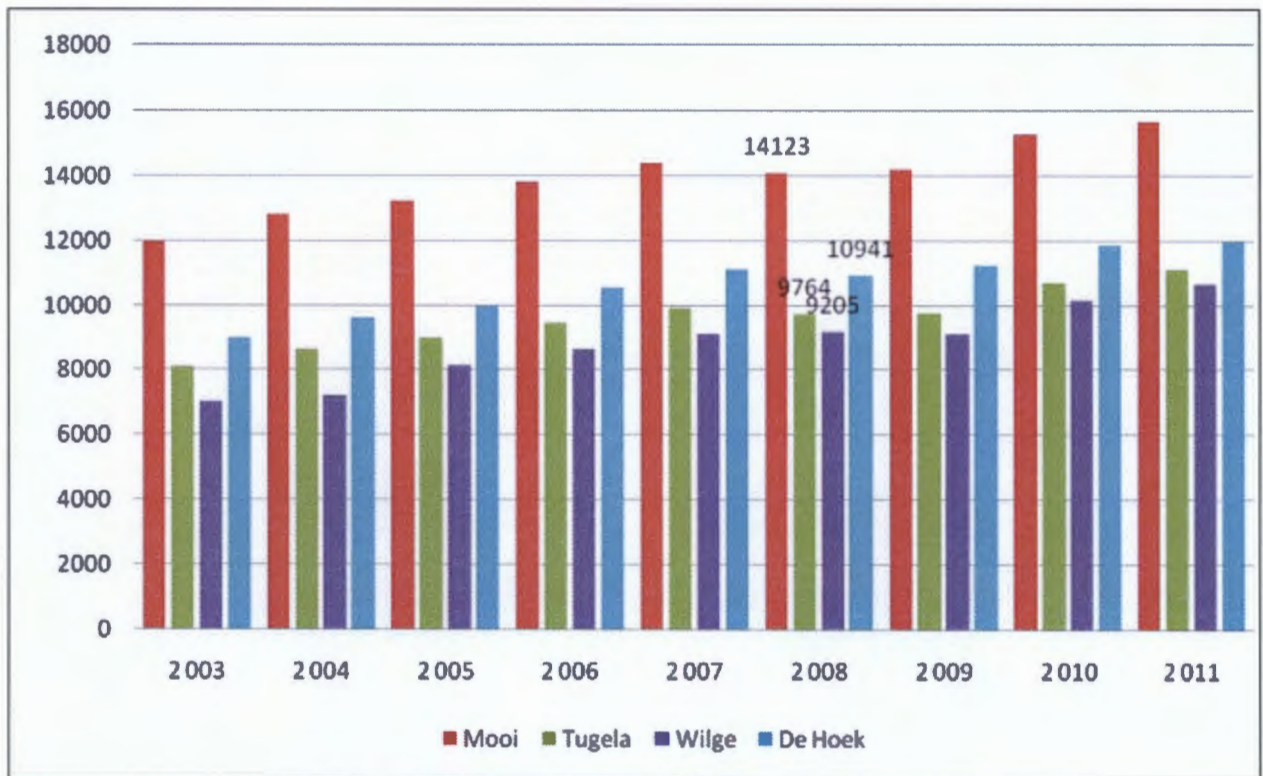


Figure 34: Annual Average Daily Traffic on N3 Toll Route
Source: N3TC, 2009

The Route, which links two of the largest cities in the country, passes through large rural areas and urban settlements. The N3 is a Class 1, or primary mobility route that carries large volumes of traffic and is a regional connector. The Route traverses terrain that varies from hilly to mountainous resulting in different operating speeds for the various types of traffic using the infrastructure. There are, therefore, large speed differentials between the different classes of vehicle on the route and drivers need to be fully aware of this at all times to avoid rear-end collisions. A one-way journey can take five to six hours in a light motor vehicle and eight to ten hours in a large truck. It is important that drivers make necessary stops to rest, due to the risk of fatigue. Unfortunately, about half the truck drivers prefer to make the journey during the night, which increases the possibility of incidents, due to fatigue and reduced visibility (N3TC, 2009).

The management and operation of this route requires the dedicated attention of several organisations. There are law enforcement agencies who address the issues of traffic offences, such as speed, pedestrians crossing or walking on the road and illegal stopping. The emergency services, available on a 24-hour basis, work hard to manage of the situation when incidents occur. The routine road maintenance teams handle the road surface, drainage and road furniture, including road signage. Route services teams provide assistance to motorists that encounter problems with their vehicles during their journeys. These teams are connected to each other and to the general motorists via various communication channels, such as the N3TC Route Call Centre and variable message signs, as well as the media (N3TC, 2009).

3.3.2 Corridor Trends

As a result of Gauteng being land locked, the trends considered here will focus only on road and rail freight modes. The following trends on the Johannesburg to Durban freight corridor were reported by the Department of Transport in the National Freight Logistics Survey (2005):

- The required capacity for the Gauteng – Durban corridor was projected to reach 57 million tons in 2020. However by 2004, the corridor was already operating at 53 million tons and given recent growth rates, was expected to grow by a further 38% prior to 2020.
- It was reported that less than 20% of the goods transported along this corridor can be transferred to other ports. Therefore, 80% of goods destined for Durban are either for local consumption or it would not be economically efficient to export from an alternative port. With the serious implications of this high freight load on the sustainability of this corridor, alternative strategies are required to provide additional capacity.
- The operational capacity of rail was estimated at 20% of the installed capacity, with delays at marshalling yards on route to the port of Durban impacting severely on the competitiveness of rail. Other infrastructure constraints, such as different electric currents, which require four locomotive changes and the age of rolling stock, continue to reduce efficiency and increase operating costs.
- Traffic flows are not balanced in each direction, with greater demand on the infrastructure for the Johannesburg to Durban journey, than from Durban back to Johannesburg.

The KZN DoT has stated that certain sections of the N3 corridor between Gauteng and Durban are relatively congested and in some locations there is a high vulnerability to lengthy delays for example through Van Reenen’s Pass, due to accidents and poor weather. The rail network parallel to this route is, however, operating at approximately 35% capacity (KZN DoT, 2004). With maintenance and improvement efforts on the road network unable to keep up with the growth in freight traffic, investment in the rail network could play an important role in alleviating congestion in major freight corridors.

Figure 35 displays the tons transported via rail between Gauteng and Durban over the period 2001 to 2002. Both the northbound (to Gauteng) and southbound (to Durban) are shown.

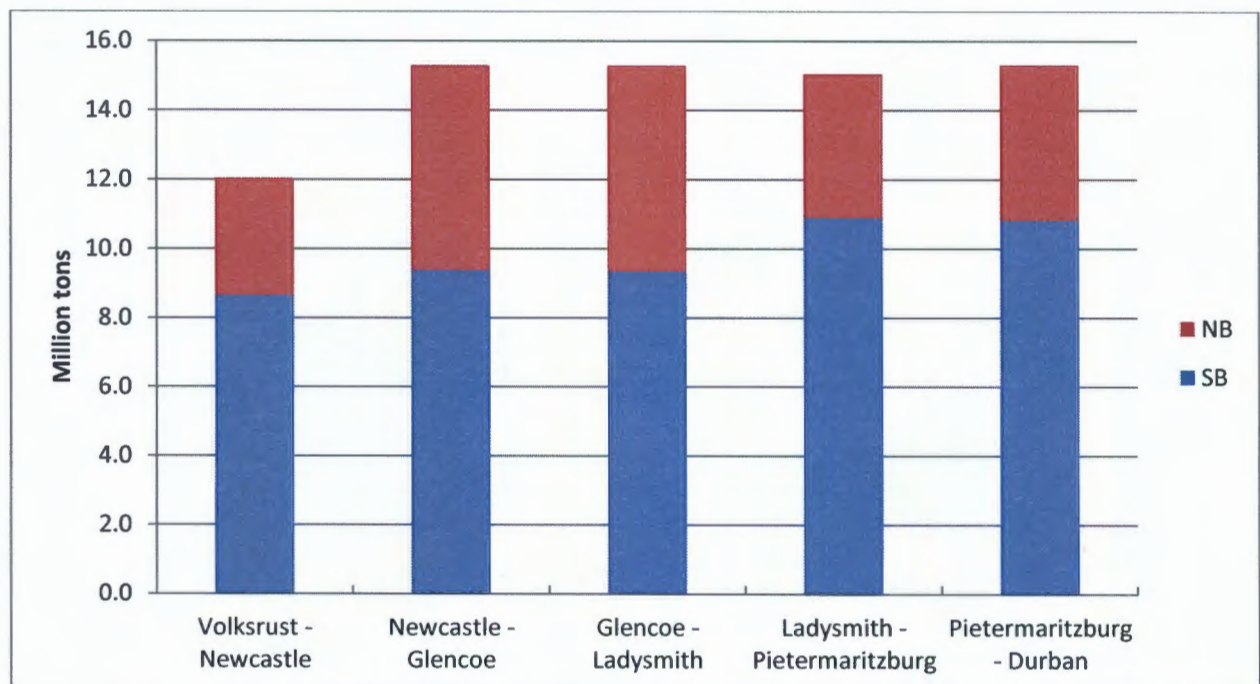


Figure 35: Million tons transported via rail on the Durban – Gauteng line between 2001 and 2002
 Source: KZN DoT, 2004

An estimated 15 million tons are transported between Pietermaritzburg and Durban by rail annually. Figure 36 illustrates the tons transported via road on the N3 and recorded passing through toll plazas.

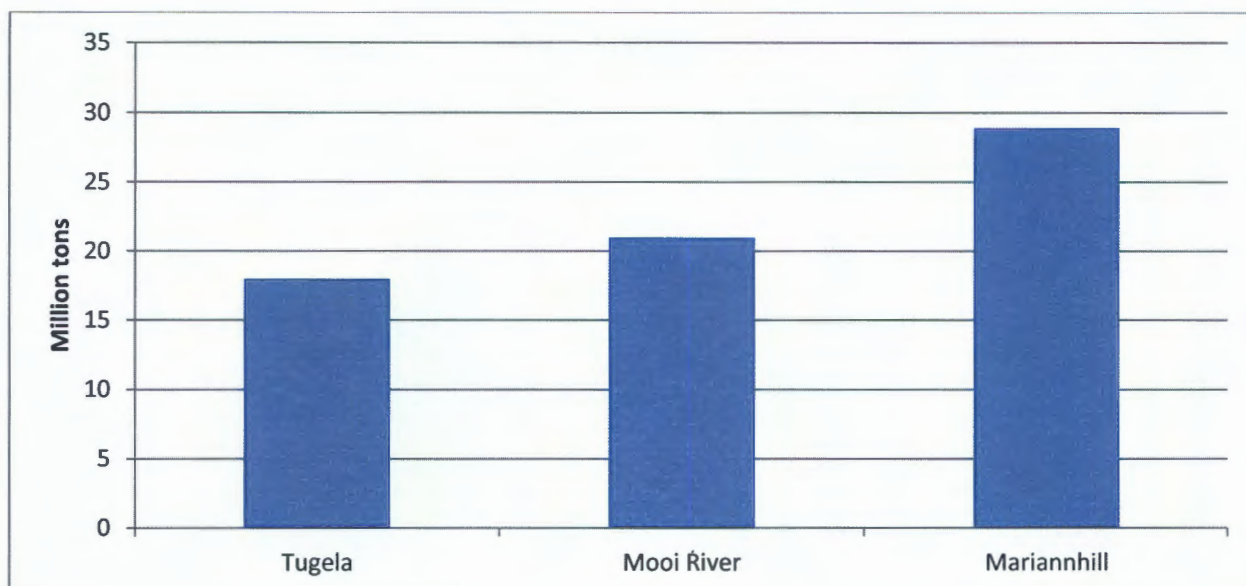


Figure 36: Million tons transported via road on the N3 in 2003

Source: KZN DoT, 2004

In 2003, there was a total of approximately 29 million tons transported via road and recorded at the Mariannhill Toll Plaza. In comparison to the adjacent rail line which transported approximately 15 million tons in the preceding year, this is almost double by road. This clearly indicates the importance and dominance of road freight along the N3 corridor.

3.3.3 Freight through Port of Durban

The importance of the port interface with land transport cannot be under stated. The National Department of Transport's Action Agenda stated that "Ports, as a key inter-modal facility in the import-export channel, provide a critical lever for any strategy, which seeks to focus the scope of a transport system. As far as bulk exports are concerned, existing flows are already highly consolidated. In respect of general cargo, an opportunity exists to counteract a future increase in shipping costs by reducing the average numbers of ports of call and by consolidating container traffic into a limited number of ports" (Rail Road Association, n.d.).

The transport of goods, traditionally moved via sea vessel between Durban, Cape Town and intermediate points, has shifted substantially to road in recent years. The transit time via road is often quicker than via sea. However, the impact on the road network should also be considered. The coastal highway (N2) between these points has experienced ever heavier road traffic on a route that is mountainous for much of the distance. This has led to traffic congestion and road degradation in a number of areas. Rail is an alternative but there is no direct route. A comparison of the travel distances between different locations for road, rail and sea is provided in Table 4.

Table 4: Transport distances for different modes between various destinations

Route	Rail	Road	Sea
Durban – East London	1 444 km	674 km	407 km
Durban – Port Elizabeth	1 536 km	984 km	618 km
Durban – Cape Town	2 091 km	1 753 km	1 307 km

Source: Rail Road Association, n.d.

The distance travelled by sea is clearly much shorter than by road or rail, and in many cases marine transport is cheaper, depending upon commodity type, port charges and supporting mode logistics. However, the transit time via sea is invariably longer depending on the sailing times and dispatch / delivery requirements. A further consideration is energy consumption and the type of fuel used by the various modes.

Marine transport relies on bunker fuel, currently priced at US\$ 545.71 / metric ton (www.bunkerindex.com as at 8 May 2015). The result when converting from US\$/mt to cents/litre will vary depending on the type of diesel and temperature. However, based on a temperature of 15°C, density of 0.850 kg/l and an exchange rate of R11.92 to the US\$, the cost of bunker fuel equates to 553 c/l.

Road transport consumes diesel, much of which is refined from imported petroleum, which costs the country valuable foreign exchange. The current price of diesel is 1 118 c/l in Gauteng (www.shell.co.za as at 8 May 2015).

Whilst rail is routed over longer distances, it is more energy efficient due to the fact that between Durban and Cape Town, all but 235 km of the 2 091 km distance is electrified. The Rail Road Association notes that it is, generally, accepted that electricity generated from coal-fired thermal power stations is the cheapest present energy source in South Africa, while saving the country valuable foreign exchange. This source of power might be cheap, but it certainly is not an environmentally friendly way to produce energy, and in recent times has become an unreliable energy source due to the Eskom load shedding issue.

The total freight tonnage processed through the Port in 2002/2003 is estimated at 58 million tons, up from an estimated 54.1 million tons in 2001. It is significant that the high volume petroleum category constitutes 45% of total tonnage through the Port. This commodity creates minimal demands on land side transport infrastructure. This is due to most movements from tanker to refinery occurring via a pipeline.

No detailed data on a split of Durban harbour imports and exports between road hauliers and rail transport is available. It is, generally, agreed that road freight is responsible for the majority of port related cargo movements, and that road's share has been rising significantly over the past few years (eThekweni Transport Authority, 2005) which has resulted in the increased congestion in and around the port.

This trend is indicative of the poor rail service levels when compared to road-based services. A more detailed analysis of the road/rail freight split to and from the Port is clearly required. The issues that need to be addressed are (Marsay, 2005):

- The user costs of the modes,
- The reliability of the modes,
- The availability of the services, and
- The delivery times associated with the use of each of the modes.

3.3.4 Use of Pipeline Network

The pipelines moved approximately 2.3 million tons of refined products and 4.6 million tons of crude oil per annum in 2005. The refined products line had potential for expansion up until about the year 2007, whereas the crude oil line was already running close to capacity (eThekweni Transport Authority, 2005). The new Multi Product Pipeline (MPP) which was commissioned in 2012 has enabled the pipeline network to increase the annual volume by an additional 8.76 million tons per annum once operating at capacity.

3.3.5 Durban Airport Freight Movement

Airfreight cargo handled at King Shaka International Airport (formerly Durban Airport) is mainly destined for Johannesburg Airport, with smaller quantities going to Cape Town, Port Elizabeth and East London (eThekweni Transport Authority, 2005). All cargo transported by road is destined for Johannesburg Airport. SAA Cargo also provides a road freight service between Durban and Johannesburg Airports, handling larger cargo items not transported by airfreight. During 2003 an estimated 283 heavy vehicle trips were made transporting approximately 9 400 tons of cargo. In 2003 there were approximately 11 000 tons of inbound airfreight to Durban International Airport and 4 000 outbound tons (eThekweni Transport Authority, 2005).

3.3.6 Concerns if the Status Quo Continues

The benefits of an integrated freight sector are reported as being lost through reductions in reliability and an increase in cost to consumers. The impact of this results in the following situation on a corridor level, particularly on the high value export corridor between Gauteng and Durban (DoT, 2005):

- Inability to cope with growth in demand for freight traffic, due to insufficient investment,
- Mode transfer of goods from rail to road as a result of a rail system that is characterised by its inefficiency and unreliability,
- Port and airfreight systems without necessary capacity to deliver a cost effective and reliable service, and
- Growth in heavy vehicles (an increasing percentage of which are overloaded) utilising the secondary road network, which is not designed or maintained to a sufficient standard with which to support such traffic.

The National Freight Logistics Strategy (2005) outlined critical decisions, which required immediate attention. One was to upgrade the capacity on the Durban corridor and port, or to switch the corridor import/export traffic to another corridor and port. This is a drastic decision but it highlighted the current state of the corridor in terms of available capacity. The Department of Transport (2005) concludes by stating that the Durban – Gauteng corridor, which transports a large percentage of traffic for domestic consumption must be able to perform efficiently in the long term. In order to do so, the rail performance gap should be improved and a multimodal solution for the use of road and rail should be enhanced. Increased rail investment in this corridor is called for and will be imperative to enhance national competitiveness. The importance of the N3 Corridor is highlighted by the Presidential Infrastructure Coordinating Commission's (PICC's), in which it has been identified as a Strategic Infrastructure Project (SIP).

3.3.7 Forecasting Freight on the Corridor

Growth in freight traffic was reported to have exceeded most of the 20 year forecasts made by Moving South Africa, Action Agenda (DoT, 1998) at least 14 years earlier than expected. Whilst this is an indicator of economic growth, the freight infrastructure has been placed under increased pressure to be able to sustain this growth (DoT, 2005). The current and projected corridor volumes are displayed in Figure 37.

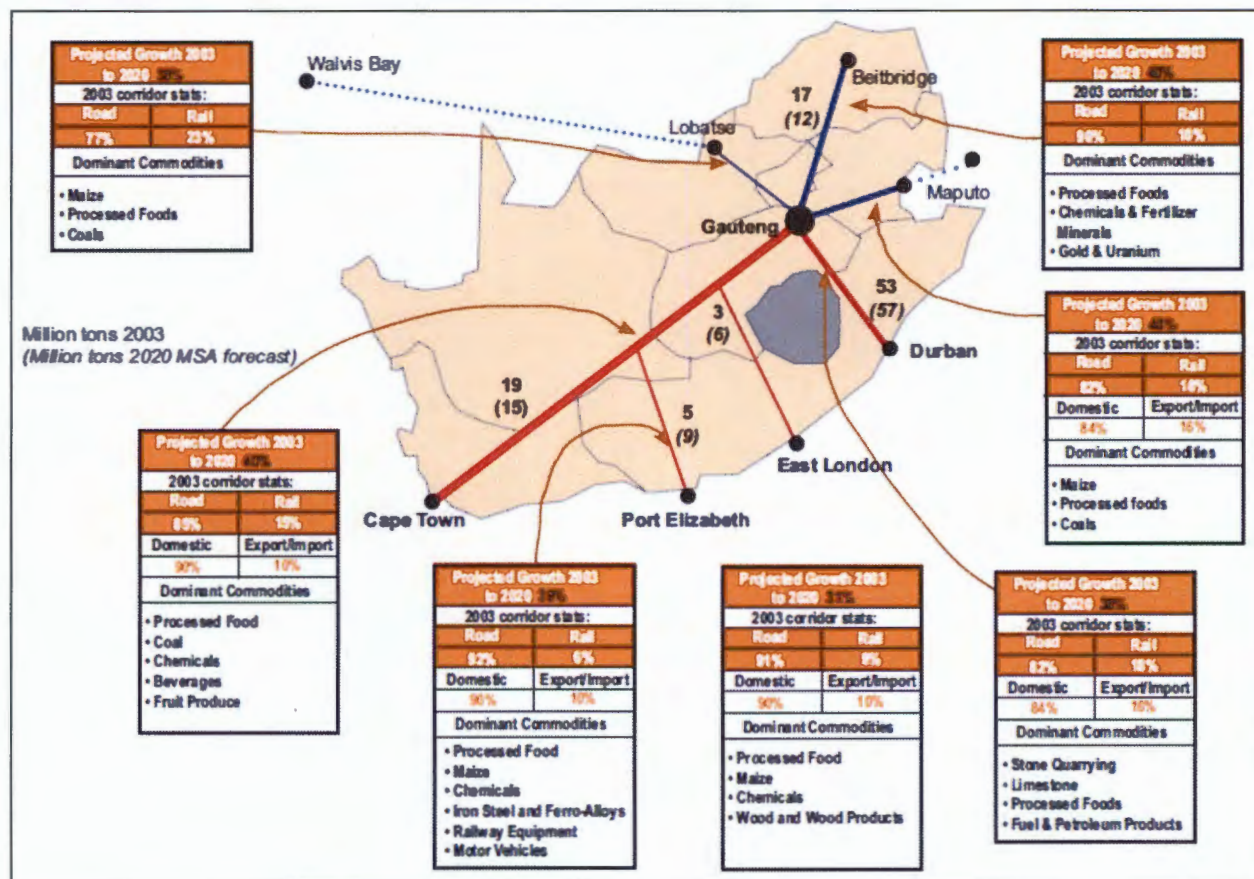


Figure 37: Current and projected corridor volumes
Source: DoT, 2005

It is clear that the Gauteng – Durban corridor carries the greatest proportion of freight, which was estimated at 53 million tons in 2003 (54.6% of total). Road is the dominant mode and carries 82% of all freight in this corridor. Freight transported for domestic purposes accounts for 84% of this, with the remaining 16% attributed to export/import from the Port of Durban. The freight volumes are forecast to increase by an additional 38% by the year 2020 along this corridor alone.

Since 2008, there has however been a national drive to lower logistics costs and improve freight efficiencies. This program is known as Strategic Infrastructure Project 2 (SIP 2) as identified by the Presidential Infrastructure Coordinating Commission (PICC). In determining the total estimated impact of indirect costs associated to road freight, it is important to consider the demand for road freight in the future. Transnet has produced the SIP 2 Demand Book, which covers all freight demand that impacts on the road, rail and pipeline flows between Gauteng and Durban for the next 30 years. Additional information can be sourced directly from the Transnet document, which includes sufficient detail on individual commodity based movements. The purpose of the book is to guide capacity planning initiatives on the corridor and is a reference source on:

- The macro factors impacting freight demand growth;
- Surface freight demand for the corridor irrespective of mode;
- Industrial basins; and
- Long-term unconstrained forecasts per mode for rail, ports and pipelines.

The forecasts in the book are based on the Transnet Freight Demand Model (FDM) 2014 which uses 2012 as the base year. The FDM uses three scenarios namely a low, likely and high path as distinct macroeconomic scenarios. The outputs of the likely scenario are now discussed. It is however important to note some of the assumptions used in preparing these forecasts which are as follows (Transnet, 2014):

- Population growth by approximately 1.1% per annum;
- Government expenditure of 3.9% per annum (slightly higher than GDP) to make up for the backlog in social infrastructure;
- The following global economic trends:
 - Reliance on mineral exports implies dependence on major trading partners' economic growth (about 3%);
 - World economic growth is slower than previously forecasted;
 - Medium-term economic growth of China and India will slow down from 10% p.a. to 6.5% p.a.;
 - Mature economies (e.g. USA and Germany) GDP less than 2.5% especially because of budget deficits;
 - The current euro crisis is expected to continue over the short to medium term; and
 - Most countries are expected to be more protective against exports from Asia.

The projected growth in demand for freight is presented by cargo type, commodity, origin / destination, direction and mode up to the year 2043. Of particular interest is Transnet's estimate of the modal split between road and rail in future years. It is noted that this estimate is based purely on Transnet's own assessment of addressable market potential and is therefore subjective. Figure 38 and Figure 39 present the projected growth per cargo type per direction for rail.

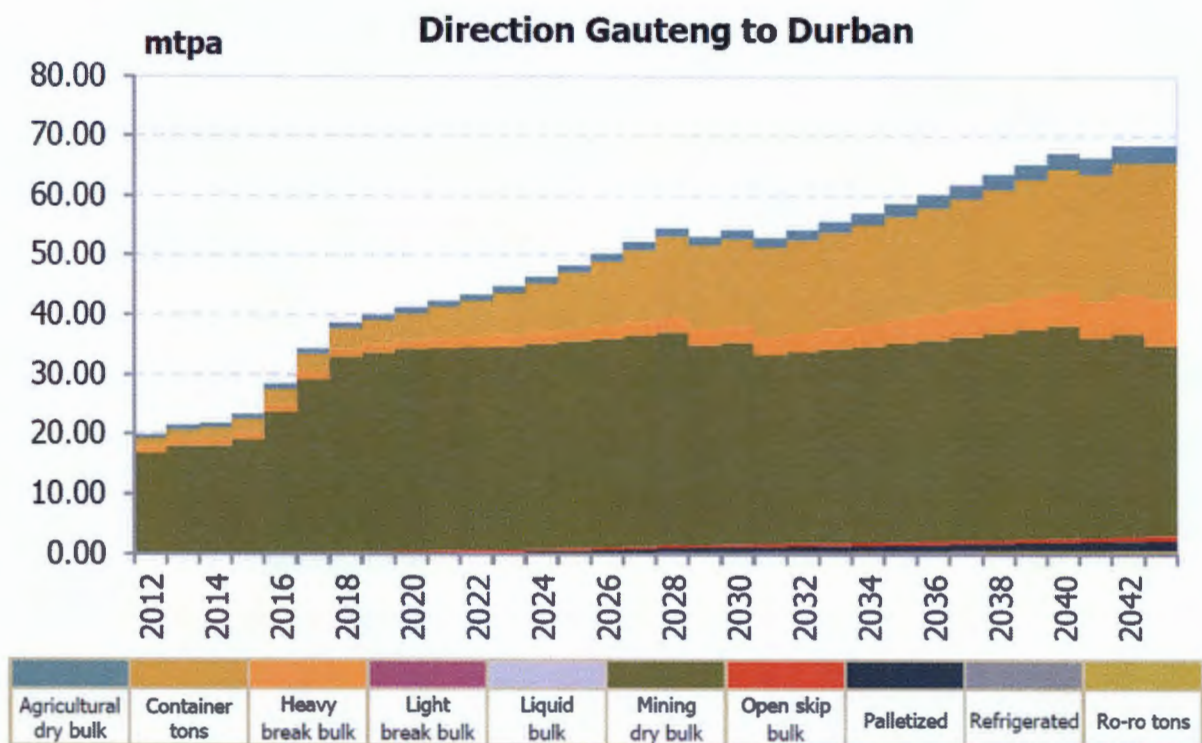


Figure 38: Corridor rail freight forecast per cargo type from Gauteng to Durban
 Source: Transnet, 2014 (note: Ro-ro refers to roll on, roll off)

Product travelling from Gauteng to Durban via rail is projected to increase from 20 million tons per annum (mtpa) to approximately 68 mtpa. This is equivalent to an average growth rate of almost 8% per year from Gauteng to Durban on rail alone. Mining dry bulk (16.63 to 31.99 mtpa) and container tons (1.54 to 22.93 mtpa) are the two cargo types predicted to grow significantly over this period. The total estimated train equivalent per day is expected to increase from 23 in 2012 to 159 by 2043.

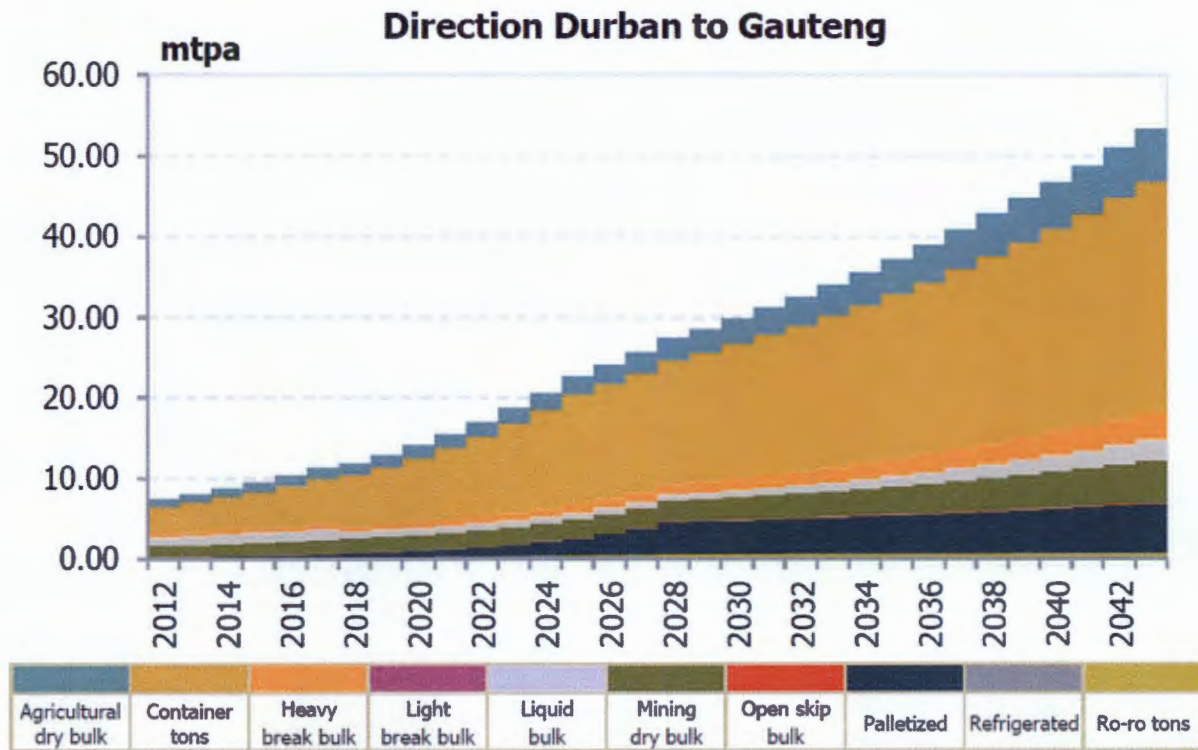


Figure 39: Corridor rail freight forecast per cargo type from Durban to Gauteng
 Source: Transnet, 2014

In the opposite direction, from Durban to Gauteng, rail freight is estimated to grow from 7 mtpa in 2012 to 53 mtpa by 2043. This represents a total increase of 650% or an average of 21% per year over the 30 year period. Similarly to the opposite direction, container tons (3.29 to 28.80 mtpa) are projected to grow significantly by 2043. The total estimated train equivalent per day is expected to increase from 22 in 2012 to 180 by 2043. In comparison to rail, road freight growth projections are moderate as illustrated in Figure 40 and Figure 41.

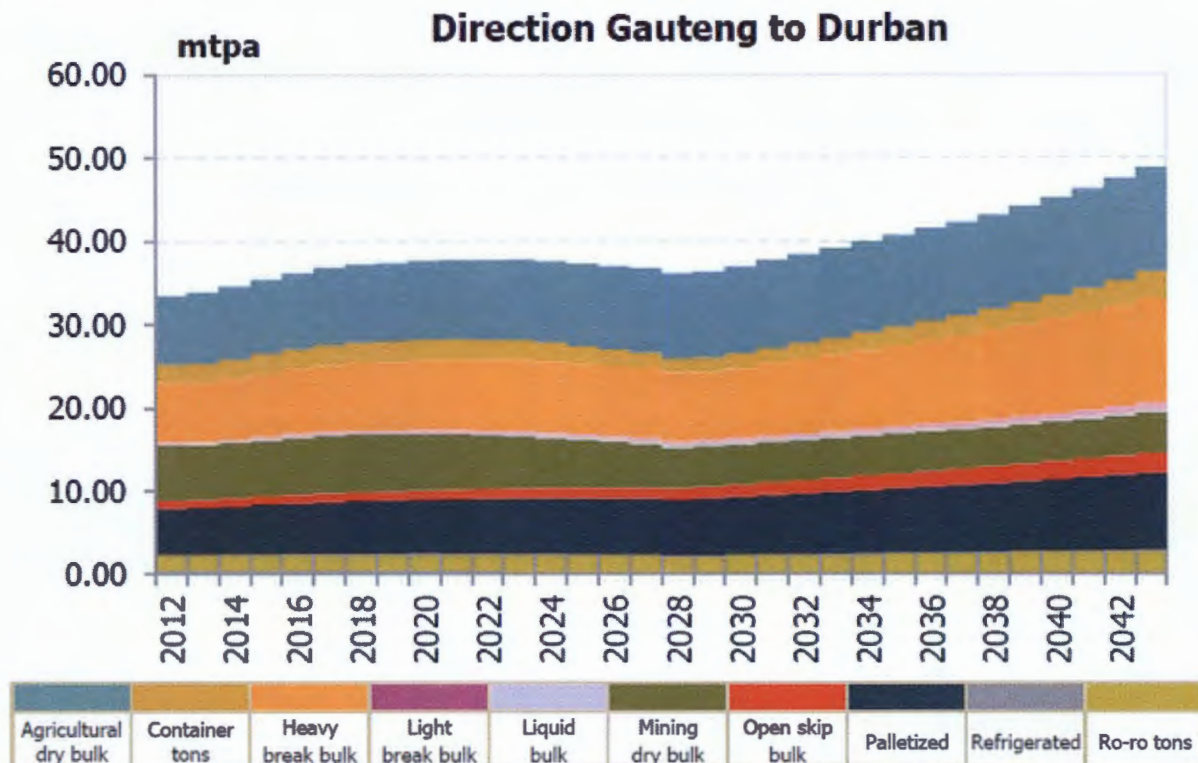


Figure 40: Corridor road freight forecast per cargo type from Gauteng to Durban
 Source: Transnet, 2014

Road freight from Gauteng to Durban is projected to grow from 33 to 49 mtpa (46%), or at an average growth rate of 1.5% per year. Agricultural dry bulk (8.16 to 12.44 mtpa) and heavy break bulk (7.04 to 12.39 mtpa) are the cargo types expected to show significant growth. Total growth is estimated to result in an increase in equivalent truck numbers from 2 450 to 3 572 (46%) per day from Gauteng to Durban.

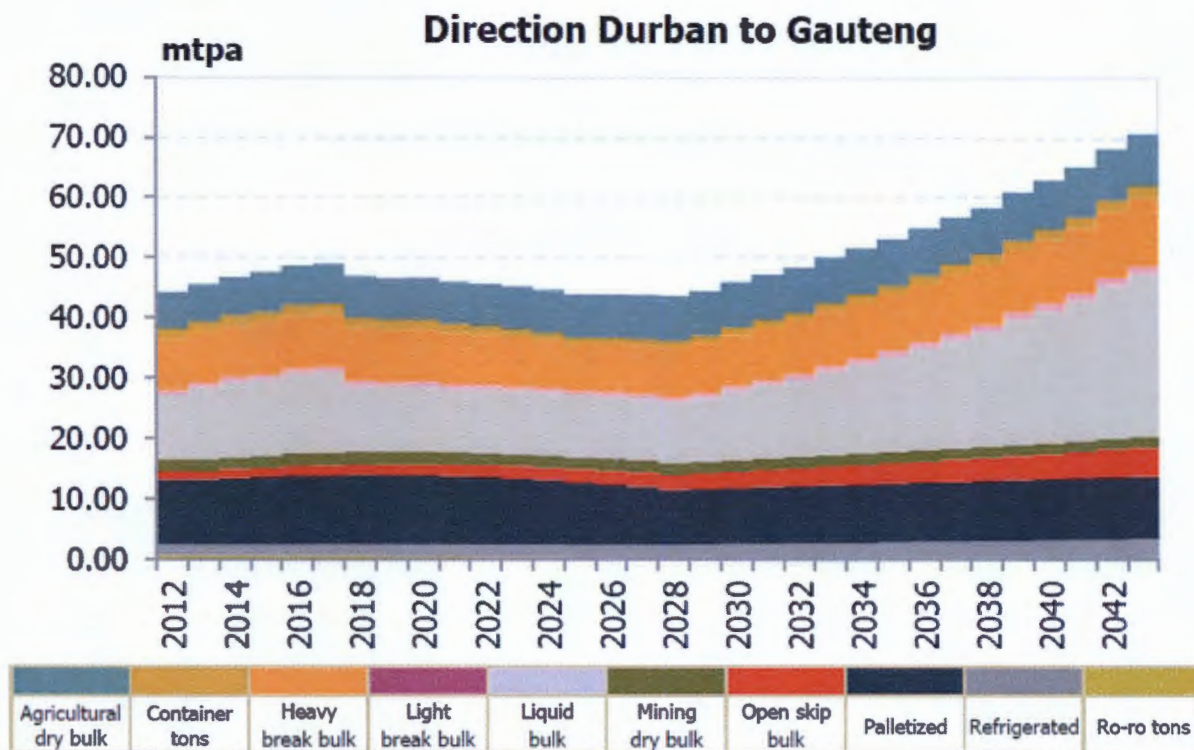


Figure 41: Corridor road freight forecast per cargo type from Durban to Gauteng
Source: Transnet, 2014

Road freight from Durban to Gauteng is projected to grow from 44 to 71 mtpa (60%), or at an average growth rate of 1.9% per year. Liquid bulk (10.62 to 27.09 mtpa) is the cargo type expected to show significant growth over this period. The total growth is estimated to result in an increase in equivalent truck numbers from 3 533 to 5 744 (63%) per day from Durban to Gauteng.

Overall, the freight profile shows that all freight flows, irrespective of origin or destination or distance travelling on the corridor is forecast to increase by 186% by 2043 (Transnet, 2014). This translates into an average annual growth rate of 3.4%. General freight growth rates are closely linked to economic growth, and as such should the South African economy succeed in growing at a higher rate there is likely to be an impact on the growth in freight volumes as well.

It is evident that volumes moved via road are significantly higher than volumes moved by rail. In the general direction of Gauteng to Durban (and back) road transported about 75% of all freight in 2012. According to Transnet's Freight Demand Model this percentage is forecast to decline to 63% by 2043. In turn, in 2012 there was an uneven spread between rail freight flowing from Gauteng to Durban and vice versa with just more than 72% of rail freight flowing from Gauteng to Durban and less than 28% in the reverse direction. This situation is forecast to become more balanced in 2043. In contrast road freight is more evenly distributed in each direction.

As the SIP2 Demand Book has been specifically developed for the Johannesburg to Durban Corridor it will be used as the source document on which growth assumptions and projections are calculated in this document.

3.4 Summary of the Status Quo

This section provides an overall summary of the state of freight transport in a global, South African and Corridor perspective.

3.4.1 Summary of Global Freight Transport

In a global environment, and due to the freight transportation industry being highly competitive, the private sector chooses the most cost-effective mode for transportation. For this reason, intermodal trips often comprise a very small (less than 11%) portion of the total freight transport trips made. Within a country, most goods are moved by road, when compared by weight and value. Rail does however compare closely when considering ton kilometres.

The rising trend in world exports indicates the strong connectivity among countries and the increased globalisation of economic activities that generate freight movements. Almost all countries export goods, and the United States receives exports from more than 200 countries; however, the overwhelming majority of global exports are concentrated in only a few countries. In 2008, the concentration of world exports among the top trading nations was significant (US Department of Transportation, 2010):

- More than half (51%) of the exports were from 10 countries,
- Three-quarters (76%) were from 25 countries, and
- Approximately 91% were from the top 50 countries.

In 2008, the global economic downturn had a significant impact on freight. This can be justified as freight is generated by economic activity and therefore responds to global financial market fluctuations. Prior to 2008, the main challenge experienced by the freight sector was the significant growth in trade that resulted in capacity constraints within the freight system. From 2009 onwards the challenge has been to manage the excess capacity as a result of freight businesses contracting in tough financial times due to reduced trade volumes.

The logistics sector of global supply chains includes freight transportation, warehousing, border clearance, payment systems, and increasingly more functions outsourced by producers and merchants to dedicated logistics service providers. As a result, the importance of good logistics performance for economic growth, diversification, and poverty reduction is firmly established (World Bank, 2014).

Whilst logistics growth is critical for global economic improvements, the top 25% of countries on the LPI placed the greatest importance collectively on national data tools and green logistics. This demonstrates the importance of the availability of information through websites, satellite tracking, etc, which enables logistics firms to be more efficient and effective as well as to integrate all aspects of the supply chain. In addition, the highest ranked logistics countries value the environment and hence place significant importance on any initiatives that could decrease the impact of logistics on the environment. The LPI also shows that the quality of services is driving logistics performance in emerging and richer economies. Logistics performance is strongly associated with the reliability of supply chains and the predictability of service delivery for producers and exporters.

3.4.2 Summary of South African Freight Transport

It can be concluded from the information outlined in this chapter, that the playing fields in the market for freight transport have tended to be unfairly weighted in favour of road transport. This is supported by the following observations (Stander and Pienaar, 2002):

- Rail lines and services were built and provided to boost economic growth particularly at the onset of the 20th century. Not much consideration was given to the financial viability and these operations were subsidised by the tax payers of South Africa.
- Road freight transport was tightly controlled for approximately six decades (1930 – 1990), but the gradual deregulation thereof, which has occurred since the late 1970s has caused a gradual shift of general freight from rail to road.
- Road users contribute 5% of total government revenue through revenue generated from the fuel levy alone, whilst expenditure on transport and communication amounts to 4% of total government spending.
- Laden heavy vehicles do not contribute proportionately to light motor vehicles for their use of roads and could be considered to be “subsidised” by light motor vehicles, should all fees and levies associated with road usage be considered.
- Spoornet (Transnet Freight Rail) is required to pay the same fuel levy as road vehicle operators for the diesel that they use. If this is considered as a fuel levy, which as discussed, is seen as a road user charge then this could be deemed to be unfair towards rail operators. However, if this cost is viewed as a general form of taxation, then it is similar to VAT or company tax that Spoornet has to pay.
- Increases in the legal axle limit for a truck has been disputed due to the fact that increased load will increase the potential damage to infrastructure, and in particular to road pavements. On the other hand, it has been argued that if infrastructure is upgraded to accommodate additional loads then there is likely to be a higher effectiveness and lower transport cost, which ultimately could benefit the economy. A similar argument can be directed at rail infrastructure, in terms of international gauge sizes, etc. The trade off in terms of total costs between upgrading infrastructure (rail or road) and the potential improved efficiency has not been calculated to date.
- Road freight is more competitive in some areas whereas rail freight is more competitive in others. Road freight transport is generally more competitive for shorter trips and higher value goods, whilst rail is for longer trips and lower value goods.
- In the industrial and logistics oriented market, freight transport clients prefer high quality of service (transport cost is not as important) and road transport service quality is regarded as being superior to that of rail transport.
- Appropriate incentives (and/or disincentives) as well as market mechanisms need to be introduced in order to influence the behaviour of companies and their customers to achieve desired climate change outcomes.
- Appropriate technological options to contribute to greenhouse gas reduction should be available at an appropriate cost and with a clear business case for adoption, to companies and organisations. This is in conjunction with clear, consistent and accepted methods for calculating, and the accountability for delivering emissions reductions.
- Networks need to provide appropriate capacity for the efficient operation of freight services, and freight operators (together with their customers), need to make effective use of the available capacity in order to maximise journey time reliability.
- A consistent and effective framework is needed to support the competitive and efficient operation of the logistics industry, with the required investment (private and/or public) and consistent planning decisions to support strategic development of freight infrastructure. This is of the utmost importance for strategic freight corridors.

- A clear understanding of the skills and numbers of employees needed to support a competitive and effective industry, both currently and in the future is required.
- There must be an appropriate and equal treatment of the impacts of freight and logistics operations on society, taking into account economic and environmental factors with a suitable appreciation of both the costs and benefits.

3.4.3 Summary of Johannesburg to Durban Freight Corridor

As a result of Gauteng being land locked, the primary freight movements are via road and rail. Up to 80% of the goods transported along this corridor cannot be transferred to other ports, as they are either for local consumption or it would not be economically efficient to export from an alternative port. With the serious implications of this high freight load on the sustainability of this corridor, alternative strategies are required to provide additional capacity.

Despite the high volume of goods transported along the corridor, the operational capacity of rail was estimated at 20% of the installed capacity, with delays at marshalling yards on route to the port of Durban impacting severely on the competitiveness of rail. Other infrastructure constraints, such as different electric currents, which require four locomotive changes and the age of rolling stock, continue to reduce efficiency and increase operating costs. A further challenge is that road traffic flows are not balanced in each direction, with greater demand on the infrastructure for the Johannesburg to Durban journey, than from Durban back to Johannesburg.

Since 2008, there has been a national drive to lower logistics costs and improve freight efficiencies. Transnet has produced the SIP 2 Demand Book, which covers all freight demand that impacts on the road, rail and pipeline flows between Gauteng and Durban for the next 30 years. Additional information can be sourced directly from the Transnet document, which includes sufficient detail on individual commodity based movements.

The benefits of an integrated freight sector are reported as being lost through reductions in reliability and an increase in cost to consumers. The impact of this results in the following situation on a corridor level, particularly on the high value export corridor between Gauteng and Durban (DoT, 2005):

- Inability to cope with growth in demand for freight traffic, due to insufficient investment,
- Mode transfer of goods from rail to road as a result of a rail system that is characterised by its inefficiency and unreliability,
- Port and airfreight systems without necessary capacity to deliver a cost effective and reliable service, and
- Growth in heavy vehicles (an increasing percentage of which are overloaded) utilising the secondary road network, which is not designed or maintained to a sufficient standard with which to support such traffic.

The National Freight Logistics Strategy (2005) outlined critical decisions, which required immediate attention. One was to upgrade the capacity on the Durban corridor and port, or to switch the corridor import/export traffic to another corridor and port. This is a drastic decision but it highlighted the current state of the corridor in terms of available capacity.

4 SIGNIFICANCE OF FREIGHT TRANSPORT IN SOUTH AFRICA

Havenga (2010) highlights the significance of the freight transport network through a review of the first and latest policy frameworks of democratic South Africa. Both frameworks identified the freight transport network as one of the key challenges to national economic competitiveness, sustainable development initiatives, and broad-based upliftment (Havenga, 2010). “*Almost everything we use daily has been moved by a freight operator – be it the food on our plate, the chair we sit on, or the clothes we are wearing*” (UK Department for Transport, 2008). This statement was made by the Secretary of State for Transport in Britain in the foreword to ‘*Delivering a Sustainable Transport System*’, and it indicates that industry, as well as society as a whole, rely heavily on freight transport. Transport is said to be second only to education in terms of the “multiplier effect” on investment return (Rail Road Association, n.d.). The significance of freight transport cannot be disputed. This section aims to highlight the significant contribution that freight has in terms of economic growth, as well as provide an overview of the costs of freight in relation to GDP.

4.1 Contribution to Economic Growth

Havenga (2010) discusses a number of international studies which highlight the important relationship between logistics and national competitiveness:

- According to the United Nations (2002), the comparative efficiency of a country’s logistics chain is of vital importance in enhancing the competitiveness of its industry and commerce.
- Lakshmanan and Anderson (2002) show that improved productivity in the freight transport sector enhances the productivity of the overall economy.
- The World Trade Organisation (2004) reports that “*the effective rate of protection provided by transport costs is, in many cases, higher than that provided by tariffs*”.

Marsay (2005) argues that it would be more economically efficient to accommodate the growth in freight transport on the road network rather than attempting to expand the rail network. The main motivation for this point of view is that the railway mode is technologically inferior to road transport technology for the majority of current transport needs. The following three Economic Theories were used to compare the different transport technologies (Marsay, 2005):

- Theory of comparative advantage,
- Role of technology in economic growth, and
- Theory of economic regulation of industries.

Comparative advantage – the wealth of a nation or society will be maximised if its resources are concentrated on sectors at which it performs better (Marsay, 2005). The theory of comparative advantage also states that if factors other than comparative economic production cost are allowed to determine investment priorities, then a country will be less well off than it might otherwise be.

Technology and economic growth – economists have struggled to single out factors which have led directly to economic growth. Nonetheless, a paper presented by Hahn and Matthews (1964) suggested that the variable most strongly correlated to economic growth over the long term was in effect technology (Marsay, 2005).

Regulatory economics – after recognising the influence of technology on the economy, the next logical step is to efficiently and effectively manage technology (Marsay, 2005). The role of regulatory economics is to identify the conditions that promote the benefits of technology whilst taking steps to mitigate the adverse effects.

Marsay (2005) goes on to state that the true test of a transport mode's technological efficiency is to fund all of its own costs, and further whether the technological application can generate returns on investment or whether it will require an ongoing subsidy. Railway technology is called inefficient and is characterised by the following (Marsay, 2005):

- An almost global inability to pay for its own infrastructure costs, mainly due to the complex and costly infrastructure required for an effective rail transport service, and
- An inability to generate tax revenues from the rail transport industry; despite large investment from government coffers there is often little financial return.

Many countries have not recognised that the inability of rail to cover its costs is not purely a result of operational inefficiency. In fact, poor management and operational efficiency are indicators of an inefficient transport technology. This, however, focuses purely on a financial comparison of the modes and does not consider non-financial benefits or mode externalities. In addition, it appears that from the examples provided, that only the total financial costs of each sector are considered – i.e. there is no separation of costs and returns between freight and commuter services (Marsay, 2005).

Marsay (2005) then investigates the possibility that socio-economic benefits are significant enough to justify the financial disparity. The conclusion was that, for most studies undertaken to date, investments in the rail infrastructure would not yield a good return on investment for public money spent. In 2003, the Strategic Rail Authority published research on 'Sensitive Lorry Miles', which aimed to determine the external benefits created when shifting freight from road to rail or water. A major observation from this research is that a sum of the environmental costs (noise, pollution, climate change) are significantly small in relation to congestion costs, irrespective of the nature (motorway, rural, urban) of road considered. Marsay (2005) suggests that it would be unlikely in South Africa that environmental considerations would be a determinative factor for the justification of rail investments.

In order to illustrate these points, Marsay (2005) provides an illustrative example of the Gauteng to Durban Corridor, in which the aim is to double the respective carrying capacities of road and rail freight in this section. The tonnage mode share between road and rail is 53 million to 9 million tons respectively, or an 84:16 split. It is further estimated that of the 53 million tons carried by road, two thirds (36 million tons) of this share is transported on the N3. Given the current operating capacity, rail would theoretically have no problem in doubling its capacity with limited financial investment in the existing rail infrastructure required. The depots at each end of the line would, however, require significant enhancement to limit the overall 'door to door' delivery time. Transnet were quoted as planning a R10 to R40 billion investment on recapitalisation of their assets. Marsay (2005) estimated that R15 billion would be spent on the N3 rail corridor over the next 10 years. This would result in an increase in rail capacity by 9 million tons or an additional 15 % to the total freight corridor capacity. The equivalent expenditure on road infrastructure, with an estimated all-in cost for design and construction of the pavement, structures, and interchanges at R25 million per kilometre, would purchase a dedicated dual freight highway with two lanes in each direction for 600 kilometres parallel to the N3. This would result in an increase in road capacity – able to handle up to 72 million tons annually, or an additional 58% to the total freight corridor capacity. Both strategies would alleviate congestion on the N3 and improve commuter conditions (Marsay, 2005).

Marsay (2005) acknowledges that not all environmental, socio-economic and logistics calculations were taken into consideration, but that based on the infrastructure capacity enhancement alone, there is already a sufficient gap between the modes to make rail investment a futile exercise (Marsay, 2005).

Whilst the services provided by road transport companies have a positive contribution to economic growth, this is accompanied by externalities. Certain operators, in an attempt to maximise their profits, are continuously overloading freight vehicles. This ultimately leads to the reduction in the life cycle of the road infrastructure. Methods are in place to monitor/control overloading – such as weigh bridges – but these are not entirely successful for the following reasons (Van der Mescht, 2006):

- The alternate parallel route is not always monitored concurrently,
- Staff limitations result in stations that are not in operation 24/7, and
- Operating capacities limit the number of vehicles that can be processed daily.

The road freight industry has, to date, been unsuccessful in its attempt to be self-regulatory.

4.2 Freight Transport Costs In Relation to South African Gross Domestic Product

The Council for Scientific and Industrial Research (CSIR, 2014) reported that logistics costs in South Africa for 2013 were R423 billion or 12.5% of Gross Domestic Product (GDP). The transportation cost component is 61.6% of the total logistics costs; this is much higher than the world average of 39% (CSIR Built Environment, 2008). Havenga (2010) cites numerous sources which indicate that South Africa's logistics costs, as a percentage of GDP, are high in global terms:

- Bowersox and Closs (1996) calculated an average for industrialised nations of 11.7%,
- According to the United Nations (2002), Japan's logistics costs are about 10% of GDP, while in the USA, the figure was 10.1% in 2007 (Wilson, 2008), and
- For some less-developed economies, these costs exceed 30%. Moreover, the differences between countries appear to be widening (Bowersox and Closs, 1996).

Figure 42 compares the logistics cost components in 2004 (Havenga, 2010) with same in 2013 (CSIR, 2014). The four components measured are transport; inventory and carrying cost; management, administration and profit; and storage and port handling.

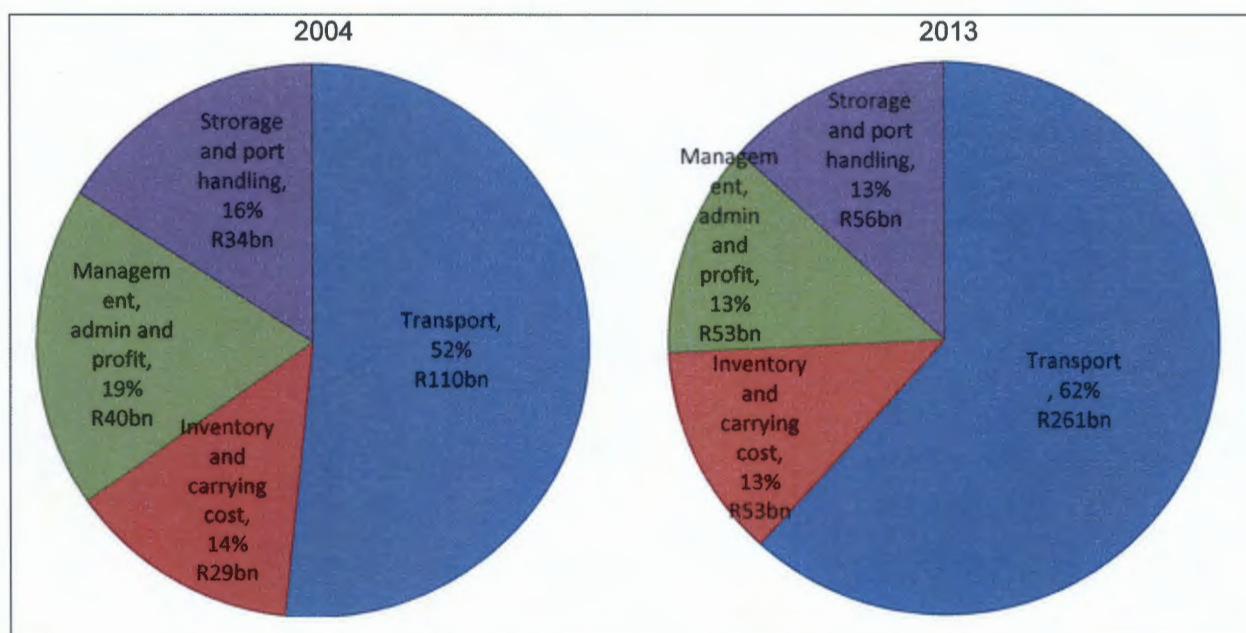


Figure 42: South Africa's logistics cost components in 2004 vs. 2013

Source: Havenga, 2010 and CSIR, 2014

Of the total logistics costs in 2013 (R423 billion), transport costs account for almost two thirds of this at a value of R261 billion. Between 2004 and 2013, the total cost of logistics increased by R210 billion and

transport by R151 billion. In comparison to each other, transport costs have increased whilst the remaining three have decreased (percentage wise). The total value of logistics costs has almost doubled (99%) in ten years. Over this same period, fuel (diesel) increased from R4.00/l to R12.48/l – a 212% increase.

The primary reason for the large portion of costs due to transport, is the reliance on road transport rather than rail. This has been further compounded by high fuel prices and long distance road freight haulage (mainly between Gauteng and coastal areas) on the major corridors. Transport is an input cost into extraction, manufacturing and service processes just like any other input in the economy. The base commodity purchased can be described as ton-kilometres, and it is a fact that South Africa needs more of this commodity per unit extracted, produced or service provided than most countries in the world. Apart from that, unlike most other processes, transport is dependent directly on a risky and unpredictable core cost driver – the price of fuel. It can often be difficult to manage a cost which is as unpredictable as the price of fuel. In South Africa it appears, however, that clear strategies to minimise this impact are not common practice. The transport costs, as a percentage of GDP can, therefore, be expected to be erratic and exposed to global risks; this is illustrated in Figure 43 (CSIR Built Environment, 2014).



Figure 43: The cost of transport expressed as a percentage of GDP between 2006 and 2014
 Source: CSIR Built Environment, 2014

During the 2007 calendar year, the average diesel price increased by 32%. The price of fuel is responsible for an estimated 32% of all road transport costs and, therefore, a dramatic increase in fuel costs, as experienced in 2007, can have significant effects on logistics costs (CSIR Built Environment, 2008).

The 10th Annual State of Logistics Survey included an assessment of the transport costs in relation to GDP for selected African countries; this is illustrated in Figure 44.

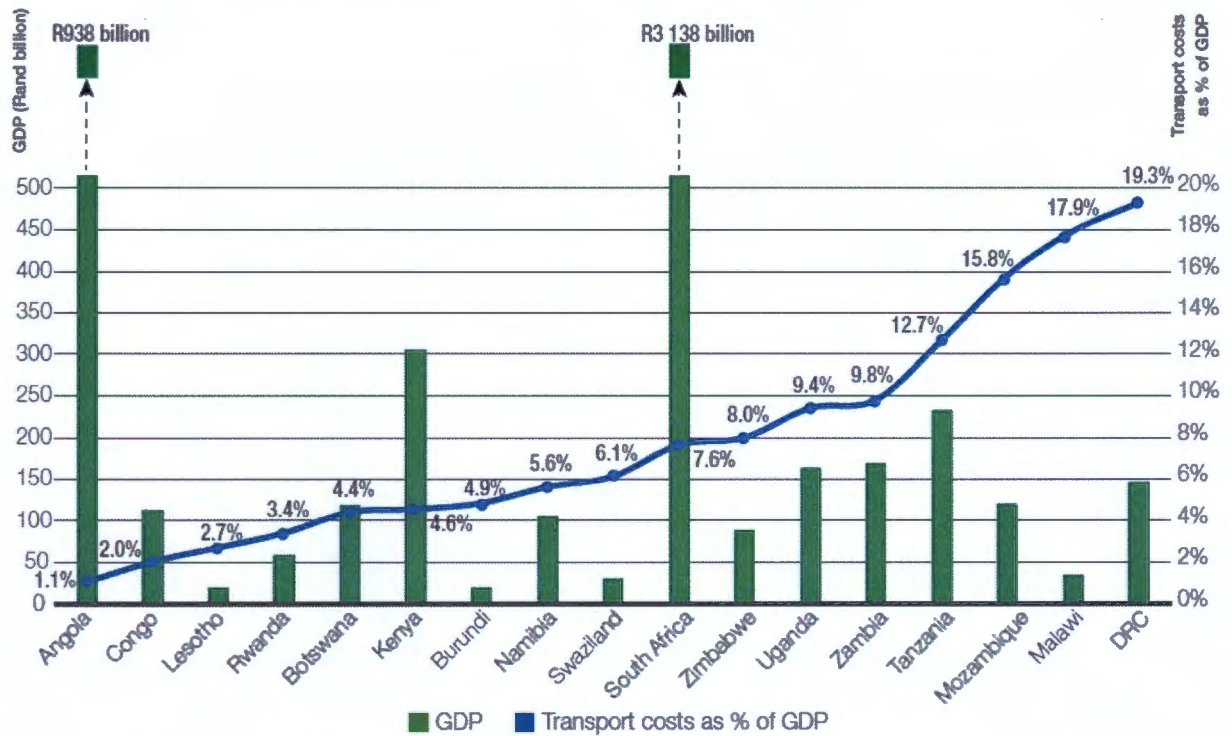


Figure 44: Transport costs as a % of GDP for selected African countries in 2012
 Source: CSIR Built Environment, 2014

Transport costs in South Africa accounted for 7.6% of GDP (R3.1 trillion) in 2012. By comparison, Angola's transport costs are only 1.1% of GDP (R0.9 trillion). Angola has exceptionally low transport costs as a percentage of GDP due to the heavy reliance on crude oil exports that take place by sea and therefore do not add to land transport costs, but contribute to the GDP (CSIR, 2014). This serves to show that each country's underlying economic structure impacts the link between transport costs and GDP. As such, direct comparisons between countries should be done with caution.

Havenga (2010) notes that demand for transport is a derived demand; and therefore, in terms of an opportunity cost, unnecessary transport should be eliminated. South Africa produces less than half a percent of the world GDP, but requires 2% of the world's surface freight ton-kilometre, resulting in a contribution of 1% to the world's carbon dioxide emissions (Havenga, 2010). This problem is aggravated by the fact that the majority of corridor freight transport is by road. Figure 45 illustrates the allocation of transport costs to various geographic areas, as well as the modal split between road and rail for corridor transport costs.

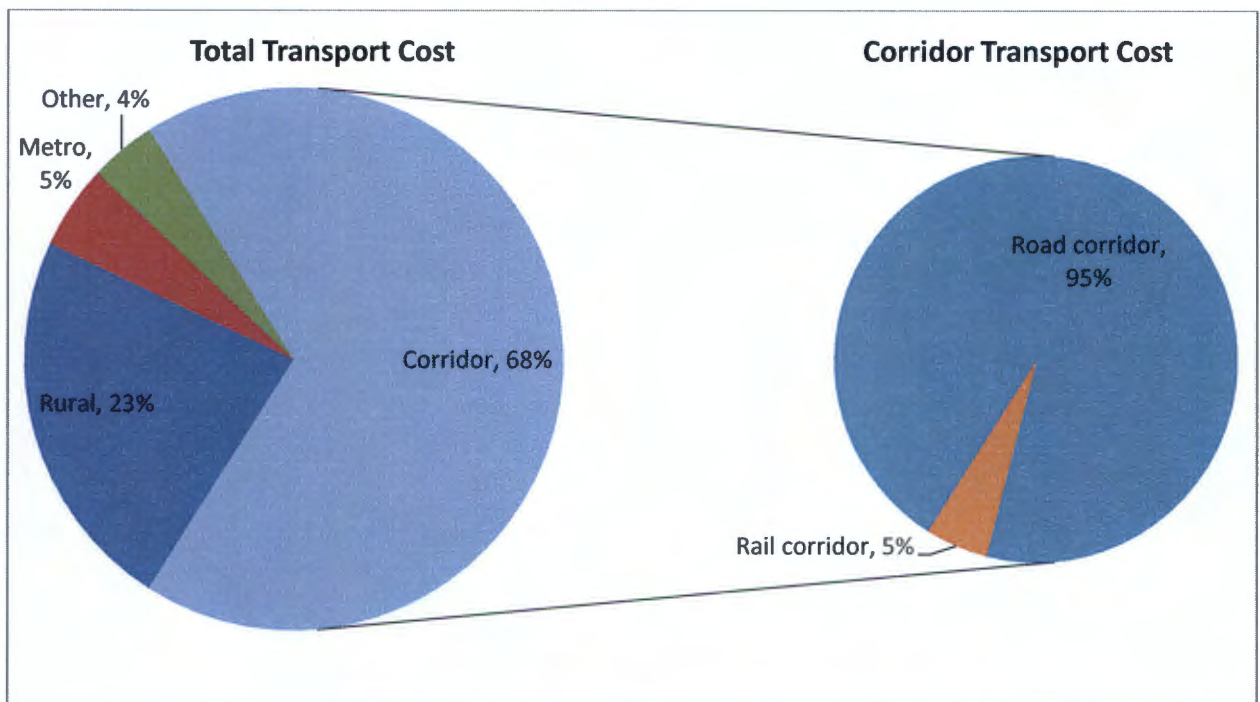


Figure 45: Structure of South Africa's freight transport market

Source: Havenga, 2010

Corridor transport costs are the significant contributor (68%) to total transport costs, followed by rural with a 23% contribution. Road freight accounts for 95% of the corridor costs, and hence, overall corridor road freight is responsible for 65% of all transport costs.

Whilst external costs are difficult to control on a local or global scale, it is important to minimise these costs where possible. The fact that South Africa has remarkably higher transport costs in comparison to the world average is proof that a more efficient alternative should be possible. These alternatives need to include the optimum use of each transport mode so as to minimise direct transport costs related to freight transport.

5 THE NATURE AND IMPACT OF ROAD FREIGHT AND LOGISTICS

Given both the economic and social significance of road freight transport, as was established in the previous chapter, it is imperative that the nature of the associated negative impacts of road freight transport is understood. This chapter first seeks to identify and define the types of impacts, and then provide a more in-depth understanding of the impacts specific to the Johannesburg to Durban Freight Corridor.

5.1 *Direct versus Indirect Impacts*

At a high-level, the impacts of road freight can be split into two broad categories, namely: direct and indirect impacts. Direct impacts refer to costs borne by the owner or operator of the freight companies, whereas indirect impacts arise when the social or economic activities of one group of persons (i.e. freight companies) have an impact on another group and when that impact is not fully accounted, or compensated for, by the first group (European Commission Community Research, 2003).

The direct impacts of road freight consist of the following elements (Havenga, 2010):

- Transport costs,
- Storage and port handling costs, and
- Management and administration costs.

An increasing amount of research into the indirect impacts of transport has been conducted over the last decade, with numerous impacts identified in the literature (OECD, 1997, Jorgensen, 2009). The following are the most important indirect impacts which are specific to road freight transport, and relevant to the Johannesburg to Durban Freight Corridor:

- Accidents,
- Congestion,
- Energy efficiency and resource consumption,
- Exhaust emissions and air pollution,
- Noise pollution,
- Traffic enforcement, and
- Uptake of land.

The nature of the above indirect impacts, along with two other indirect impacts, overloading and social, for which isolated studies have been conducted upon but not included in overall studies on indirect impacts, have been investigated. Furthermore, an argument on whether or not the decline in rail infrastructure should be considered as an indirect impact is also included.

As discussed in Chapter 4, South Africa has comparatively high transportation costs, much of which is due to road freight. These costs are however, due to direct costs. The total cost of transportation – inclusive of indirect costs – could be significantly greater than the 'known' direct costs. For this reason, this chapter explores the nature of the indirect impacts such that they may be factored into the total cost of road transportation. The outcomes of the investigation are detailed in the remainder of this chapter.

5.2 Accidents

5.2.1 Overall accident statistics

“Road crashes kill nearly 1.3 million people every year, and leave millions more injured or permanently disabled. Impaired driving, unsafe roads and other dangers shatter lives in a matter of seconds” - Ban ki-Moon, United Nation Secretary General (2011).

A road accident is often classified as a fatal, major, minor, or damage-only collision. A fatal collision involves the death of a person/s either immediately or within six days of the collision. A major collision involves serious injuries to persons, whilst a minor collision involves slight injuries to persons. A damage-only collision as the terminology suggests, involves only vehicle damage with no injury of any kind to persons.

Between 14 000 and 18 000 people are killed annually (www.arrivealive.co.za) on South African roads. According to the African Health Observatory (AHO, 2013), road accident-related fatalities are the fourth highest cause of death in South Africa at 2.6% of total fatalities. Over the 12-month period from 1 April 2010 to 31 March 2011, the number of fatal crashes decreased by 103 (0.94%) from 10,948 crashes over the same period the previous year to 10,845 in 2011 (RTMC, 2012). The International Transport Forum's (ITF) Road Safety Annual Report (2013) states that South Africa has seen a 25% increase in fatal crashes over the past 20 years.

ITF's Road Safety Annual Report (2013) ranked South Africa the worst of 36 other countries in terms of the number of road fatalities. Road fatalities per 100 000 inhabitants was at 27.6 deaths in 2011; this was excessive in comparison with developed countries like the United States of America (10.4) or Australia (5.6). Whilst developing countries included in the report did not exceed South Africa's road death toll, both Argentina and Colombia reached around 12 road fatalities per 100 000 inhabitants, while Malaysia came off second-worst at 23.8 (International Transport Forum, 2013). This report also estimated the economic cost of South Africa's road crashes to be R307 billion each year, using the human capital method. The impact in terms of Rand value resulting from road accidents is increasing significantly.

Compared to European cities, the fatality rate in South Africa is between five and eight times higher (Vanderschuren, 2007). Several external factors, such as economic growth, population growth and migration, and growth in active vehicle fleet, might be influencing the growing fatality and accident rate:

- The South African economy grew at an average rate of 5% between 2004 and 2007; this slowed to 2% from 2008 to 2012 due to the global economic downturn (www.statssa.gov.za).
- As per the most recent census, the South African population in October 2011 was at 51.8 million. Compared with the October 2001 figure of 44.8 million, this indicates a growth of 15.6% over a 10 year period (www.statssa.gov.za).
- In 2004 and 2005, South Africa had record car sales running for 18 months. Every month the amount of new vehicles sold was higher than the month before. The high fuel price did not seem to decrease sales. According to the television programme *Carte Blanche* (16 October, 2005), car ownership was growing by 10% a year. Only in 2007, did car sales begin to slow down (Vanderschuren, 2007). However, in 2010 new car sales began to increase again – reaching an all-time high of 42 915 cars in September 2014 (www.tradingeconomics.com).

Figure 48 displays the annual number of fatal crashes per province between 2006 and 2009. The 2009 statistics are not complete, but there is an indication that the number of fatal crashes is decreasing each year in each province.

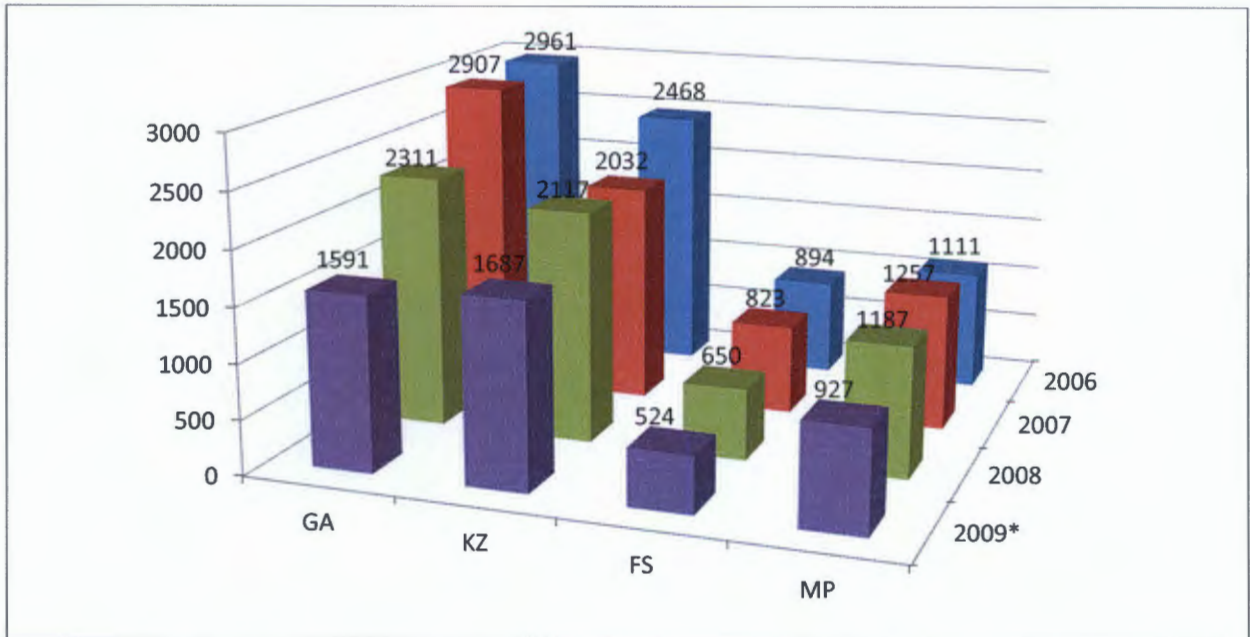


Figure 46: The annual number of fatal crashes per province (2009* up to end September)

Source: RTMC, 2010

The number of road fatalities per province (indicated in Figure 47) is similar to the reduction in the number of fatal crashes. The majority of provinces have displayed a downward trend in terms of number of fatalities.

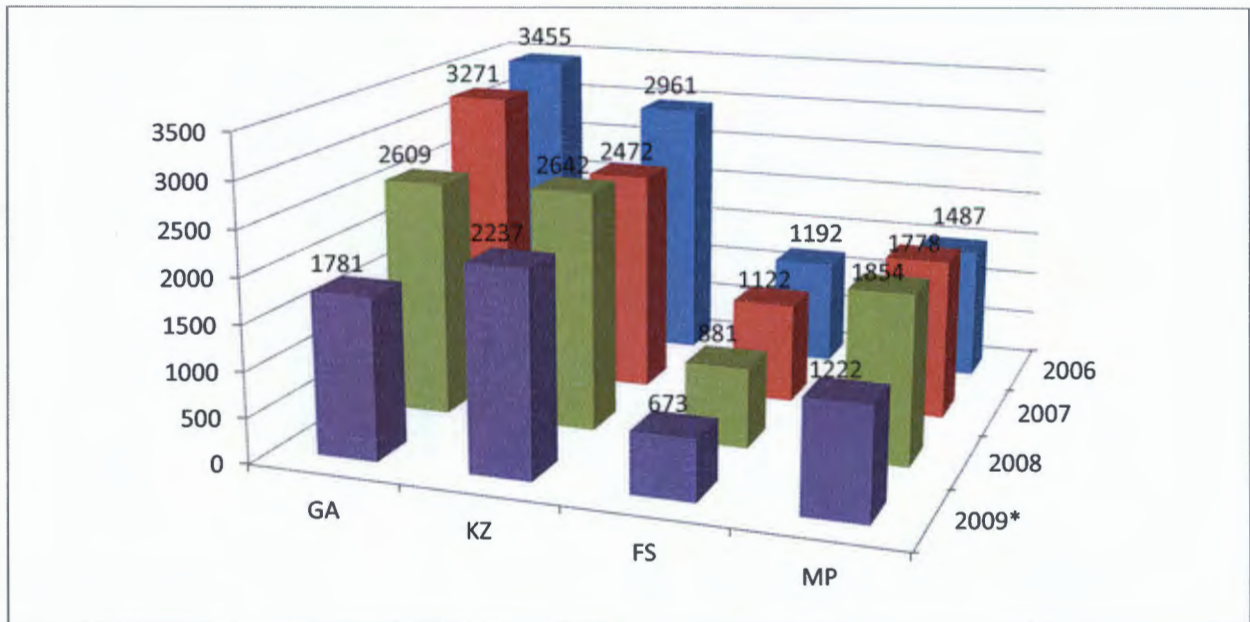


Figure 47: The annual number of road fatalities per province (2009* up to end September).

Source: RTMC, 2010

5.2.2 Accident statistics by mode

In order to evaluate the impact of road freight, it is important to determine whether heavy vehicles are more inclined to be involved in incidents than passenger cars. The modal split between passenger vehicles and freight vehicles will result in a greater number of passenger vehicles being involved in accidents. One way to make the figures comparable is to evaluate the average modal split of heavy vehicles and passenger cars with the ratio of incidents in which these two modes are involved. For example, if on average the N3 corridor traffic consists of 10% heavy vehicles and 90% passenger cars, then with all else being equal, the ratio of accidents that these modes are involved in on the same portion of road should also be 90/10.

According to the National Department of Transport's Annual Transport Statistics (2002) there are approximately 253 000 registered heavy vehicles with a Gross Vehicle Mass (GVM) greater than 3.5t in South Africa (approximately 26 000 of these are buses). The number of HGV's remained almost unchanged between 2001 and 2004 and is equivalent to approximately four percent of all self-propelled vehicles in South Africa. Bester (2001) shows that the percentage of other vehicles on the road has a substantial impact on the number of road fatalities of a country.

Figure 48 schematically represents the number of vehicles involved in road traffic collisions according to vehicle type.

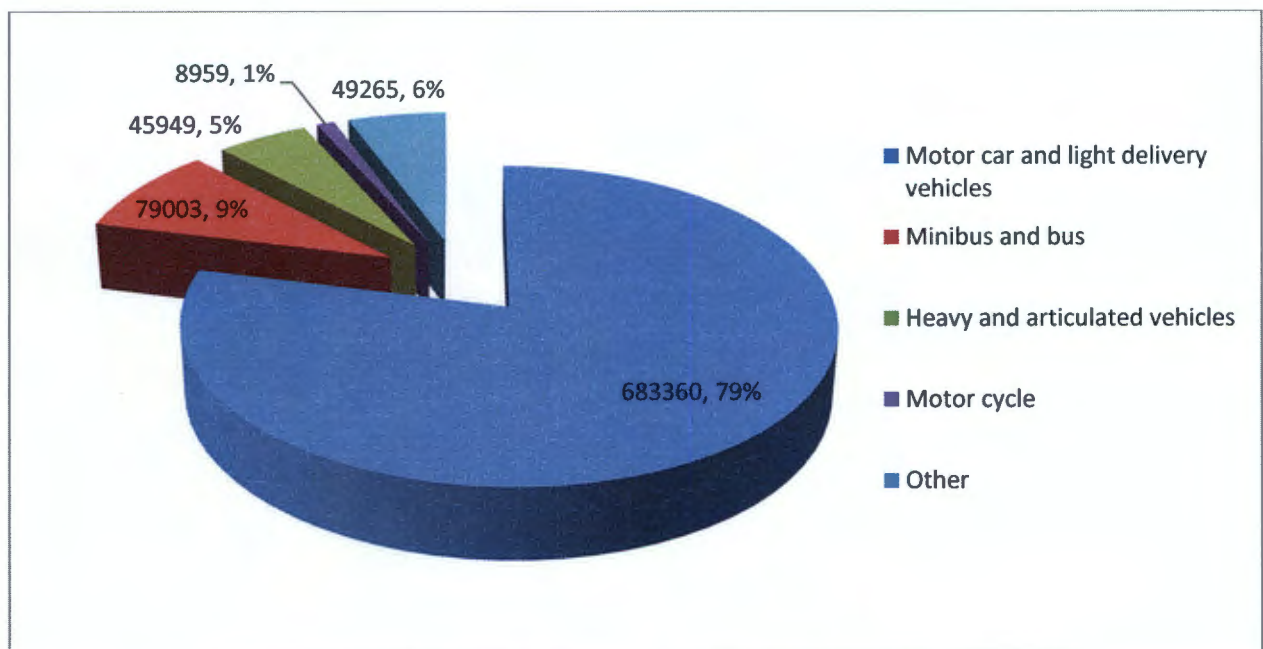


Figure 48: Vehicles involved in road traffic collisions

Source: Schutte, 2000

The estimated number of vehicles (per type) involved in fatal crashes is provided in Figure 49 and Figure 50. Trucks were involved in 6.3% of the fatal crashes between 2007 and 2008, and 5.2% of the fatal crashes between 2008 and 2009.

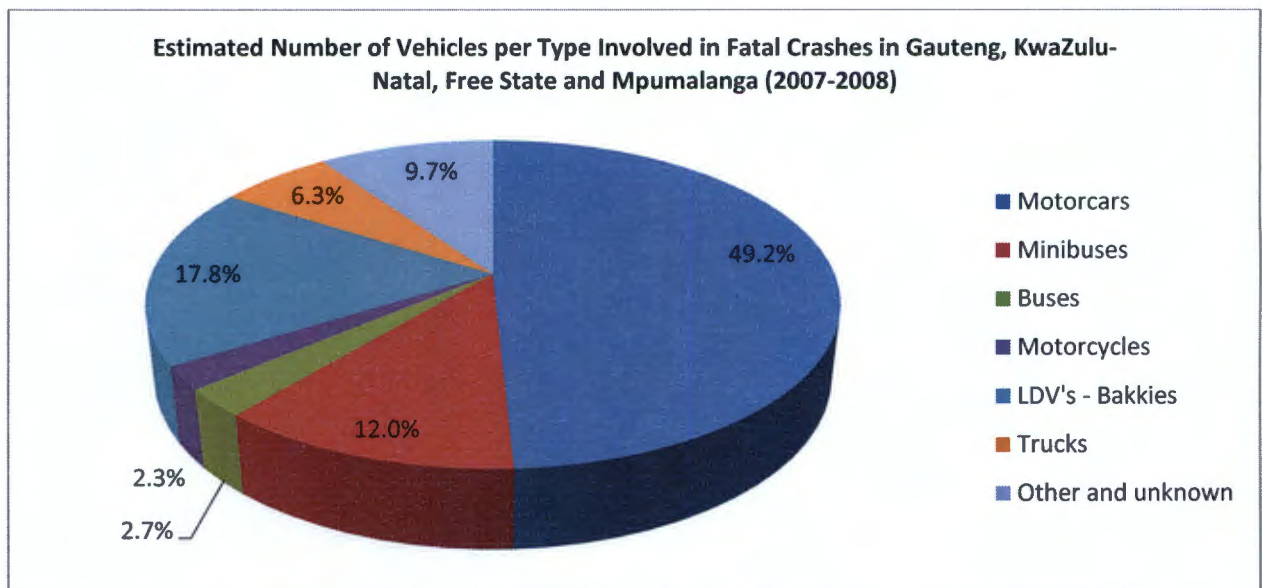


Figure 49: Estimated number of vehicles per type involved in fatal crashes (2007 - 2008)
 Source: RTMC, 2010

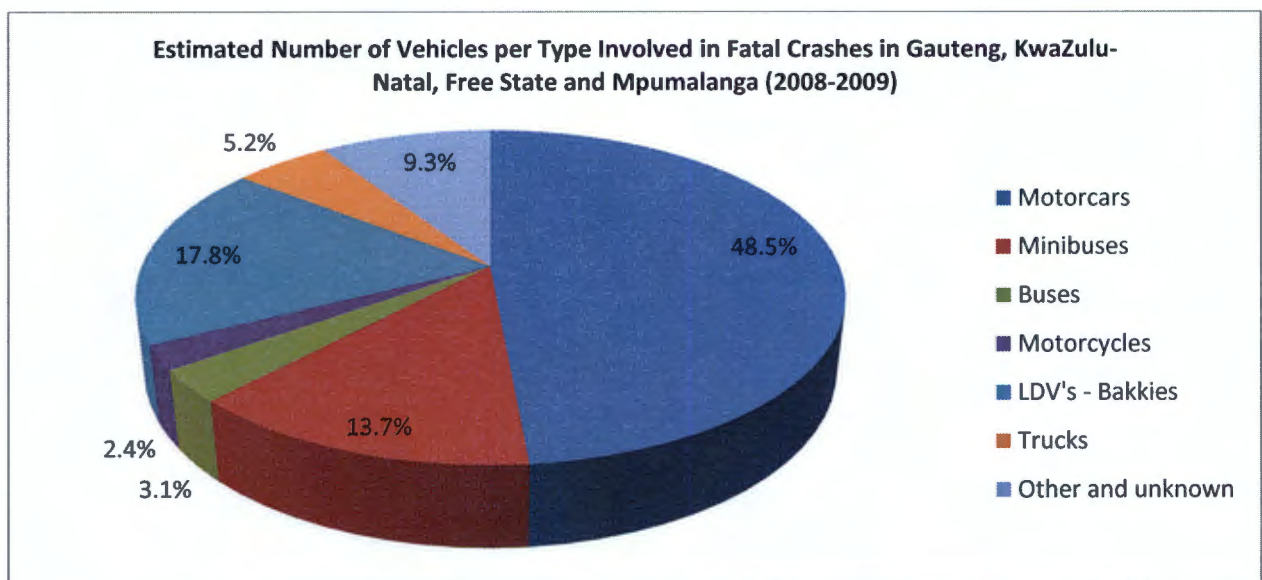


Figure 50: Estimated number of vehicles per type involved in fatal crashes (2008 - 2009).
 Source: RTMC, 2010

Whilst it is encouraging to note that there is a decline in the percentage of fatal crashes (year on year) involving heavy vehicles, it is still proportionally higher than the percentage of heavy vehicles in comparison to total vehicle traffic.

5.2.3 Causes for accidents in HGVs

As illustrated by the above figures, trucks are involved in proportionally more fatal crashes in relation to the percentage of heavy vehicles (4%) as a total of all self-propelled vehicles in South Africa. Bester (2001) found that in rural areas, the proportion of heavy vehicles involved in accidents is greater than that for passenger cars. The greater proportion of accidents among heavy vehicles is a result of a number of factors, some of which may include:

- Geometric design (sharp corners, steep slopes),
- Driver behaviour (aggressive, unsafe, tired),
- Loading (overloaded, uneven).

- Weather (wind, fog, rain), and
- Vehicle condition (lack of regular maintenance, aged fleet, un-roadworthy).

Heavy trucks accelerate more slowly than smaller vehicles; hence, there is an increased accident risk when smaller vehicles attempt to pass slow-moving trucks, especially when there are no climbing lanes on upward sloping sections of road.

Bester (2001) cites findings from earlier research (Bester, 1997) that show that in addition to the physical characteristics of heavy vehicles (acceleration, deceleration, mass, size, stability), there are another two important factors that contribute to the higher accident rate – namely the driver and trip length characteristics. Long trips and consequently long working hours may be a contributing factor to the number of trucks involved in accidents. For example, Maldonadoa et al. (2002) found that 24% of heavy-vehicle road accidents in South Africa may be attributed to drivers falling asleep at the wheel.

Overloading of heavy vehicles also poses a safety risk and may be a cause of a number of accidents; this will be revisited in Section 5.9: Overloading.

The International Road Transport Union produced a report on European Truck Accident Causation (2007); findings indicate that 85.2% of the investigated accidents involving trucks may be attributed to human error, 25% of which were caused by the truck driver. Weather conditions (4.4%), infrastructure conditions (5.1%), and technical vehicle failures (5.3%) did not cause a significant amount of the investigated accidents. It must be noted that this in the context of a different country – in South Africa, these other factors may play a more significant role.

For example, between September 2008 and September 2009, the number of un-roadworthy trucks in Gauteng, KwaZulu-Natal, Free State and Mpumalanga increased, whilst the number of un-licensed vehicles in all provinces decreased. Figure 51 displays the number of un-roadworthy and un-licensed trucks in each of the four provinces that the N3 passes through.

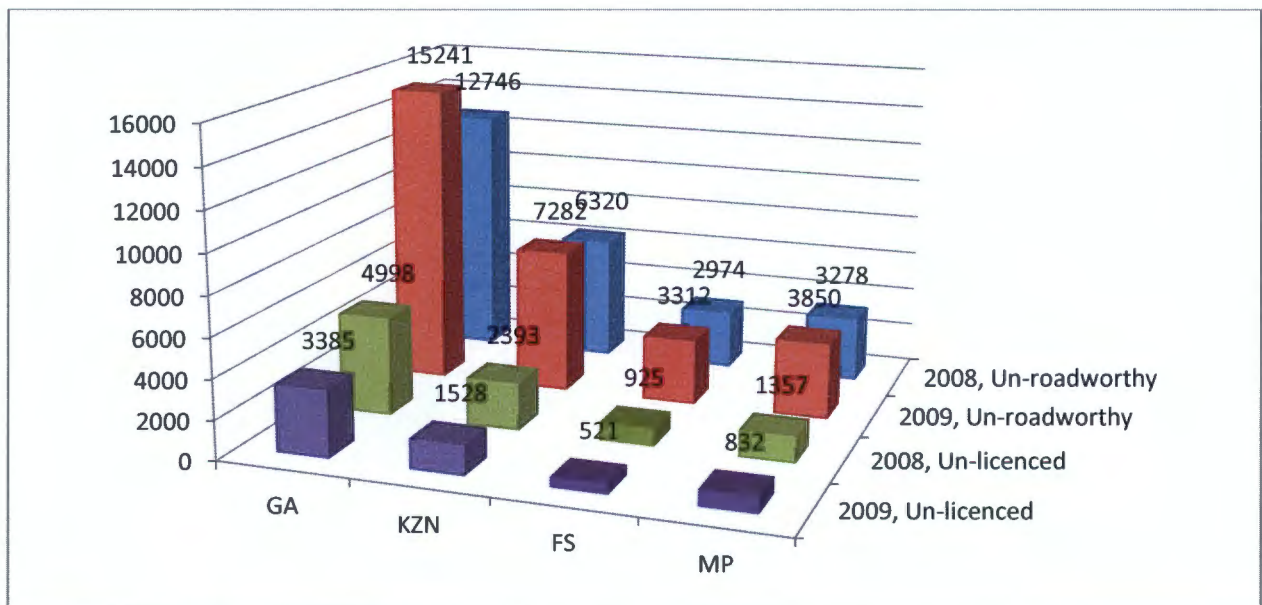


Figure 51: The change in number of un-roadworthy and un-licensed trucks between 2008 and 2009
 Source: RTMC, 2010

The number of un-roadworthy trucks has increased from September 2008 to September 2009 by between 11.4% in the Free State to 19.6% in Gauteng. During the same period, the number of un-licensed trucks

decreased by between 32.3% and 43.7% in Gauteng and the Free State (respectively). An increase in the number of un-roadworthy trucks could be a contributing factor to the number of accidents.

Figure 52 displays the number of fatalities for trucks occurring between 2007 and 2008 according to user (driver, passenger and pedestrian). The number of pedestrian fatalities is higher than that for drivers or passengers, indicating their vulnerability.

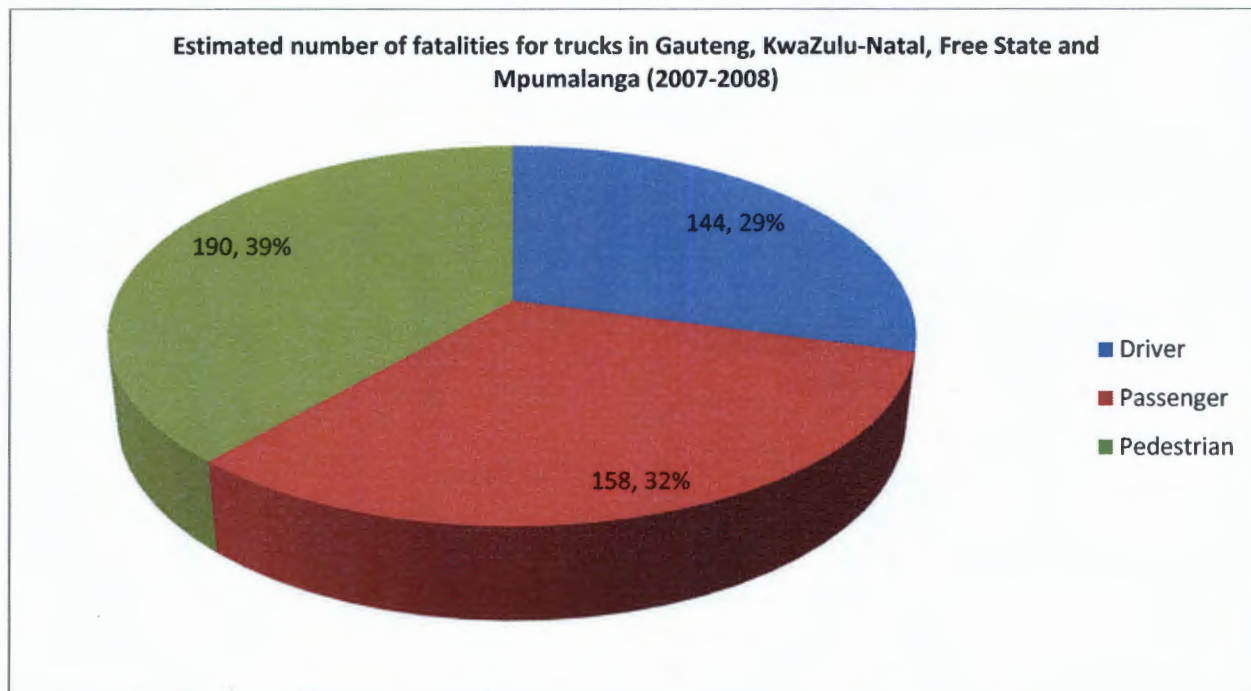


Figure 52: Estimated number of fatalities for trucks (2007-2008)
 Source: RTMC, 2010

Figure 53 displays the number of fatalities for trucks between 2008 and 2009 according to user (driver, passenger and pedestrian). There has been a significant decrease in the number of driver and passenger fatalities in comparison with the 2007 and 2008 period. The number of pedestrian fatalities has remained similar to the previous year, and is now remarkably higher than for the other users.

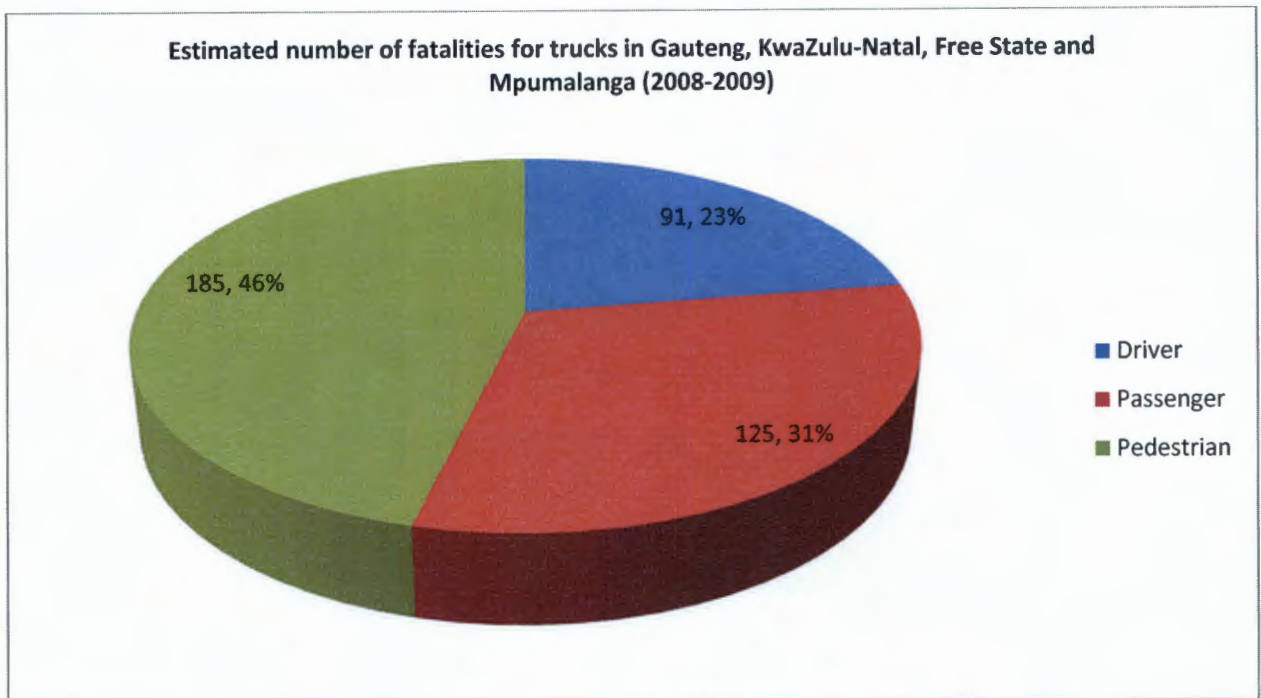


Figure 53: Estimated number of fatalities for trucks (2008-2009)

Source: RTMC, 2010

5.2.4 Current practices implemented to improve road safety and decrease the number of accidents

Whilst it is difficult to attribute one single external factor directly to the ever growing safety problem in South Africa, migration and active vehicle fleet most probably play a significant role. Measures, such as traffic calming, the introduction of Road Safety Audits, the training of more traffic officers, and road safety campaigns, aiming to decrease fatalities, have been adopted in South Africa. Unfortunately, no significant decrease in fatalities has been witnessed due to these measures. Intelligent Transport Systems (ITS) to improve traffic flows, as well as road safety, have been and continue to be implemented in South Africa.

The 2015 Road Traffic Safety Management Plan aims to reduce the rate of accident fatalities arising from road and other transport by half by the year 2015. This is based on the 2006 Millennium Development Goals. It was agreed that the 2007 fatality numbers would be used as the benchmark and the maximum allowable number of road fatalities per quarter per province up to the end of 2015 were calculated as continuous reduced target figures over the 8 year period (RTMC, 2009). Figure 54 depicts the percentage above or below the calculated target for accident fatalities in each province.

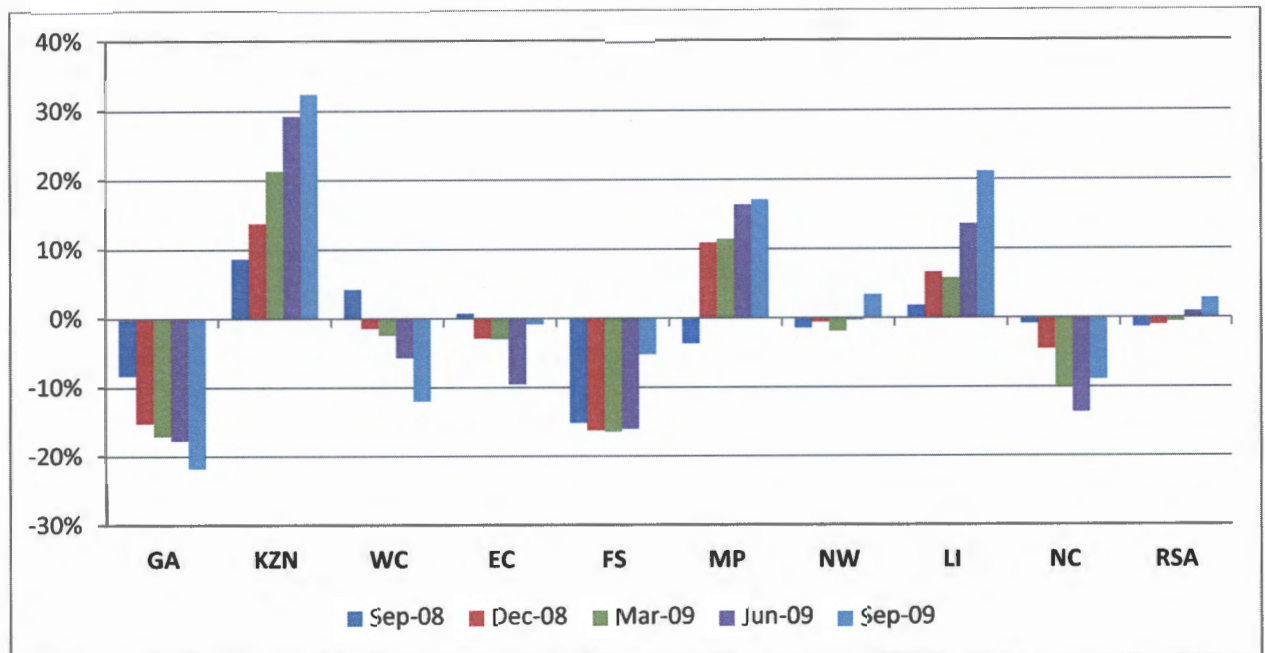


Figure 54: The percentage difference between actual and target accident fatality figures

Both the Gauteng and Free State provinces were well on their way to meeting the 50% reduction in fatality targets by 2015. However, Figure 54 indicates that KwaZulu-Natal is the overall worst performing province with a continued increase in the quarterly number of road fatalities – confirming that the road safety measures implemented to date are not assisting.

Stationary vehicles, in particular heavy vehicles in the emergency lane, and occasionally in the travelling lanes, often do not display emergency triangles, which is attributed to the cause of many horrific crashes. In many cases, motorists make use of objects, such as fire extinguishers, coke bottles and the like, as makeshift pre-warning tools.

In an attempt to address this concern, the N3TC procured quality emergency triangles and supplied them to N3TC Route Services and staff to provide to drivers that do not display their triangles. In 2008, 69 of these triangles were supplied and placed in vehicles that did not have their own. In addition, the N3TC communicated with trucking companies, informing them that their vehicles were not equipped with an emergency triangle and that N3TC had supplied one to their specific vehicle. To date, this project has been highly successful and N3TC believes that it contributed towards reducing the number of incidents along the Route and ultimately saving lives (N3TC, 2009).

The United Nations has declared 2011 to 2020 as the decade of action for road safety. With a focus on road safety, there is likely to be a number of campaigns launched which aim to improve safety on our roads. It is important to ensure that the road freight sector also take the necessary steps to improve safety. The South African National Department of Transport has signed the UN Declaration and is registered as a UN Road Safety Collaboration Partner.

The World Health “World Report on Road Traffic Injury” speaks about six recommendations that countries should follow to improve their road safety records and save lives. Based on these recommendations, the Western Cape Government appointed the Department of Transport and Public Works to implement the Safely Home Programme which is aimed at reducing the number of people killed on the province’s road by 50% by the end of 2014. Safely Home recognises that South Africa in general and the Western Cape in

particular have among the most dangerous roads in the world and strives to fulfill the UN Decade of Action's goals to reduce road carnage.

5.3 Congestion

Congestion in transportation networks occurs when users compete for limited capacity; congestion results in increased travel times, increased operating costs, unreliability in travel time, and increased air and noise pollution (Demir et al., 2015). Congestion delays on a given route may be recurrent or non-recurrent; for example, an accident/breakdown would cause a non-recurrent delay, whereas slow-moving traffic due to road capacity that does not adequately cater for the volume of traffic in peak periods would be a recurrent delay. While such costs are a direct cost for freight operators, the cost to other users of the transportation network can be considered an externality.

As a direct result of the fact that road is preferred over rail for freight transport, there are significantly more HGV's on the road than was the case 10 to 15 years ago (National Association of Automobile Manufacturers South Africa, 2008). Part of this can be attributed to a growing economy for which heavy vehicles play an integral part. The roads are, however, shared by freight, public and private transport, and the growth in freight vehicles on the road has been matched by the growth in number of private transport vehicles. The resulting combined effect is that roadways in South Africa are becoming more susceptible to congestion during peak traffic and through minor incidents.

5.3.1 Freight vehicle flows on the N3

The KZN Freight Transport Data Bank conducts a comprehensive survey of major freight routes in order to evaluate the characteristics and extent of road freight traffic on both provincial and national routes in KwaZulu-Natal. Traffic count information is obtained using either electronic or visual counts. This technique requires trained surveyors to position themselves at selected strategic points and to record the relevant characteristics of each freight vehicle that passes. The survey is done in both directions on the road for a period of 12 to 24 hours. The information is extrapolated to annual totals for each parameter, to provide an overall estimate of the characteristics of the freight vehicle movements by road at that survey point. The direction of traffic is recorded as North-bound/South-bound or East-bound/West-bound as appropriate (KZN DoT, n.d.).

One of these data survey points is at the Mariannhill Toll Plaza on the N3 between Pietermaritzburg and Durban. Figure 55 and Figure 56 display statistics relating to the most recent freight data survey. The exact date or period for which these counts were undertaken was not given. Vehicles travelling from Johannesburg to Durban are travelling in an East-bound direction, whilst those travelling from Durban towards Johannesburg are travelling in a West-bound direction.

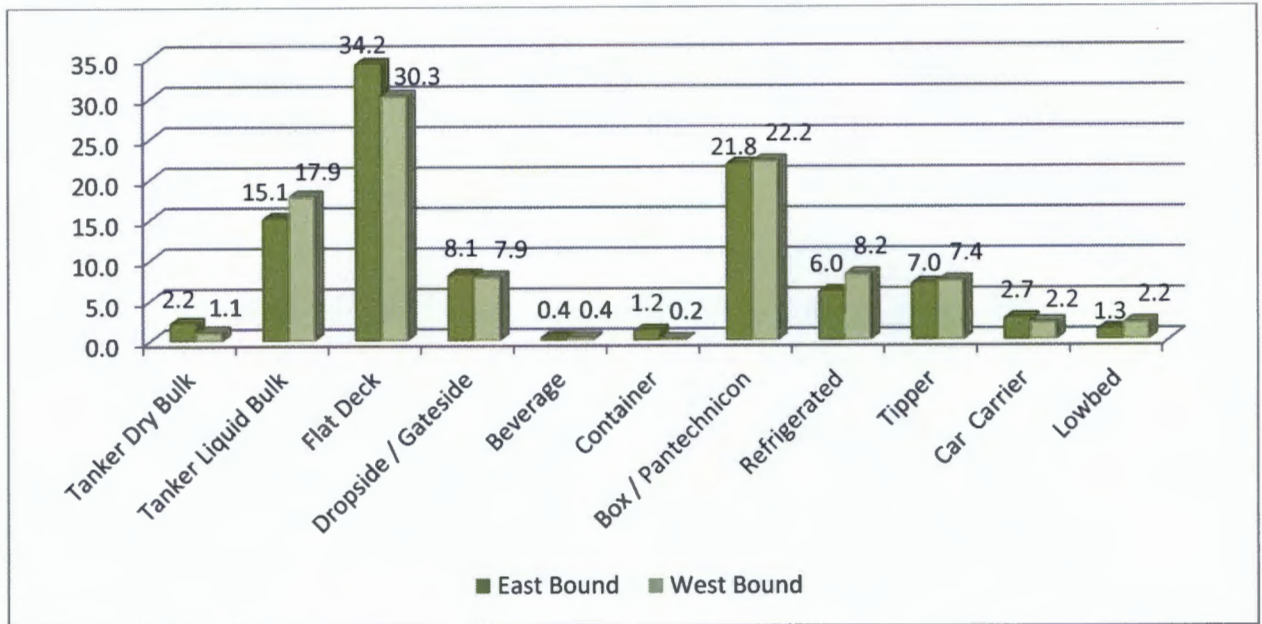


Figure 55: A breakdown of the proportion of road freight vehicles according to vehicle type
 Source: KwaZulu-Natal Department of Transport, n.d.

Figure 55 indicates that Flat Deck, Box/Panttechnicon and Tanker Liquid Bulk vehicles are the most common type of freight vehicles recorded in both directions passing through Mariannahill Toll Plaza. In both directions, the combination of these three types of freight vehicles account for more than 70% of the total freight traffic recorded.

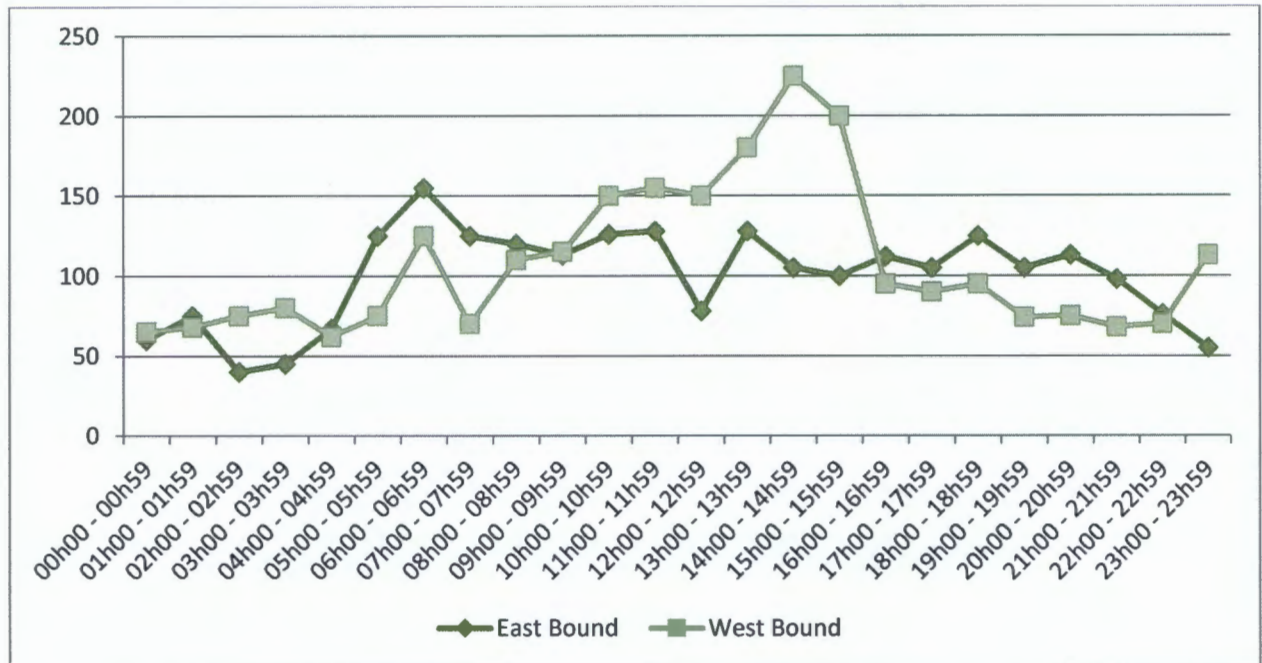


Figure 56: Freight vehicle traffic flow by direction on the N3 at Mariannahill Toll Plaza
 Source: KwaZulu-Natal Department of Transport, n.d.

The morning and afternoon peak periods are the times when a road network will experience the greatest problem with available capacity, as commuters attempt to get to work (or school) in the morning and back to their place of residence in the evening. As additional vehicles are introduced onto the road network, the peak period duration also continues to increase.

Figure 56 displays the freight vehicle traffic flow for a 24 hour period. The peak hour in an East-bound direction is between 06h00 and 07h00 with approximately 150 freight vehicles in this hour. There is an extended peak period in a West-bound direction which occurs between 13h00 and 16h00, with the highest demand occurring between 14h00 and 15h00 with approximately 225 freight vehicles per hour. The peak hours of Heavy Goods Vehicles (HGVs) are similar to the peak hours of commuter traffic, which as a result puts strain on the road network.

5.3.2 Local congestion causes

A common source of frustration for private cars and other light vehicles is delays resulting from HGVs using the right hand lane in order to overtake one another. This is particularly the case on sections of road where there are only two lanes per direction, and it is exacerbated further in mountainous areas where no climbing lanes are provided.

HGVs travel at lower speeds because of speed limiting devices or uphill gradients, and one HGV overtaking another can take a significant amount of time which can result in cars behind these vehicles being delayed. TRL Limited (2010) provides an example of a 12m long HGV travelling at 90 km/h overtaking another HGV at 88 km/h. The manoeuvre will take 79.2 seconds and 1980 metres to complete. If, on the other hand, the two HGVs are 18.75m long, the same overtaking manoeuvre will take 103.5 seconds and 2587.5 metres.

The impact of poor overtaking manoeuvres is more prevalent on one or two lane single carriageways as a slower moving HGV can only be passed by either crossing into oncoming traffic or in the fast lane. It is common to see two, and in some cases three HGV's passing on an incline. This is most likely as a result of the fact that two HGV's will travel at similar speeds on a decline, but this speed is drastically reduced on an incline as a result of the specific gross vehicle mass, condition, and power of each vehicle. Improper overtaking manoeuvres could result in congestion as surrounding vehicles are forced to slow to the speed of the climbing HGV's while they overtake one another. In some cases, this also leads to accidents due to the high speed differentials, or where overtaking takes place in the face of oncoming traffic.

The growth in number of medium, heavy and extra heavy commercial vehicles sales in South Africa is displayed in Figure 57 (National Association of Automobile Manufacturers South Africa, 2008). The graph shows that since 1998 there has been a continued increase in the number of these vehicle sales – which have more than tripled in the 9 year period up to 2007.

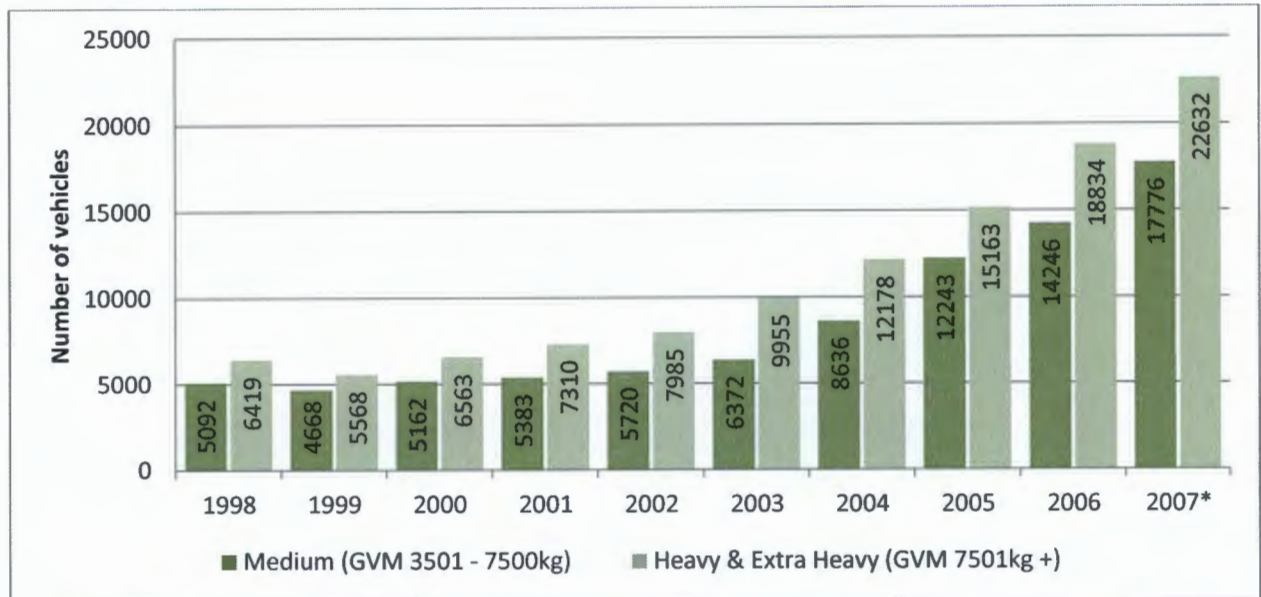


Figure 57: Indication of the growth in medium, heavy and extra heavy commercial vehicles in South Africa
 Source: National Association of Automobile Manufacturers South Africa, 2008

Heavy vehicles can also cause congestion as a result of breakdowns and accidents. Whilst it is clear that HGV's sales have increased, it is also unlikely that these new vehicles are replacing the older fleet of vehicles at the same rate. As the general age of HGV's increase, they are more likely to be susceptible to breakdowns. Where HGV's are involved in accidents, they may require specialised tow trucks to remove the vehicle from the main thoroughfare; additionally, spilled cargo might require hazardous treatment or road maintenance crews to remove spilled cargo from the roadway. All of these factors are likely to cause significant delays to motorists, and in some cases can result in entire roadway closures.

Figure 58 is an example of some of the horrific incidents that occur on the N3. This particular accident occurred outside Cato Ridge (midway between Durban and Pietermaritzburg). Heavy vehicles were involved in the incident and lives were lost as a result. Congestion resulting from the accident meant that other vehicles were delayed for a number of hours, and even the alternative routes were not able to cope with the diverted traffic demand.



Figure 58: Accident on N3 near Cato Ridge, resulting in both carriageways closed for considerable period
 Source: airserve.co.za

5.4 Energy efficiency & resource consumption

The transport sector consumes approximately 20% of global energy reserves and up to 90% of oil reserves (Tran:SIT, 2007). In order for South Africa to meet the 'required by science' targets, which is to reduce annual emissions by 1 300 Mt CO₂ equivalents per year by 2050, its transport sector will need to be changed drastically. In its Energy Efficiency Strategy of 2005, government advocates a 9% final energy demand reduction for the transport sector by 2015 (CSIR Built Environment, 2008).

The movement of goods and people is a major contributor to negative environmental impacts. These impacts vary from energy consumption and air pollution to soil erosion and the like. There are also freight transport-specific impacts which account for a number of negative environmental impacts that are not sustainable in the long term. According to Lane and Vanderschuren (2010), the freight energy demand from non-renewable sources accounts for approximately 40% of the total transport energy demand in South Africa.

The renewability indicator (Zhou, Jiang and Qin, 2007) is a measure of the consumption of non-renewable natural resources. It takes into account the scarcity of different fossil fuels and the amount of fossil fuels consumed. Non-renewable resources are exploited at a higher rate than they are generated. Table 5 contains the scarcity ratios of global non-renewable fossil fuels as published by Zhou et al (2007).

Table 5: Global outlook for non-renewable fossil fuels

	COAL	NATURAL GAS	CRUDE OIL
Remaining years to being extinct	250	50	40
Scarcity ratio of resources	0.4	2	2.5

Source: Zhou et al, 2007

Coal and crude oil are the two non-renewable fossil fuels that are used as a primary energy source in the South African freight system. Almost all of the electricity generated in South Africa is produced by coal power stations. In addition, coal is used to produce liquid fuels for transport.

The renewability indicator values for different modes of freight transport in South Africa are displayed in Figure 59. Transport modes which are dependent on electricity are considered to be more sustainable than the modes dependent on liquid fuels. This is as a result of the scarcity factor of oil, which is much higher than that of coal.

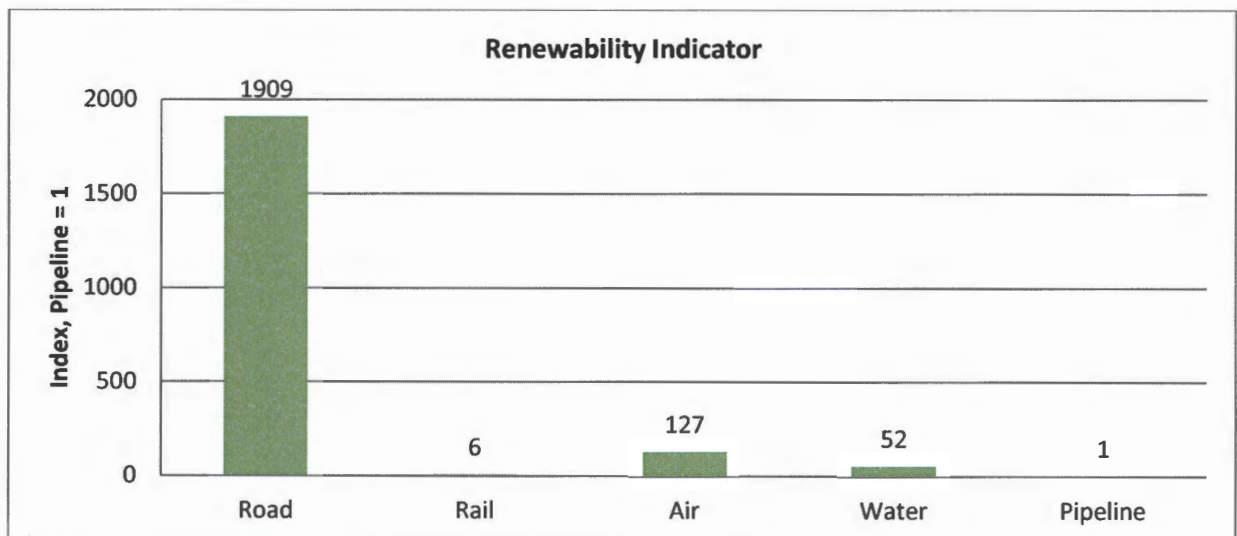


Figure 59: The renewability indicator values for different modes

Source: Lane and Vanderschuren, 2010

Jorgensen (2009) supports the above notion, and states that, “the use of electric energy generated from coal by railway locomotives when compared to diesel road vehicles, is considered to be much more environmentally friendly.” With this in mind, the indirect impact of using road to transport freight, as opposed to rail, can be seen as the opportunity cost of using a resource with a higher renewability indicator when a resource with a lower renewability indicator can be used in its place. It is, however, important to note that

certain goods can only be transported by specific modes; this should be taken into consideration when determining the value of the opportunity cost.

5.5 Exhaust emissions & air pollution

The transport sector is the second largest contributor to Greenhouse Gas (GHG) emissions in the World (Lane and Vanderschuren, 2010). Air pollution is considered to be the most important environmental threat posed by transportation (OECD, 1997). Air pollution can be split into two primary types:

- Emissions of gases which impact on air quality, and
- Greenhouse gases (GHGs) which affect the climate (Lane and Vanderschuren, 2010).

As described by Demir et al. (2015), emissions can also be categorised according to its impacts – ranging from local, regional, and global scales. Emissions that affect air quality have local and regional impacts, whereas GHGs have global effects.

5.5.1 Emissions affecting air quality

The emissions most relevant to air quality include: particulates (PM₁₀), Sulphur Oxides (SO_x), Nitrogen Oxides (NO_x), Carbon Monoxide (CO) and Volatile Organic Compounds (VOC). These emissions have a variety of impacts, some of which include (Lane and Vanderschuren, 2010):

- Contributing factor in respiratory and heart diseases,
- Damage to the fabric of buildings,
- Contribute to acid rain,
- Component in photochemical smog, and
- Implicated in crop damage.

Demir et al. (2015) state that other pollutants related to transportation such as toluene, benzene, polynuclear hydrocarbons, hydrogen sulphide, and dioxin have impacts that are as yet unknown.

Fine particulate matter may be particularly harmful to human health as they are easily inhaled and penetrate the lung. Gaseous air pollutants are linked to respiratory diseases, childhood asthma, heart disease, cancer, and higher rates of premature adult deaths. CO reduces the oxygen-carrying capacity of blood, potentially increasing the risk of heart disease. VOCs and NO_x may increase the risk of heart disease and respiratory disease, and cause damage to ecosystems. CO, VOCs, and NO_x cause direct damage to health and the environment and are so named conservative pollutants; these pollutants are however, also precursors to ozone and hence implicit contributors to global warming.

The severity of the impact of these pollutants also depends on the nature of the pollutant. For example, Forkenbrock (1999) illustrates as follows: while CO emissions are likely to be concentrated along major freight corridors, in rural areas they will be too dispersed to have a significant negative impact on rural populations. Conversely, SO₂ leads to the creation of acid rain, which in turn causes widespread damage. Likewise, the reaction between NO_x and VOC results in smog – this affects large regions.

Road transportation has been shown to be the most polluting freight transportation mode for all air pollutants (barring particulates) and Greenhouse gases by various studies (Demir et al., 2015). For example, emissions factors for CO, CO₂, HC, NO_x, SO₂, particulates, and VOCs for three modes were obtained from OECD (1997) and are displayed in Table 6 (OECD, 1997).

Table 6: Air Emission Factor Ranges for Truck, Rail, and Marine, in grams/ton-km

Pollutant	Truck	Rail	Marine
CO	0.25 - 2.40	0.02 - 0.15	0.018 - 0.20
CO ₂	127 - 451	41 - 102	30 - 40
HC	0.30 - 1.57	0.01 - 0.07	0.04 - 0.08
NO _x	1.85 - 5.65	0.20 - 1.01	0.26 - 0.58
SO ₂	0.10 - 0.43	0.07 - 0.18	0.02 - 0.05
Particulates	0.04 - 0.90	0.01 - 0.08	0.02 - 0.04
VOC	1.10	0.08	0.04 - 0.11

Source: Organisation for Economic Co-operation and Development, 1997

Within each transport mode there are significant variations in the reported emission estimates, depending on factors such as payload and vehicle characteristics. It can however be seen from Table 6, that trucks are significantly more polluting than trains or boats, and this is applicable for all pollutants listed above. Despite these differences, the modes with the highest ton-kilometres will always produce the most emissions and will, therefore, have the greatest negative impact on air quality.

Facanha & Horvath (2006) investigated the life cycle of emissions (in this case CO₂, NO_x, particulates, and CO) associated with the road, rail, and air freight modes. The analysis includes all life cycle stages for the vehicles, fuel, and transportation infrastructure. On average, it was found that the vehicle operation phase contributes 70% of total emissions of CO₂ for road, rail, and air freight. This research therefore serves to illustrate that tailpipe emissions alone underestimate the total emissions of freight transport. Considering the total life cycle, it was found that rail freight has the lowest total air emissions. Depending on the pollutant, rail was found to contribute 50 – 94% less than road freight (Facanha & Horvath, 2006).

5.5.2 Greenhouse gas emissions

The greenhouse effect is the process whereby Greenhouse Gases (GHGs) trap solar energy and consequently raise the temperature of the earth. This process influences the global climate system, the stability of which is essential to facilitate life on earth. Carbon dioxide (CO₂) and methane (CH₄) are the two main GHGs produced by transport (Lane and Vanderschuren, 2010). In fact, according research (Bureau of Transportation Statistics, 1996) cited by Forkenbrock (1999), CO₂ contributes 85% of total GHG emissions when weighted by global warming potential. The impact of the GHG emissions on climate change are determined by comparing the historical temperature changes with those predicted by models that exclude human influence (Demir et al., 2015).

Demir et al. (2015) state that while GHGs are not classified as an air pollutant (such as the emissions discussed above), in 2009 the United States Environmental Protection Agency recognised that GHGs are dangerous to human welfare as they contribute to climate change.

Demir et al. (2015) list the key GHGs produced by transportation as carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and ozone (O₃). The common unit for GHG emissions is tons of CO₂ equivalent (Lane and Vanderschuren, 2010). Demir et al. (2015) cite the Intergovernmental Panel on Climate Change as estimating that 13.1% of all GHG emissions originate from the transportation sector. Furthermore, as at December 2014, the level of GHGs is approximately 399 ppm and are increasing further (Demir et al., 2015).

Brinkman et al. (2005) state that Life-Cycle Analysis (LCA) is also the most suitable method to calculate overall GHG emissions of different transport modes. Within transportation, there is also the fuel-cycle analysis which is referred to as a Well-To-Wheels (WTW) analysis. As the name implies, LCA takes into account the full life cycle impacts, including the construction of fuel production infrastructure or that required for producing the vehicles (Brinkman et al, 2005). The WTW analyses on the other hand does not account for impacts prior to the operation of the Well. The WTW analysis can be split into two stages: Well-To-Tank (WTT) and Tank-To-Wheels (TTW) as indicated in Figure 60.

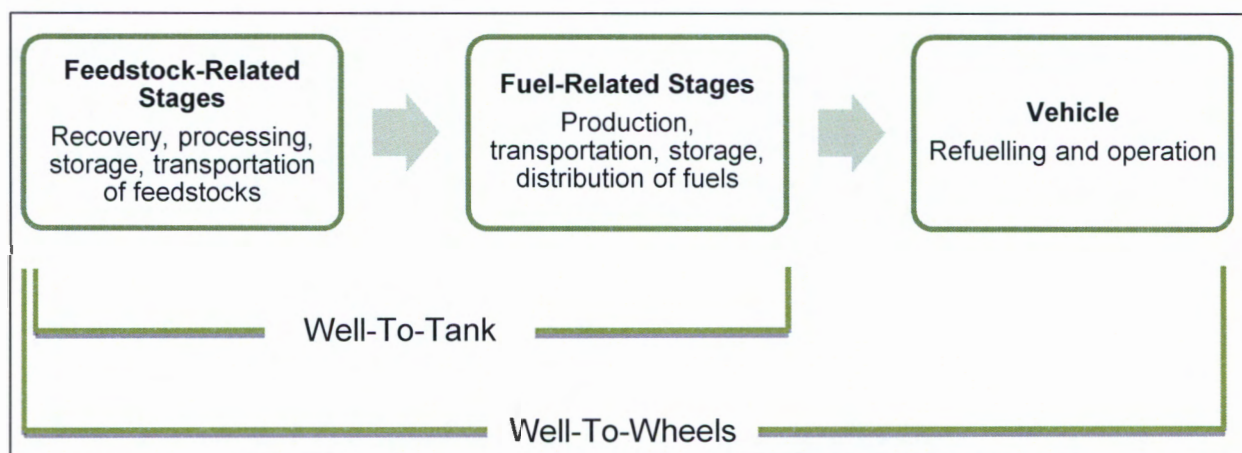


Figure 60: Scope of a well-to-wheels analysis for fuel/vehicle systems

Source: Brinkman et al, 2005

The WTT stage begins with fuel feedstock recovery and ends with fuels available in vehicle tanks. The TTW stages cover daily vehicle operation activities. In order to do a total energy cycle analysis, additional data on the emissions produced whilst manufacturing the vehicle is required. In this method, the emissions generated by scrapping old vehicles, and disposing thereof in an applicable manner, should also be taken into account.

Lane and Vanderschuren (2010) presented the calculated GHG emissions per mode, which is displayed in Figure 61. The modes that are dependent on liquid fuels have been split into the WTT (blue portion) and TTW (red portion) to indicate the two stages of the WTW analysis. Rail and pipelines use electricity as a primary energy source, and therefore Lane and Vanderschuren (2010) based the calculation of GHG emissions on Eskom's 2007 published average GHG emissions level of 0.958 kg CO₂ eqt/kWh.

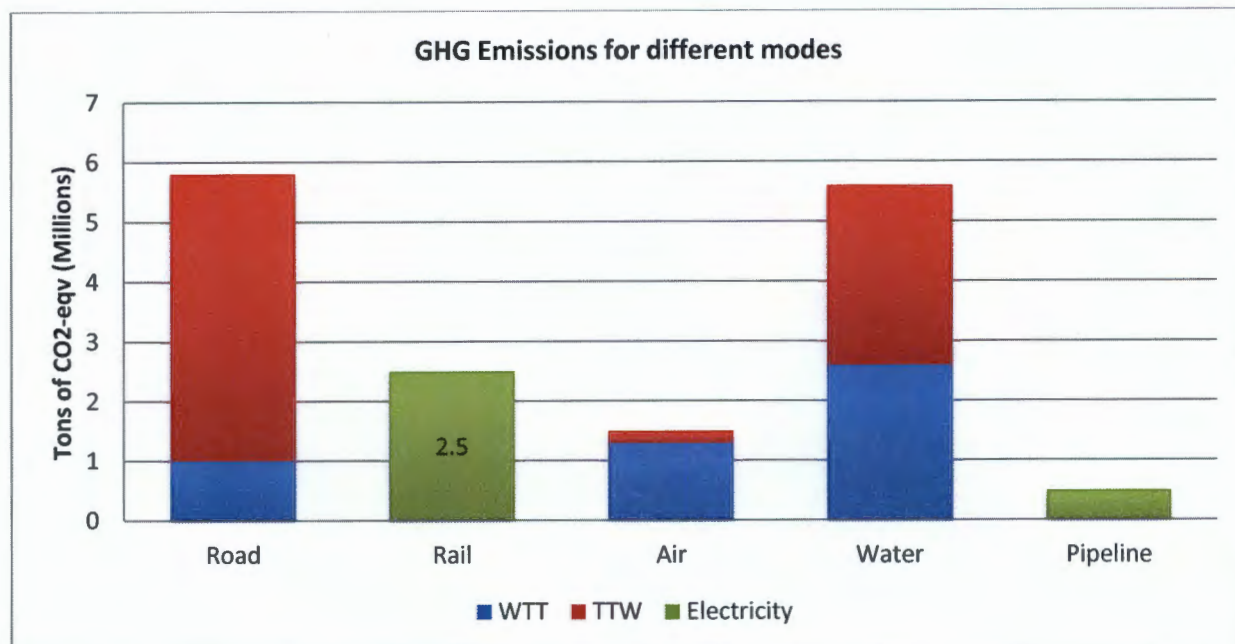


Figure 61: Greenhouse gas emissions from different modes
 Source: Lane and Vanderschuren, 2010

From Figure 61 it can be seen that approximately 21% of the GHGs emitted by road transportation are produced in the stage prior to actual operation of the vehicle. This shows a similar trend to the research conducted by Facanha and Horvath (2006) discussed above.

Again, it can be seen that road transportation produces the largest amount of emissions (GHGs in this case); rail produces 43% of GHGs emitted by road transportation.

Determining the full impact of transport emissions on air quality is problematic to estimate, as there are sometimes time lags between emission and detection. In addition to this, the ability to quantify the actual impact of each emission on public health or as damage to the environment is challenging (Lane and Vanderschuren, 2010).

Transport is the fastest growing emitting sector. It is also a very complex sector as it encompasses a number of contributing factors which include fuels, vehicle technology, infrastructure, as well as behavioural changes. An approach, which considers a single factor only, will not do enough to solve the problem, and a global approach to transport emissions is required to targets as many factors as possible to ensure an overall reduction in emissions. CSIR Built Environment (2008) suggests that this type of global approach will need to be focused around the following two strategies:

- Modal shifts in the way human and freight movement is achieved, and
- Utilising new technology to transfer away from the use of petrol and diesel.

5.6 Noise Pollution

Transportation-related noise pollution is an increasing issue affecting mainly urban areas. The need to effectively manage the noise effects associated with land transport activities is gaining prominence due to a range of factors, including (Land Transport New Zealand, 2010):

- Increased private vehicle use,
- Greater number of vehicles and increasing traffic densities,
- Increased proportion of trucks and service vehicles,

- Changing travel patterns (i.e., vehicles are on the road at all hours of the day and night, not just peak hours),
- Growing population,
- Increasing population densities in most urban centres (particularly around transport nodes, and
- Increased community awareness of adverse factors in the environment.

Land transport noise arises from vehicles travelling on road and rail corridors (Land Transport New Zealand, 2010). Road transport-related noise pollution is essentially due to the operation of the vehicle and its movement. Ouis (2001) states that vehicle-related noise has four components, namely the engine, exhaust, tyres, and air turbulence; air turbulence and the sound of tyre-road contact become more significant at higher driving speeds that would be encountered on, say, a freight corridor. Noise is measured in decibels (dBA) and is a logarithmic scale. A 10 dBA increase represents a doubling in noise level (Land Transport New Zealand, 2010).

Noise pollution in areas close to transportation routes is dependent on the volume, speed, and composition of the passing traffic; composition is the most important factor – one combination truck travelling at 55 mph produces noise equivalent to that of 28 passenger cars. One such truck produces a noise level of 90 dBA at 50 feet away (Forkenbrock, 1999). Other factors that affect the level of noise pollution include vehicle type, payload, road gradient, and road surface (Demir et al., 2015).

Populations close to heavily trafficked routes are most severely affected. Forkenbrock (1999) states that noise levels decrease with distance at a rate that is greater than a linear relationship; traffic noise reaches background noise levels at approximately 1000 feet from the transportation route. This relationship will vary depending on the traffic volume. Other obstructions – such as hilly terrain, thick vegetation, trees, or buildings – decrease noise levels. Figure 62 (Forkenbrock, 1999) represents a generalized relationship between the daily traffic volume, distance, and noise. This figure shows the distance from the roadway at which 55 dBA and 65 dBA occurs, given different daily traffic volumes.

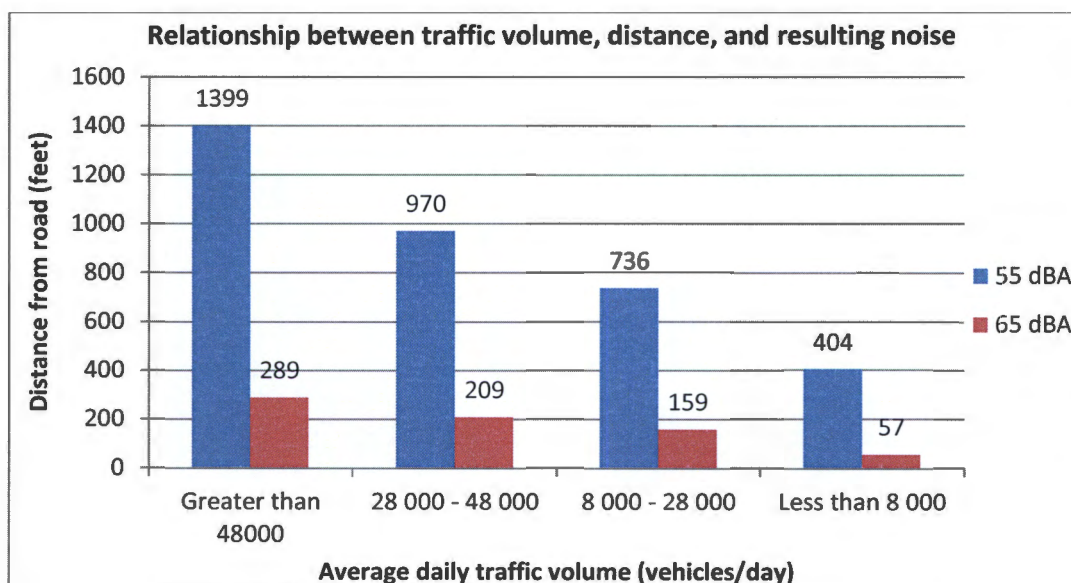


Figure 62: Relationship between traffic volume, distance, and noise
 Source: Forkenbrock, 1999

Surveys have indicated that people feel noise pollution is the most disruptive problem caused by highways. Noise pollution is particularly intrusive for facilities such as schools, nursing homes, hospitals, and churches. Studies have shown that levels also affect property values. The impact of noise is also dependent on the

time of occurrence – for example, noise pollution that causes sleep disturbance has a higher impact than noise disturbances during the day (Demir et al., 2015).

Transport-related noise pollution is a nuisance for those that experience it on a regular basis; in fact, long-term exposure or exposure to severe noises may result and/or contribute to in health problems. Some of these include stress, sleep disturbance, cardiovascular disease, and short-term or long-term hearing loss (Demir, et al., 2015).

Demir et al. (2015) detail the relationship between health issues and the level of noise as follows: low levels of noise pollution (below 60 dBA) may be acceptable for short durations but may result in health problems (such as those cited above) as the duration increases; moderate levels (60-85 dBA) of noise may result in nervous stress reactions and increase the risk of cardiovascular disease; and noise above 85 dBA may cause hearing damage.

5.7 Traffic Enforcement

South African road users are not renowned for respecting the 'rules of the road', which is part of the reason for the high accident rates. As a direct result of the fact that road transport is not self-regulating, there is an increased reliance on enforcement measures. Traffic enforcement in terms of heavy vehicle traffic can relate to the following (RTMC, 2010):

- Overloading,
- Maintenance of vehicles (tyres, brakes, etc.),
- Tired drivers, and
- Speed.

South Africa can invest in first world policies, regulations and infrastructure upgrades, but without proper enforcement measures there will continue to be violations. The Road Traffic Management Corporation (RTMC) is an Agency of the Department of Transport and is responsible for road traffic enforcement.

The RTMC, in conjunction with various authorities, revised the National Rolling Enforcement Plan (NREP), which was launched by the National Minister of Transport on 10 September 2010. The key objective of this revised plan was to stop and screen 1 million vehicles per month nationally. The purpose of this plan was to increase visibility of enforcement officers and thereby encourage motorists to obey the rules of the road. Between October 2010 and March 2011, the RTMC reportedly stopped and screened a total of 7 734 766 vehicles throughout the Country (Government Statistical Service, 2006).

Regular enforcement of heavy vehicle traffic would assist in addressing the challenges listed above. Without regular monitoring, some drivers and/or trucking companies take risks in order to minimise turnaround times and maximise profits. Due to the extensive road network, it can be a very costly exercise to conduct roadside enforcement on a regular basis. This requires other alternatives, such as trucking company inspections, automatic surveillance and detection (CCTV, WIM). A final aspect, which needs to be addressed in the South African context, is the matter of prosecution when offences are detected. Without successful prosecution drivers are likely to continue to disobey road rules. Currently, legislation pertaining to enforcement and prosecution is being addressed through the formation of the Administrative Adjudication of Road Traffic Offences (AARTO) Act. This is aimed at improving road safety through establishing a procedure for the effective and expeditious adjudication of infringements.

The lack of traffic enforcement exacerbates the indirect impacts of road freight transport, such as overloading, accidents, etc., and therefore can be seen as a cause of those indirect impacts. However, when considering the additional resources needed (e.g. more staff and new monitoring infrastructure) to improve the regulation of the road freight industry by the initiatives discussed above, it is apparent that the traffic enforcement itself is also an indirect impact associated with road freight.

5.8 Uptake of Land

By estimating the size of infrastructure required by each freight mode, the space utilised, or uptake of land, by each mode can be determined. For road transport this is estimated as the space taken up by roads or the road reserve. Rail's uptake of land is estimated based on the space consumed by rail tracks, and similarly for pipeline land uptake. Infrastructure in the form of buildings and facilities (such as terminal buildings, parking lots or harbours) are excluded from this analysis. The land uptake of aviation and water transport is therefore zero (Lane and Vanderschuren, 2010).

Lane and Vanderschuren (2010), cite the Department of Transport as stating the extent of the South African road network is 182 000 km, the rail network is 25 000 km, and there are 3 829 km of pipelines. Based on the manner in which land uptake is determined, road transport will therefore have a much greater impact on land use than either rail or pipelines. In addition, the road reserve allowed for roads is usually much greater than that for rail or pipelines. If the road network has an average road reserve of 80m, rail a reserve of 30m and pipeline a 10m reserve, the South African road network occupies approximately 380 times more land than pipelines and 19 times more than rail.

In a separate study, Jorgensen (2009) suggests that when considering the uptake of land, the capacity of the routes needs to be considered in order to effectively compare different modes of freight transport. In the study, two modes, road and rail, are compared. The route chosen for the road is the proposed 600 km dedicated dual-lane truck highway that could be constructed, and the route chosen for rail is the existing Johannesburg to Durban double track railway. Table 7 gives the values in the study, and shows that rail requires a third of the land uptake, but has capacity for 2.3 times as much freight volume. This implies that for the same volume of freight, one requires 7.3 times as much land uptake for road as opposed to rail.

Table 7: Land uptake and capacities per mode on the Johannesburg to Durban Freight Corridor

Mode	Reserve width (m)	Land uptake (m ² /km)	Capacity per direction (tons/annum)
Road	95-100	95 000	36 000 000
Rail	30	30 000	83 125 000

5.9 Overloading

Vehicles are the major cause of road deterioration, and the impact is even greater on heavily trafficked roads. Each vehicle that travels on a road causes an instant, small, but significant deformation of the pavement. In places where there are a number of vehicles it results in a cumulative effect, and this progressively leads to permanent deformation and the deterioration of the road surface (Robot, 1998).

Pavement damage is a function of the number of axle passes and the axle weight. An increase in the weight of a given vehicle will therefore accelerate the deterioration of the pavement (Luskin & Walton, 2001). In an article available from the Department of Transport's website, HGV's were called the "*destroyers of roads and traffic safety hazards*". While legally loaded heavy vehicles are reported to cause a relatively small

amount of damage to the road, illegally overloaded heavy vehicles are reportedly responsible for approximately 60% of the damage to the road network in South Africa (Robot, 1998).

An increase in axle weight has been found to cause more than proportional increases in pavement damage; in fact, the relationship appears to be exponential, with a variety of studies showing the exponent to be close to 4 (Luskin & Walton, 2001). Research in the United States of America and South Africa has shown that an axle carrying double the legal load may cause as much damage as 4 to 60 times as one legal axle load, depending on the condition of the structure and type of road (Robot, 1998). Luskin & Walton (2001) attribute the variation in the power of the exponent across different studies to the use of different measures of road damage. For example, Luskin & Walton (2001) cite previous research (OECD, 1988) in which the exponent varied from a power of 2 for cracking and 8 for rutting. OECD's (1988) review of international evidence found that the exponent of 4 is reasonable for flexible pavements, but that an exponent of 11 is a reasonable for rigid pavements (Luskin & Walton, 2001).

A balance between the quantity of goods to be transported and the number of heavy vehicles moving these goods is required. This, however, is a fine line; as discussed above, fewer heavy vehicles with a resulting higher gross mass per vehicle, would do further damage to the road network. On the other hand, Luskin & Walton (2001) found that the impact of gross increases in weight can be reduced or made benign by adding additional axles, thereby reducing the weight per axle.

The potential effects that worsening road conditions can have on the broader economy include increases in vehicle damage and costs, vehicle operating costs, pavement damage and costs, damage to transported cargo, environmental damage and costs, increase in congestion, and decrease in safety. For example, a limited case study indicated that trucks travelling on roads with average and bad riding conditions experienced an increase in operating costs of between 7 and 16 times respectively (CSIR Built Environment, 2008).

Overloading of heavy vehicles (and hence exceeding the carrying capacity of the vehicle and loading limit of the tyres) is also a concern for safety and vehicle reliability. For example, if a HGV exceeds the loading limit of the tyres, it is more likely to have a blown tyre or obtain a puncture. This could lead to an accident or breakdown, thereby impacting on the safety of the driver and those around him/her.

Excess loads place higher demands on a vehicle's dynamics and braking performance. Stopping distance is lengthened beyond the norm (for a given vehicle) when trucks are overloaded. This increases the risk of an accident if: the driver does not take note of the need to adjust his/her normal driving habits; the truck is in poor condition; or road surfaces are wet/slippy (Karim et al., 2013).

Additionally, Taylor et al. (2000) state that previous studies show a correlation between overloading and safety non-compliance. For example, one study cited by Taylor et al. (2000) found that overloaded trucks were three times more likely to be found in violation of safety and driver regulations. The correlation between overloading and safety non-compliances may be both be a factor of reduced regulation and inspection.

5.9.1 Overloading of HGVs in South Africa

The asset replacement value of the road network in South Africa is estimated to be in excess of R165 billion, and approximately R2.1 billion per annum is spent on road construction and maintenance to

safeguard this asset. It is further estimated that the damage caused by illegally overloaded vehicles costs the taxpayer some R 550 million per annum (Robot, 1998).

The permissible mass of vehicles is determined by the Road Traffic Regulations made in terms of the Road Traffic Act, 1996. There are different methods to determine whether a vehicle is deemed to be 'overloaded'. These include (but are not limited to) the carrying capacity of the vehicle, loading limit of tyres, and carrying capacity of the road.

In 1996, there were 58 904 heavy vehicles weighed at weighbridges throughout South Africa, 33% of which were overloaded (Robot, 1998). It was estimated that between 15 and 20% of all heavy vehicles travelling on South African roads are overloaded (Robot, 1998). Roadside surveys have found that 1 in 8 (13%) of all trucks weighed along the N3 are overloaded to some degree or other (N3TC, 2013).

There are a number of reasons behind the high prevalence of overloading, the most prominent being commercial self-interest. The N3, as well as the alternative routes that make up the N3 corridor, are monitored on a regular basis to detect overloaded vehicles avoiding the main weigh-bridges. Such vehicles are then diverted to the nearest as-sized weigh-bridge for processing and if necessary, prosecution (N3TC, 2013).

There are currently five permanent as-sized (calibrated) weigh-bridges on the N3 and two on the alternative routes operated by the KwaZulu-Natal Road Traffic Inspectorate (RTI). Six weigh-in-motion stations (WIMs) have also been installed along the route to monitor the degree and severity of overloading (N3TC, 2013). The seven weighbridge locations are displayed in Figure 63.



Figure 63: Location of weighbridges on the N3 corridor between Gauteng and Durban

Although weigh stations are permanent structures, they are generally not fully staffed for 24 hours a day. It is therefore possible that there could be in excess of 1 in 8 vehicles that are overloaded. Additionally, if a staffing routine is established at the weigh station, this could enable freight operators to plan trips to avoid weigh stations at certain times. The enforcement and degree thereof on alternate routes could also mean that more vehicles are overloading than that initially identified. Alternative means of detecting overloaded vehicles and the associated enforcement are required. One possible solution is to integrate overload control systems with recently installed fibre optic cables adjacent to the National roads.

Whilst it has been established that overloading of heavy vehicles on National roads results in deterioration of the infrastructure, HGV's that utilise secondary routes running parallel to the corridor in some sections result in accelerated deterioration of regional/metro roads; this is due to the difference in design parameters and expected vehicle loading on these secondary routes.

The co-operation of all road users in terms of complying with vehicle regulations relating to axle load limits is critical if the South African road network is to be kept at a consistently good standard. Without this broad

co-operation, the efforts from road authorities to maintain the existing infrastructure will need to be increased (Robot, 1998). By implementing more regular overload control that is in operation on a 24/7 basis (through the use of intelligent technology such as fibre optic cables, Closed Circuit Television (CCTV) cameras and Weigh in Motion), it will decrease the prevalence of overloaded HGV's. This would cause the operational cost of long distance road freight transport to increase and could cause certain sectors to re-evaluate the mode alternatives.

5.10 Social

The social impact of road freight transport includes health, safety, security and the creation of physical barriers. There is limited research available which discusses the social impacts of freight. However, a small amount of research was obtained which is discussed in the Section.

5.10.1 Health

Mercedes-Benz South Africa (MBSA) reported in November 2010 that the once stable industry of about 70 000 South African truck drivers is now under threat from the impact of poor health and the shortened life span of its driving workforce.

MBSA reports that the effects of HIV/Aids can be seen in the constant search to replace drivers lost through high absenteeism, disability or death. The result is that trucks are left standing, reducing earning potential or, worse, driving once thriving transport companies to closure and inevitable job losses (Lazenby, 2010).



5.10.2 Safety and security

Safety and security in terms of heavy vehicles can be interpreted in numerous ways. In this case, safety will include driver safety along a route. The N3TC has noticed an increasing tendency for heavy vehicles travelling along the N3 Toll Route to park in the vicinity of the toll plazas to rest, which is being done as opposed to using truck stops along the route. There are a number of risks to the driver, vehicle, freight, plaza facilities, plaza staff and motorists associated with this practice. The risks include (N3TC, 2009):

- Increasing crime in the form of theft and hijacking,
- Road safety, and
- Prostitution.

It could be argued that these risks are no more prevalent at these informal stops as they are at formal stops. This is true to some extent; it would, however, be easier to control and manage formal truck stop areas using fencing, lighting and police patrols rather than in the vicinity of all toll plazas.

5.10.3 Driver working hours

The 9th Annual State of Logistics Survey for South Africa (CSIR, 2012) reports that the average transport distance on the Gauteng to Durban and Western Cape to Gauteng corridors is 831 km. At an average speed of 80 km/hr, this would take in excess of 10 hours to travel, which highlights the social impacts in terms of a driver's time spent on the road.

In fact, as per Maldonado et al. (2002), three quarters of the surveyed long-haul South African truck drivers reported that long working hours contributed to their sleepiness, with over half of said drivers stating that they worked in excess of 70 hours per week. These working hours are comparable to that experienced by truck drivers in other countries. Again in common with long-haul drivers in other countries, South African truck drivers often work illegally long hours to supplement income and/or meet company deadlines in a competitive market (Maldonado et al., 2002).

Inadequate sleep or interrupted sleep and the resulting sleep deprivation can be associated to 62% of the respondents admitting to falling asleep at the wheel. As discussed in Section 5.2: Accidents, 24% of heavy vehicle accidents have involved drivers falling asleep at the wheel (Maldonado et al., 2002).

Sleep deprivation affects cognitive function, mood, and motor tasks. The aspects of driving performance most affected are speed and position on the road. Sleep deprivation therefore puts the truck driver and other road users at risk of being involved in an accident.

5.10.4 Community impacts

In addition to the drivers themselves, the communities adjacent to the highways can be impacted on in terms of negative social aspects, particularly in the vicinity of truck stops, toll plazas and other rest areas. These negative impacts include illness/disease, pollution (noise and air), and in some cases, crime. Truck stops also carry a stigma associated with prostitution, and hence truck drivers are often 'tarded with the same brush' when this is not necessarily the case. Furthermore, multi-lane freeways are known to create a social barrier between communities.

5.11 Decline in the Rail Infrastructure

As was discussed in Chapter 3, very little maintenance has been done to sustain the railway networks of South Africa over the past 20 years. In addition to this, the rail sector has lost many millions of tons of freight to road transportation. As a result of this modal shift, the effects that have already been discussed in this chapter (e.g. overloading, congestion, accidents, etc.) have been exacerbated. In this instance, the decline in rail infrastructure can be seen as a cause, and not an effect. However, the modal shift has had an indirect effect on the rail operators, which is discussed in this section.

The rail network is an asset whose lifespan covers a number of decades and throughout requires certain fixed costs to maintain and operate. As such fixed costs cannot be reduced rapidly in the event that the demand for rail decreases, the average cost per ton-kilometre and profitability are directly related to the degree of traffic density, i.e. the volume of traffic per kilometre of railroad, expressed as ton-kilometre per route-kilometre (ton-kilometre/route-kilometre). This means that the cent per ton-kilometre cost of a railroad will decrease with each additional ton-kilometre activity over the same track length, which is demonstrated in Figure 64. Therefore, the modal shift from rail to road has resulted in increased costs to rail operators, and can be seen as an indirect impact of road freight.

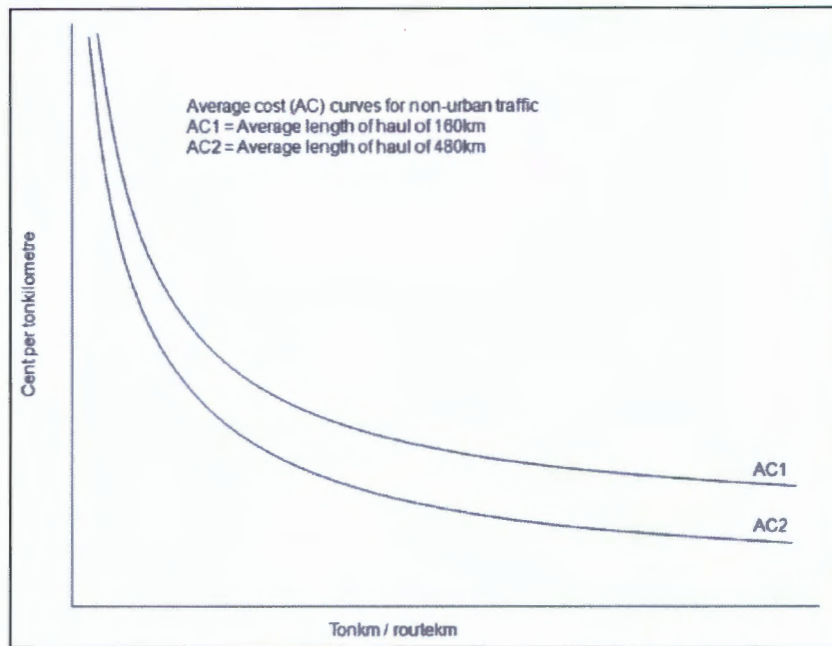


Figure 64: Stylised depiction of Harris's curve – Impact of density on rail costs
Source: Harris, 1977

6 ESTIMATED COST OF IMPACTS

The various indirect impacts of road freight transport have been discussed. This Chapter will now use local and international data to attribute costs for each of these impacts. The determination of these costs is not always faultless and therefore the reliability of this information will also be discussed, and where possible, a range of costs will be provided. Not all of the indirect impacts are measured by a monetary value, and as a result, a conversion of these costs into a monetary value is required. This is facilitated through the application of shadow pricing. Shadow pricing has a number of different definitions depending on the application. These include, but are not limited to the following:

- The Australian Graduate School of Management (2006) define that the shadow price method, *“better approximates the true opportunity cost or marginal valuation of a product or resource or service.”*
- A frequently used site for the accounting industry describes shadow pricing as, *“the assignment of a price to an intangible item for which there is no ready market from which to derive a price. Shadow prices are most commonly used in cost-benefit analyses where some elements of the analyses cannot be quantified by reference to a market price or a cost.”* (Accounting Tools, 2015)

For the purpose of this investigation, shadow pricing is defined as the method whereby monetary costs are associated with the indirect impacts of road freight transport.

In order for this information to be meaningful, it will be necessary to use a standard unit which will allow for the costs of each of these impacts to be combined to produce a global value for the indirect cost of road freight. All costs will be converted into South African cents per ton kilometre, and 2012 will be used as the base year to enable direct comparison and addition of costs. All costs will be converted from the specified currency into South African Rands, and then escalated from their given date to the 2012 base year using historical Consumer Price Indices (CPIs). Historical exchange rates between the country of origin and South African will be sourced.

6.1 Determining the Cost Attributes of Various Impacts

6.1.1 Accident costs

As was established in Chapter 5, the impact of road traffic accidents in South Africa is large. Road accident costs are often reported in per capita terms of the vehicle population in South Africa and these are very high by international standards. The specific vehicle type or distance travelled between accidents is not normally reported (Jorgensen, 2009). The consequences of these accidents include loss of life, pain and suffering, and a cost to the economy. The overall cost of an accident includes physical costs, such as vehicle damage, medical, funeral and legal costs, as well as the loss of output due to deaths and injuries (Schutte, 2000).

A quantitative analysis of the full costs associated with motor vehicle use in South Africa stated that a conservative estimate for external accident costs was R 5.04 billion in 1998 (R11.9 billion in 2012 prices). Whilst there were some concerns regarding the accuracy of the motor vehicle population in SA and the average distance travelled by each mode, the contribution to the total cost by each mode was distributed by Jorgensen (2009), and when converted to 2012 prices, is as follows:

- Cars – R 5.95 billion (50%)
- Light trucks – R 2.86 billion (24%)

- Heavy trucks – R 1.68 billion (14%)
- Buses and minibuses – R 1.54 billion (12%)

In a report prepared for the DoT, Schutte (2000) estimated the unit cost of road traffic collisions in South Africa. These costs included human casualty and vehicle accident costs. The report stated that the average cost of a human life for a fatal accident in a rural area was R 1 412 758, although the Motor Vehicle Accident Fund stated that the average payout for this type of accident was R 1 897 711 (converted to 2012 prices). These costs are significantly lower than International standards, where in Canada the equivalent payout would be R 39.6 million, or R 22.0 million in the European Union (Jorgensen, 2009) when converted to 2012 prices. These figures indicate that the value of life in South Africa is low, which does have some correlation to the number of collisions and frequent violation of the rules of the road.

If the contribution to the total cost by each mode was distributed as discussed and compared to the type of vehicles involved in collisions it would provide an indication of the impact of a collision per type of vehicle. Table 8 provides this comparison based on the available information outlined above.

Table 8: Comparison of percentage vehicles involved in collisions to percentage contribution to total collision cost

Vehicle type	Percentage of vehicle type involved in collisions	Percentage contribution to total cost of collision
Motor car and light delivery vehicles	79%	74%
Minibus and bus	9%	12%
Heavy and articulated vehicles	5%	14%
Motor cycle	1%	N/A*
Other	6%	N/A*
Total	100%	100%

* Values for motor cycles and other not available and hence excluded

This information tends to suggest that the percentage contribution ratio for light motor vehicles and light delivery vehicles is close to 1 (0.94), whilst for public transport vehicles (minibus and bus) this ratio increases to 1.32. The percentage contribution ratio of heavy and articulated vehicles is in excess of 2.5 times (2.64) the percentage of vehicles involved in collisions. This is understood as the impact of heavy vehicles when involved in a collision as being more costly as opposed to all other road transport modes.

Schutte (2000) identifies that the main use for the estimates provided on collision costs would be in the cost/benefit analysis of road investment alternatives. The cost categories considered in the investigation included:

- Loss of output,
- Hospital, medical and funeral costs,
- Pain, suffering and loss of amenities of life,
- Vehicle damage,
- Damage to goods carried,
- Damage to fixed property,
- Legal costs,
- Insurance administrative costs, and
- Towing costs.

Jorgensen (2009) cites an EU report, which indicated that average costs of accidents for heavy vehicles is 10 South African cents per ton kilometre. This is equivalent to an additional 12% to 13% of average heavy vehicle operating costs. Similar studies conducted in Australia evaluate the costs at 5.9 cents to 13.9 South African cents, whilst a preliminary study of the N3 conducted by TMT Projects indicated a figure of 3.3 South African cents per ton kilometre. The South African study did not take into account costs such as clean up, policing and congestion costs incurred by other motorists that result, due to an accident. This could increase the costs to 8.6 South African cents or more per ton kilometre (Jorgensen, 2009).

In comparison, international studies have determined the costs as follows:

- Beuthe et al. (2002) estimate the external cost of road accidents in 1995 as 0.00937 European Currency Unit (ECU) per ton kilometre, which equates to 12.821 South African cents per ton kilometre (2012).
- Pérez-Martínez and Vassallo-Magropaper (2013) estimated that the cost of accidents in 2000 amount to €cts 0.230 / ton-km, which equates to 3.103 South African cents per ton kilometre (2012).
- Forkenbrock (1999) calculated accident costs in 1994 as \$cts 0.59 / ton-km, which equates to 6.704 South African cents per ton kilometre (2012).
- Demir (2015) lists a number of sources in determining a 2010 accident cost, which range from €cts 0.165 / ton-km to €cts 0.635 / ton-km. The average of these sources is €cts 0.413 / ton-km (2010), which equates to 4.857 South African cents per ton kilometre (2012).

Although the value of a life is valued higher in Europe than in South Africa, three of the above indirect costs are considerably lower (19-64%) than the figure estimated by Jorgensen (8.6 South African cents per ton kilometre). This difference can be attributed to the fact that South Africa has one of the highest accident rates in the world. For the purpose of this study, Jorgensen's value of 8.6 will be adopted as there are no statistics specific to the Johannesburg to Durban Corridor.

6.1.2 Congestion costs

Congestion costs can be linked to increasing numbers of vehicles on the road (both light and heavy). As the volume to capacity ratio (v/c ratio) approaches 1, road users are more likely to be impacted on negatively. Differentiating the cost of congestion caused by heavy vehicles is not a simple task and it is often either not included or in some occasions double counted when considering the impact of congestion resulting from a collision.

Jorgensen (2009) cites economist Tony Twine as having estimated that if motorists in the country use 10% more fuel as a result of traffic congestion, it would cost an extra R19 billion a year (the annual spend by motorists on petrol was R 107 billion and R 81 billion on diesel).

The estimated distance travelled per type of vehicle per province per month is calculated in terms of the recommendations contained in the CSIR research report (2002), and based on the average number of vehicles per fuel type (petrol and diesel) as registered on NaTIS, and the fuel sales per fuel type, for road use, for each particular month.

The percentage allocation of the total estimated types of fuel for road usage per type of vehicle (CSIR, 2002) is as shown in Figure 65.

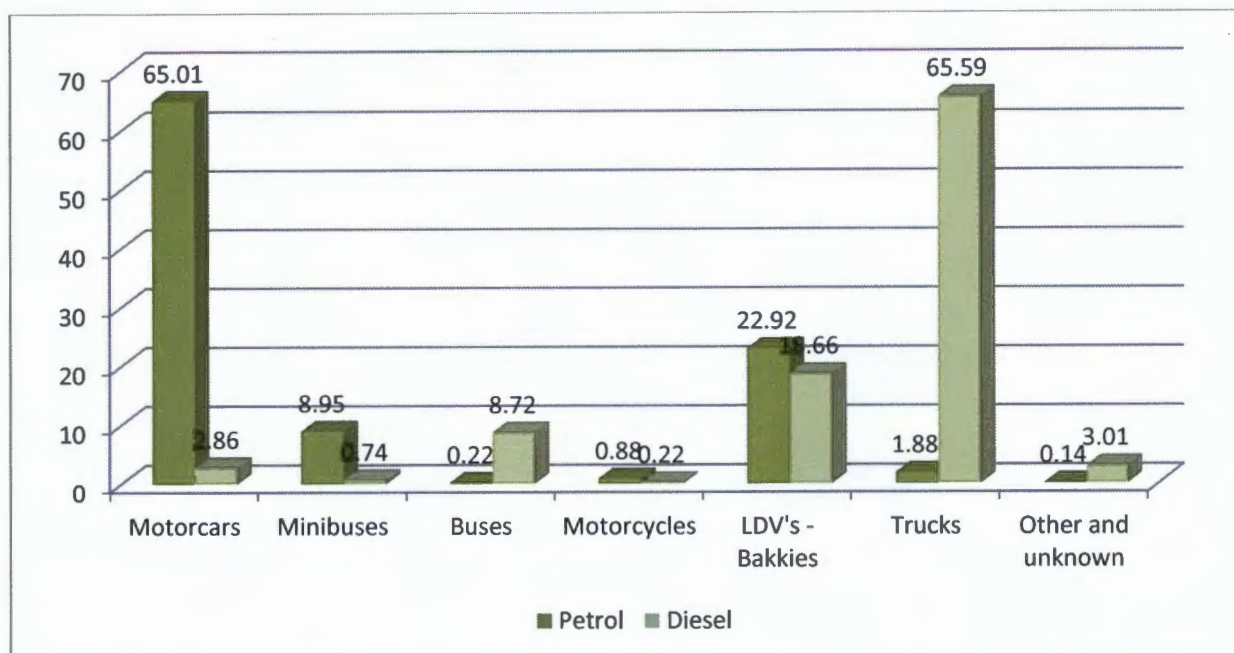


Figure 65: Allocation of the type of fuel per type of vehicle

Based on the information contained in Figure 65, together with the estimation that 10% additional fuel is required as a result of a 'congestion' cost, vehicles would attract the amounts provided in Table 9:

Table 9: Estimated costs of additional fuel required per fuel and vehicle type due to congestion

Vehicle type	Petrol (R)	Diesel (R)	Total (R)
Motorcars	6 967 447 000	232 956 000	7 200 402 000
Minibuses	959 216 000	60 275 000	1 019 491 000
Buses	23 579 000	710 270 000	733 849 000
Motorcycles	94 314 000	17 920 000	112 234 000
LDV's - Bakkies	2 456 451 000	1 519 913 000	3 976 364 000
Trucks	201 489 000	5 342 502 000	5 543 991 000
Other and unknown	15 005 000	245 174 000	260 178 000
Total	10 717 500 000	8 145 300 000	18 862 800 000

The total estimated cost of congestion for heavy vehicles is therefore estimated at R 5.5 billion. If this is compared to the total ton kilometres transported via road as reported by the CSIR in 2012 as 301 billion ton kilometres, the effective cost for heavy vehicles is R 0.019 (1.9 South African cents) per ton kilometre. However, as identified in Chapter 5, the increase in truck fuel costs is a direct cost to freight operators, and therefore this value cannot be used as an indirect cost. In order to use Tony Twine's method of an additional fuel spend of 10% to determine the indirect cost, the amount of congestion caused exclusively by road freight is required; however, this value is unknown.

Studies undertaken in EU countries have reported the cost of road traffic congestion at 0.5% of European GDP. From the 17 EU countries involved, the average congestion cost of heavy vehicles was 7.698 South African cents per ton kilometre. An Australian study has a much lower rate, equivalent of 0.266 South African cents per ton kilometre. The significant difference between these values is due to the higher traffic volumes and shorter haul routes in Europe (Jorgensen, 2009).

This would imply that the equivalent cost of congestion is in fact proportional to the current levels of congestion in a country, and even further within a particular corridor. Jorgensen (2009) uses a congestion cost of 3.6 South African cents per ton kilometre for the purpose of that study, but does indicate that further investigation on this matter is required. There is, therefore, a proposed range of congestion related costs for heavy vehicles from 0.266 South African cents to 7.698 South African cents per ton kilometre. This is an average of 3.4 or mean of 4.0 South African cents per ton kilometre.

It is believed that these costs are likely to be conservative as they do not take into account the effect of traffic congestion on freight movement (cost of delayed deliveries) and traffic safety (collisions). High congestion levels have an effect on travel times, fuel consumption and emissions released into the environment.

In comparison, Beuthe et al. (2002) estimate the road freight congestion externality costs in 1995 were 0.02108 European Currency Unit (ECU) per ton kilometre, which equates to 28.847 South African cents per ton kilometre (2012).

Demir (2015) lists a number of sources in determining a 2010 congestion cost, which range from €cts 0.13 / ton-km to €cts 4.61 / ton-km. The average of these sources is €cts 1.478 / ton-km (2010), which equates to 15.98 South African cents per ton kilometre (2012).

Swarts et al. (2012) estimated through reiterative remodelling of marginal trip costs, based on the demand elasticity of travel on a certain route, that a total of 4.39 billion minutes of extra travel time was caused by road freight. The study uses a value of R1 per minute, and determines that the cost of congestion in South Africa is 1.9225 South African cents per kilometre.

The congestion costs identified in the literature vary drastically from 0.266 to 28.847 South African cents per ton kilometre, due to various reasons. However, the only study which has been conducted on the South African context, and clearly separates the impact of road freight, is the study conducted by Swarts et al. (2012), and therefore the value of 1.9225 South African cents per kilometre will be adopted for this study.

6.1.3 Energy efficiency and resource consumption costs

As defined in Chapter 5, the indirect impact of using road to transport freight, as opposed to rail, can be seen as the opportunity cost of using a resource with a higher renewability indicator when a resource with a lower renewability indicator can be used in its place. Therefore, in order to determine the value of the opportunity cost, it is important to understand the difference between the costs of fuel to transport freight along the corridor via road, versus the equivalent being transported via rail which utilises predominantly electricity.

Transnet (2014) indicate that in 2012, 77 mtpa were transported an average distance of 277 km by road along the corridor. In addition, Jorgensen (2009) states that a single road freight vehicle carrying a 30 net ton load uses between 280 and 300 litres of fuel per 600 km trip from Johannesburg to Durban. This equates to an average fuel consumption of 0.483 l/km. Therefore, considering these figures, a total number of 2.6 million trips were required, with an average fuel use of 133.9 litres per trip, giving a total fuel usage of 343.7 million litres. At the 2012 average fuel price of R10.58 /litre for 500 ppm (parts per million) diesel, this equates to a total fuel spend of R3.6 billion on the corridor, and an effective cost of 16.9 South African cents per ton kilometre.

The information required to determine the money spent on electricity to transport freight via rail is not readily available. However, in a study conducted by Davis and Diegel (2014), it was noted that transporting freight by rail is 12.6 times more energy efficient than by road, per ton kilometre. In the absence of other costing information, it is assumed that the cost to transport freight by rail is 1.3 South African cents per ton kilometre. Therefore, the indirect impact, or opportunity cost, is 15.6 South African cents per ton kilometre.

It should however be noted that this cannot be applied to all freight transported via road on the corridor. It is accepted that rail is suitable for longer distances (in this case an assumption is made for distances of 600km and more) and that certain commodities favour rail transport (such as bulk products like coal and iron ore). Taking this into account, the total volume of freight currently transported via road, which is deemed suitable for rail is calculated by referring to the Transnet SIP2 Demand Book. For calculation purposes, it was assumed that all rail trips were over the entire length of the corridor (average of 625km). The remaining tonnage (all via road) was then apportioned according to the distance distribution for volumes and an average trip distance determined. This equates to a total volume of 13.56 mtpa that could be transferred to rail, which equates to 17.6% of the total current road freight volume.

Based on this, the estimated indirect cost of transporting freight via road that could be transported via rail can be adjusted to 2.75 South African cents per ton kilometre.

6.1.4 Exhaust emissions and air pollution costs

Throughout the world, many studies have been conducted in which costs have been assigned to both exhaust emissions and air pollution. Jorgensen (2009) cites EU studies as determining the average cost of air pollution caused by large road vehicles in EU countries during 1995 to be equivalent to 47.687 South African cents per ton kilometre. The most recent Australian study includes Greenhouse Gases (GHGs) with air pollution and reports an equivalent 9.124 South African cents per ton kilometre. The combined costs of GHGs and air pollution could be even greater given the movement of air masses which could carry emissions from rural into urban areas. Jorgensen (2009) suggests this could be as much as 11.432 South African cents per ton kilometre.

The data presented by Jorgensen shows a significant difference between the EU and Australian estimated costs for emissions and air pollution. A study entitled "Calculation of Freight Externality Costs for South Africa", conducted by Swarts et al. (2012), also determined freight transport emissions costs. The method used by Swarts et al. is based on the offset cost of emissions from the European Union, converted through GDP per capita and empirical data sourced from the Freight Demand Model (FDM) for South Africa, as applied in the Logistics Cost Model (Havenga, 2010). This information was used in tandem with vehicle data from the Road Freight Association (2011). Based on this method, in 2010, road freight transport consumed an estimated 3.768 billion litres of diesel. The total offset cost for all road emissions amounted to R11.4 billion, which is equivalent to 4.991 c/ton-km (Swarts et al, 2012).

In addition to the figures discussed already, various international literature sources valued emissions and air pollution costs as follows:

- Beuthe et al. (2002) estimate the pollutant externality costs of road freight in 1995 were 0.01820 European Currency Unit (ECU) per ton kilometre, which equates to 24.904 South African cents per ton kilometre (2012).
- Pérez-Martínez and Vassallo-Magropaper (2013) estimated that the emissions and air pollution costs in 2000 amount to €cts 0.92 / ton-km, which equates to 12.413 South African cents per ton kilometre (2012).

- Forkenbrock (1999) calculated emissions and pollution costs in 2010 as \$cts 0.23 / ton-km, which equates to 2.612 South African cents per ton kilometre (2012).
- Demir (2015) lists a number of sources in determining a 2010 emissions and pollution cost, which range from €cts 0.45 / ton-km to €cts 4.465 / ton-km. The average of these sources is €cts 1.648 / ton-km (2010), which equates to 18.969 South African cents per ton kilometre (2012).

It is clear that developed countries place a much larger value on environmental impacts and as such the equivalent cost per ton-km determined in developed nations far exceeds that identified by Swarts et al. (2012). Going forward, South Africa will however need to start applying first world principles to its transport network, particularly in order to become competitive on the global stage. Therefore, for the purpose of this research, an average of the costs provided in the various studies will be used. The total emissions cost of 12.78 South African cents per ton kilometre will therefore be used for road freight transport.

6.1.5 Noise pollution costs

The 9th Annual State of Logistics Survey for South Africa, conducted in 2012 by the CSIR reports that the total noise costs for the industry were R 4.3 billion in 2010 and R 4.5 billion in 2011. If these are compared to the total ton kilometres (423 billion) recorded in 2011, an average cost for noise per ton kilometre can be determined. The average noise cost is, therefore, 1.10 South African cents per ton kilometre (2012 prices).

This, however, assumes that road and rail generate the same noise impact, which is of course not the case. In order to try and differentiate between these two modes, an EU studies conclude that rail freight traffic creates significantly less noise than road freight, but this is a factor of the proximity of the railway line to urban areas. The fuel mode used for freight rail transport is also an important factor when considering noise levels. The EU study reported that noise costs of freight rail were 12% of that for road freight. An Australian study quantified the average noise costs for road at 0.621 South African cents per ton kilometre. This figure would vary, dependent on the route and its proximity to urban areas (Jorgensen, 2009).

Other international literature lists the following values for noise costs:

- In comparison, Beuthe et al (2002) estimate the externality costs of noise for road freight in 1995 were 0.00665 European Currency Unit (ECU) per ton kilometre, which equates to 9.1 South African cents per ton kilometre (2012).
- Pérez-Martínez and Vassallo-Magropaper (2013) estimated that the noise costs in 2000 amount to €cts 0.130 / ton-km, which equates to 1.754 South African cents per ton kilometre (2012).
- Forkenbrock (1999) calculated noise costs in 1994 as \$cts 0.04 / ton-km, which equates to 0.455 South African cents per ton kilometre (2012).
- Demir (2015) lists a number of sources in determining a 2010 noise cost, which range from €cts 0.01 / ton-km to €cts 1.18 / ton-km. The average of these sources is €cts 0.306 / ton-km (2010), which equates to 5.514 South African cents per ton kilometre (2012).

The estimated costs for noise vary and therefore an average cost will be used for this study. The average noise cost is determined as 3.92 South African cents per ton kilometre (2012).

6.1.6 Traffic enforcement costs

As discussed in Chapter 5, traffic enforcement both exacerbates other indirect impacts and itself is an indirect impact associated with road freight. The portion of traffic enforcement that was identified as an

indirect impact is the additional resources needed to improve the regulation of the road freight industry (i.e. traffic enforcement costs).

Jorgensen (2009) suggests that traffic policing costs should include highway safety, speed compliance, traffic light costs, surveillance cameras and other traffic monitoring devices. Jorgensen (2009) cited an Australian Queensland report, which presented the costs for traffic policing as 0.444 South African cents per ton kilometre.

The 9th Annual State of Logistics Survey for South Africa, conducted in 2012 by the CSIR, reports that the total policing costs for the industry were R 2.0 billion in 2011. If this is compared to the total ton kilometres (423 billion) recorded in 2011, an average cost for policing per ton kilometre can be determined. The average policing cost is therefore 0.4728 South African cents per ton kilometre (0.490 South African cents per ton kilometre in 2012 prices).

With a road freight industry that is not self-regulatory, there is an increased need for monitoring of overload testing facilities. The introduction of Freeway Management Systems (FMS) to South Africa originated in Gauteng in 2006 and has now been rolled out on National and Provincial roads in the Western Cape and KwaZulu-Natal. The FMS consists of a number of devices installed along the road, which can be used to monitor traffic and inform motorists of upstream incidents in a real time manner. An indicative cost for the full installation of these systems is approximately R 1.5 million per kilometre on a National road within KwaZulu-Natal. If these are rolled out along major road freight corridors there is an opportunity to cast a wider 'enforcement' net.

The 9th Annual State of Logistics Survey for South Africa, conducted in 2012 by the CSIR, reports that the total ton kilometres recorded on the Natcor (KwaZulu-Natal–Gauteng) and CapeCor (Western Cape–Gauteng) corridors was 8 billion in 2012. With an estimated total of 2 200km of road which need to be monitored on these routes, the estimated installation cost for CCTV surveillance systems is R 3 billion. This is equivalent to 37.5 South African cents per ton kilometre for the initial installation cost, which would realistically be off set over a number of years. If the capital costs of the system are recovered over a 15 year period, this reduces the cost to 2.5 South African cents per ton kilometre. This cost estimate is in the order of 10 times higher than those reported by Jorgensen (2009) and CSIR Built Environment (2012).

The cost identified in the 9th Annual State of Logistics Survey for South Africa will be used (0.490 South African cents per ton kilometre), and added to the costs estimated for the installation of a FMS (2.5 South African cents per ton kilometre). SANRAL have deployed Intelligent Transport Systems (ITS) technologies nationally and as such it is logical that this will continue, particularly for the Johannesburg to Durban Corridor which is a strategic route of national importance. It is further noted that the estimated costs for enforcement calculated by Jorgensen and the CSIR are very low in comparison and are likely to be an underestimate, particularly if enforcement is used as a method to curb overloading and poor driving. Therefore, the preferred cost for enforcement is 2.99 South African cents per ton kilometre.

6.1.7 Uptake of land costs

The uptake of land costs is an indirect impact that has not been widely costed in the European studies, and in South Africa, it has only been costed in the 9th Annual State of Logistics Survey for South Africa (CSIR, 2012), in which the cost assigned is 1.00315 South African cents per ton kilometre. It must be noted that the average price for the land was based on a sample of 100 vacant plots of land. Therefore the assigned

cost is most likely an underestimate when considering the higher land value of the urban areas through which the route travels through.

6.1.8 Overloading costs

A number of studies, published in the last few years, indicate that there are many potential negative effects that deteriorating road conditions could have on a country's logistics. These negative impacts can only be worsened as a result of overloaded vehicles. According to the CSIR, the impact of overloaded vehicles can be grouped into the following criteria, with the overall costs being combined to give an estimated unit rate equivalent for overloaded vehicles:

Result of Overloading	Description of Impact	Unit Rate Assigned for the Purpose of this Investigation
Vehicle damage costs	<p>The low quality of the road has an increased cost effect on the vehicle and vehicle component design costs, manufacturing and maintenance costs. These costs are typically incorporated into the costs that the vehicle owner charges to the customer for transporting cargo and, therefore, it increases the logistical costs and ultimately the final costs to the customer.</p> <p>The 7th Annual State of Logistics Survey for South Africa, conducted in 2010 by the CSIR investigated the cost of bad roads. This investigation considered the maintenance and repair costs for trucks travelling on roads in good condition and a poor condition. The difference in these costs was an average of R 1.24 per kilometre.</p>	<p>Based on an average payload of 30 tons per vehicle this equates to 4.13 South African cents per ton kilometre (assuming the travelled roads are in poor condition).</p>
Vehicle operating costs (VoC)	<p>Driving on an uneven road surface affects the speeds at which the vehicle can travel safely, which immediately affects the logistics of delivering goods at optimum times to a customer. It also increases the fuel consumption of the vehicle, leading to more carbon emissions for the same amount of cargo delivered. The carbon footprint of a transport operation will in future play a significant role in directing consumer preference and choice, with green logistics becoming increasingly important.</p> <p>Determining the specific costs of these measures is not simple as there are many flexible scenarios. For the purpose of this research it is proposed that poor road conditions, as a result of overloaded heavy vehicles, would increase vehicle operating costs by at least 5%. Given a journey time of approximately 8 hours from Johannesburg to Durban, this 5% translates into an additional 25 minutes which is considered to be very conservative. Jorgensen (2009) conducted an investigation into forestry logistics costs, which included the individual average rate per ton kilometre for road freight at 71 South African cents per ton kilometre.</p>	<p>The cost of additional vehicle operating costs is estimated at 5 % of the direct costs, which equates to 3.55 South African cents per ton kilometre.</p>

Road damage costs	<p>A decrease in the riding quality of a road causes a direct increase in the road maintenance costs. It also shortens the potential lifespan of the road, due to the increased vibration of vehicles, which in turn increases the dynamic component of vehicle loads on the road. This causes a cycle where the lower riding quality of a road causes faster deterioration of the road surface for the same amount of cargo transported.</p> <p>According to a paper prepared by (Morton, Visser and Horak, 2007b), the maintenance cost of the Johannesburg to Durban Road Corridor can be analysed in terms of the freight hauled along corridor. The maintenance cost equates to a value of R 0.113/E80.km or R212/one directional trip for a freight haulier with a Gross Vehicle Mass equivalent to the average E80/HV of 3.5 (28 tons). Taking a trip of 600km, with a mass of 28 tons the total ton-km equates to 16 800 ton-km per one way trip. The maintenance cost can now be translated into a cost per ton-km.</p>	<p>The estimated maintenance cost for road freight is 1.2 South African cents per ton kilometre.</p>
Damage to transported cargo	<p>The vibrations from the road are translated to the transported cargo, which results in damage to the cargo. The impact or cost of this damage will vary significantly based on the type of cargo. The 8th Annual State of Logistics Survey for South Africa, conducted in 2011 by the CSIR, includes a grain-loss case study, which investigated the potential wheat losses of a grain shipping company during transportation as a result of increased truck vibrations caused by bad roads in South Africa.</p> <p>The case study determined there was an additional loss of 0.62 kg/ton that translates to a loss in potential revenue of R1.39 per ton loaded. To convert this into a cost per kilometre, the average transport distance (ATD) for road freight on the Natcor (KwaZulu-Natal–Gauteng) and CapeCor (Western Cape–Gauteng) corridors will be utilized. The ATD for road freight on these corridors was 836 km in 2010.</p> <p>Potential solutions to this problem include improvements to the packaging or improvements in the design of the cargo. Both these potential solutions increase the logistics costs of the operation, since every piece of cargo requires improved design or packaging with the sole objective of protecting the cargo for the trip between the supplier and the customer. This does not add any direct value to the product, but merely adds additional costs.</p>	<p>The estimated cost for damage to cargo is 0.17 South African cents per ton kilometre.</p>
Environmental impact costs	<p>A decrease in riding quality has an effect on the environment and increases environmental costs, such as increased emissions, due to slower speeds and longer durations of transport. Lower quality roads also increases the use of resources, since better design requirements result in an increase in the materials required to construct the same goods. More materials are also required to reconstruct or</p>	<p>The cost of additional air pollution or emission costs is estimated at 5 % of the direct costs, which equates to 2.38 South</p>

	<p>repair badly maintained roads. All of these translate into an increase in environmental costs.</p> <p>The direct impact on the environment as a result of heavy vehicle overloading has not been determined directly. For the purpose of this research it is proposed that poor road conditions as a result of overloaded heavy vehicles, would increase the cost of air pollution or emissions by at least 5%. Jorgensen (2009) cites EU studies as determining the average cost of air pollution caused by large road vehicles in EU countries during 1995 was equivalent to 47.687 South African cents per ton kilometre.</p>	African cents per ton kilometre.
Total		11.43 cents / ton-km

Based on the information provided, it is estimated that the cost of overloaded heavy vehicles results in an additional 11.43 South African cents per ton kilometre.

In comparison, (Robot, 1998) estimated that in 1998 the impact of overloaded vehicles resulted in R550 million per annum (R 1 299 million in 2012 costs) worth of costs which are effectively picked up by the tax payer. Based on the total ton kilometres of road freight in 2000 (70 billion), this equates to a cost of 1.349 South African cents per ton kilometre (2012). This is considerably lower than the cost estimate determined above, however the primary focus area for Robot was on road infrastructure rather than an overview of all associated overloading costs.

6.1.9 Social costs

The social indirect impacts that were identified in Chapter 5 included health, safety and security, driver working hours, and community impacts. Determining a cost for these social impacts of road freight is not simple, and no research was found in which a cost has been associated with these impacts. Therefore, no costs have been assigned to the social impacts identified in this study. It is however expected that the costs associated with the social impacts will not be zero, and as such this study is conservative in the quantification of associated costs of indirect impacts.

6.1.10 Decline in rail infrastructure costs

The decline in rail infrastructure has been attributed to a number of factors. Whilst this research focuses primarily on the impact of road freight, it is important to consider the cost of not utilising the rail network as discussed in Chapter 5. In order to determine this cost in a manner in which it can be added to other road freight costs, the cost of not utilising rail will need to be provided in South African cents per ton kilometre.

It is widely reported that rail is losing market share on an annual basis. This results in fewer ton kilometres via rail and ultimately more via road. For the purposes of this research, the reduction in ton kilometres via rail will be utilised as the cost of continuing with current modal split trends. It is noted that this is a broad approach, and that there are certain items of freight that are better suited to road and likewise to rail. The total annual freight movement on road and rail changed as indicated in Table 10 between 1985 and 2012.

Table 10: Increase in total annual freight movement on road and rail between 1985 and 2012

Year	Road		Rail	
	Million tons	Billion ton kilometres	Million tons	Billion ton kilometres
1985	504	46	170	92
2000	647	70	178	100
2012	1530	301	203	129
% change (1985 – 2012)	203%	554%	19%	40%

Source: Stander and Pienaar, 2002; CSIR Built Environment 2014

The increase in road freight transport far outweighs the increase in rail transport over the same time period. This clearly demonstrates the shift from rail to road as a result of the factors discussed in Chapter 3. If the total freight tonnage between these modes is considered, in 1985 the modal split was 75:25 road to rail. By 2012 the modal split is 88:12 road to rail and the total tonnage transported has increased signifying a worrying downward trend for freight rail. Whilst the net tonnage for rail increases (19%), there is effectively a reduction in modal share (total tonnage) for rail freight of 0.5% per annum.

A reduction in rail traffic will lead to an increase in costs for the remaining rail operators. For the purpose of this research, the decrease of 0.5% per annum of modal share will therefore be considered as the equivalent to an increase of 0.5% direct costs for the remaining rail operators. Jorgensen (2009) conducted an investigation into forestry logistics costs which included the individual average rate per ton kilometre for road and rail. These were 71 cents and 43 cents per ton kilometre respectively. An increase of 0.5% direct costs for the remaining rail operators equates to 0.22 South African cents per ton kilometre.

6.2 Summary of Costs

Based on the information discussed and reviewed in this Chapter, Table 11 summarises the total costs of the various indirect impacts of road freight in South African cents per ton kilometre, with a base year of 2012. It should be noted that in terms of a sensitivity test, this study reviewed a range of previous studies in each of the impact categories and as such attempted to identify the most reasonable costs which could be associated. In addition, the allocation of costs is subjective and these are not transferable to other corridors due to changes in modal share, topography and other key determining factors.

Table 11: Summary of road freight costs in South African cents per ton kilometre

Indirect Impact	Cost
Accidents	8.60
Congestion	1.92
Energy efficiency and resource consumption	2.75
Exhaust emissions and air pollution	12.78
Noise pollution	3.92
Traffic enforcement	2.99
Uptake of land	1.00
Overloading	11.43
Social	0.00
Decline in rail infrastructure	0.22
Total	45.61

The total additional cost per ton kilometre for road freight transport has been determined as 45.61 South African cents. This is the cost which is not borne directly by road freight operators. Figure 66 provides an indication of the percentage contribution of each cost factor to additional road freight transport costs.

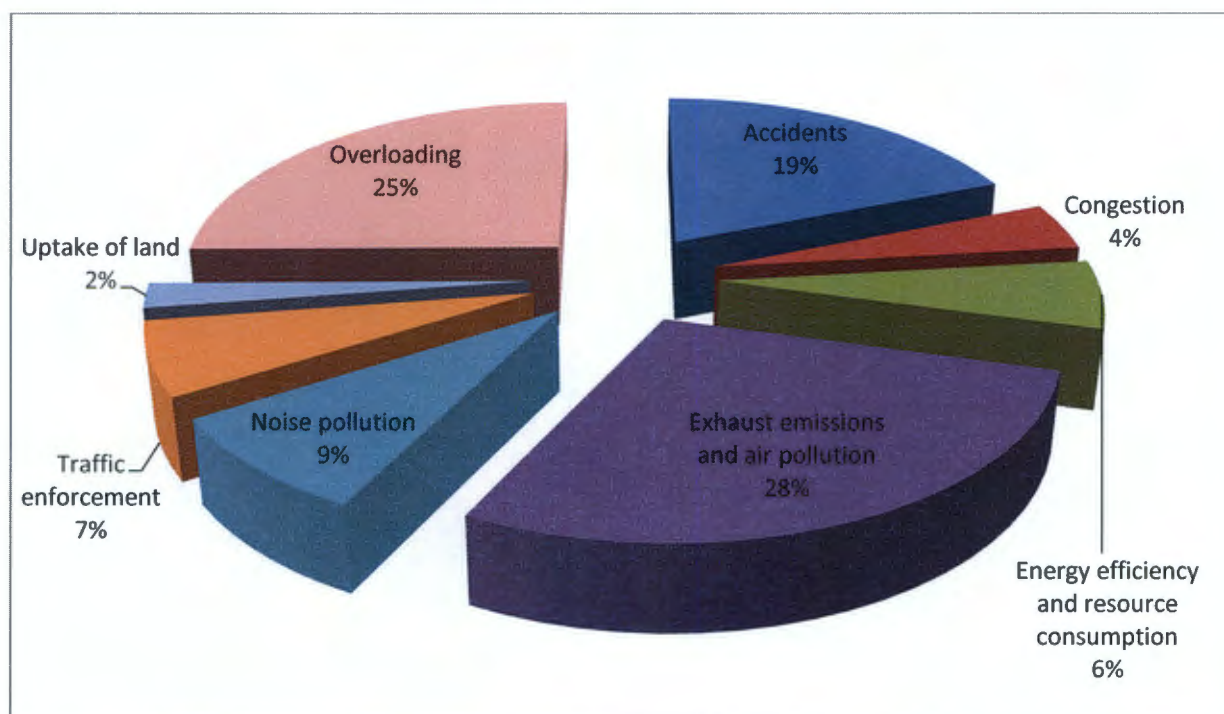


Figure 66: Estimated percentage contribution of each cost factor to additional road freight transport costs

Exhaust emissions and air pollution (28%), and the damage resulting from overloaded heavy vehicles (25%) are the largest contributors to the external impacts of road freight transport. This is followed by accidents (19%), noise pollution (9%), and traffic enforcement (7%). Energy efficiency and resource consumption contributes an estimated 6%, while congestion and uptake of land contribute 4% and 2% respectively. The largest costs due to indirect impacts provide an indication of the priority focus areas when considering intervention measures.

Transnet (2014) state that a total of 21.3 billion ton-km were transported by road in 2012 along the Johannesburg to Durban Freight Corridor. At a cost of 45.61 cents per ton-km, this equates to R 9.72 billion in unaccounted costs that the road freight sector along the corridor is responsible for on an annual basis.

6.3 Comparison to European Union External Costs of Transport

As has been identified in the research, the majority of research into costs associated with indirect impacts of transport has been conducted in European Union (EU) countries. Figure 67 to Figure 69 have been extracted from Schreyer et al (2004) in order to provide an indication of external transport costs for different transport modes as identified in 17 EU Countries. Figure 67 displays the percentage contribution by mode of transport to total transport costs.

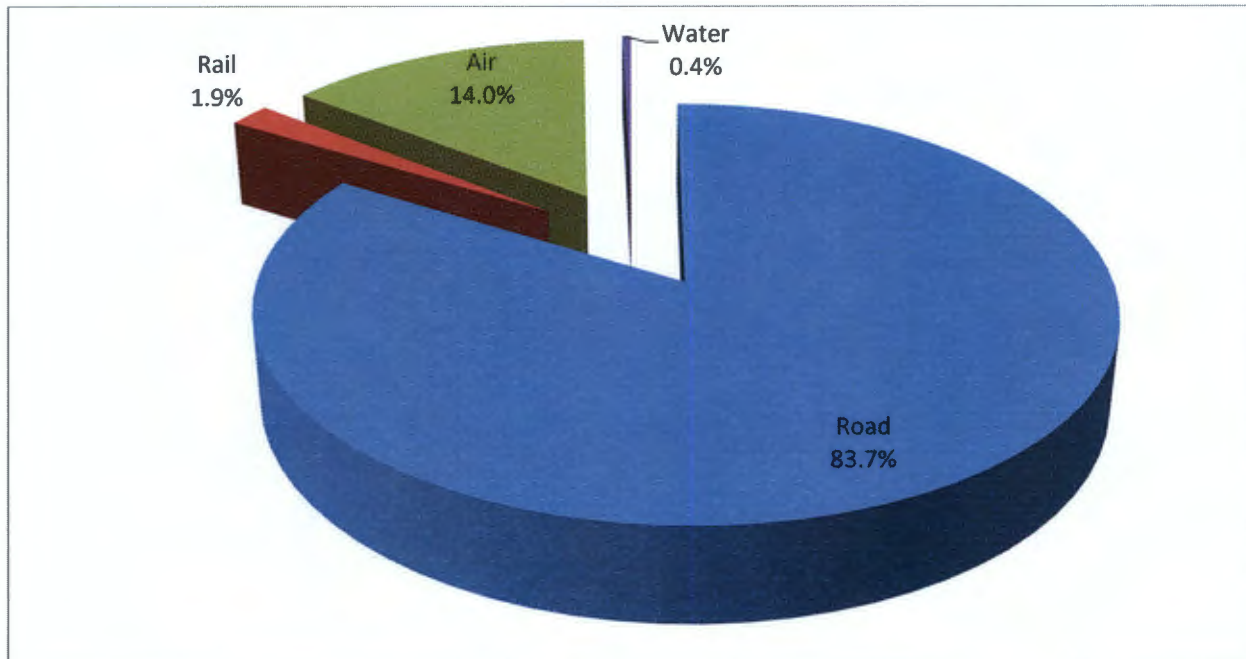


Figure 67: Percentage contribution by mode to total transport costs in 17 EU countries
 Source: Schreyer et al, 2004

Figure 67 displays that road is by far (84%) the highest contributor to external transport costs, followed by air (14%) and then rail and finally water. Figure 68 demonstrates the total contribution by mode to road transport costs in 17 EU countries. It can clearly be seen that the car is the greatest contributor (51%) to external costs, followed by Heavy Delivery Vehicles (HDV) with 30%.

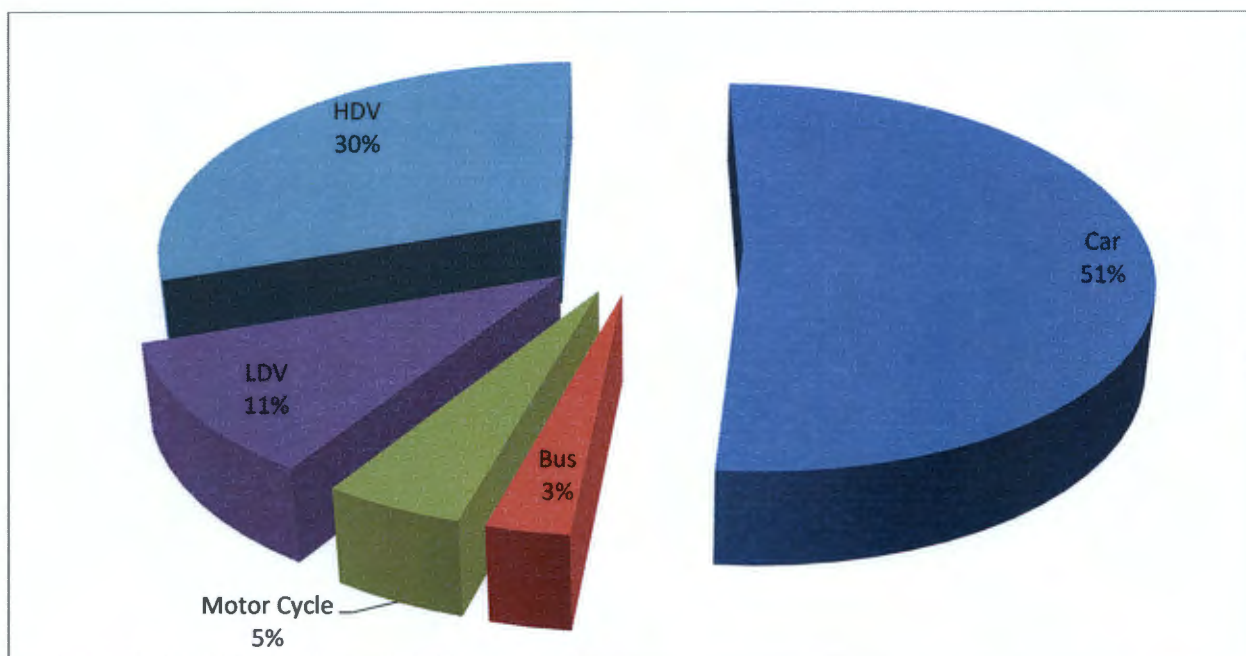


Figure 68: Contribution by land based transport modes to total road transport costs in 17 EU countries
 Source: Schreyer et al, 2004

Figure 69 shows the percentage contribution by category to the indirect impacts caused by heavy vehicles. Air pollution is by far the greatest contributor with 54%, followed by Climate change with 18%.

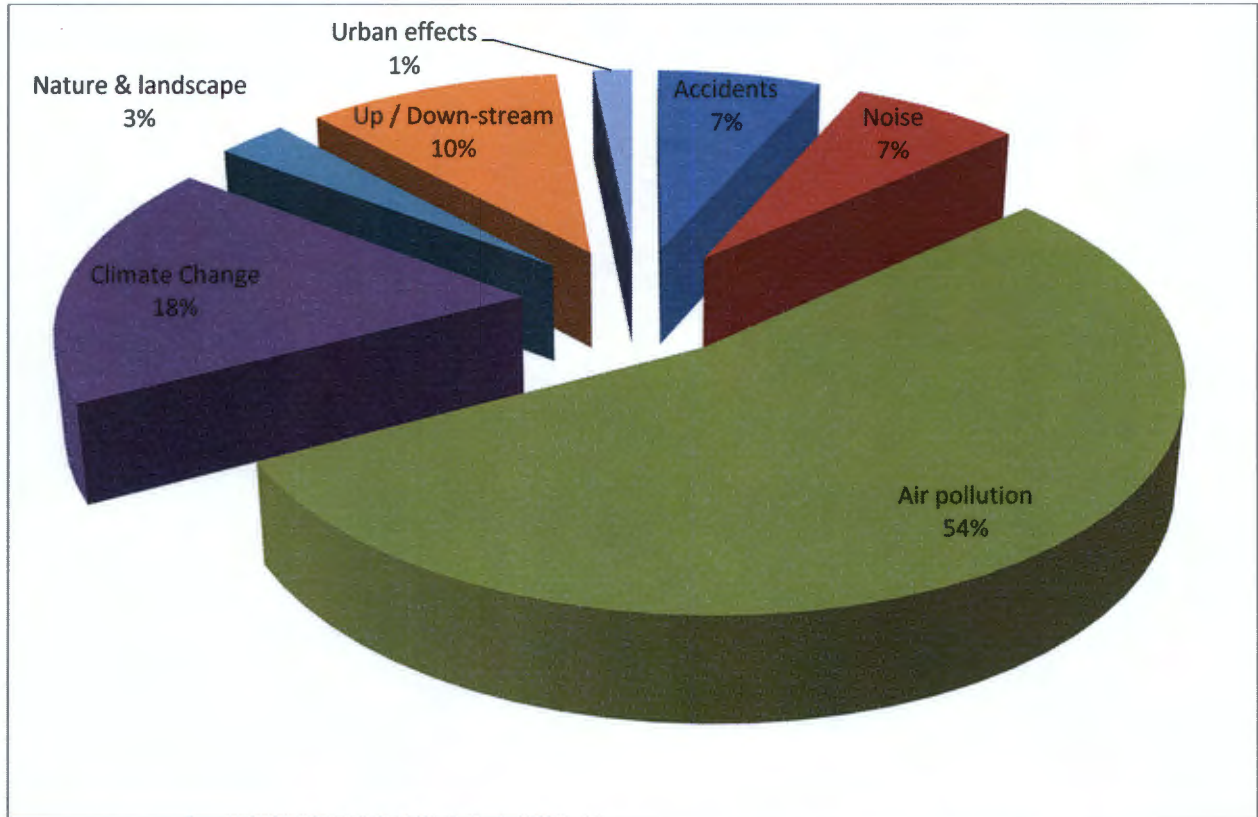


Figure 69: Categories contributing to Heavy Delivery Vehicle (HDV) Costs in 17 EU Countries
 Source: Schreyer et al, 2004

In comparison to South Africa, the EU study displays 54% impact due to air pollution, whilst in South Africa the value assigned for exhaust emissions and air pollution accounted for 28%. The second highest factor identified in the investigation is overloading with 25%, however this is not included in the EU study. It has been discussed that the overloading of heavy vehicles is a major challenge in South Africa, and this is coupled with South Africa's extremely high accident rates. Both of which contribute to externality costs for heavy vehicles and can explain why there is a difference between EU and South Africa.

7 MITIGATION OF IMPACTS OF ROAD FREIGHT ON THE JOHANNESBURG TO DURBAN FREIGHT CORRIDOR

7.1 Road Freight Transport Improvements

The indirect impacts of road freight have been identified and methods to reduce or mitigate these impacts will now be considered. The importance of road freight to the South African economy cannot be overstated. However, solutions to current road freight transport methods are required in order to develop and maintain a sustainable freight transport industry. Irrespective of whether a drastic policy shift is introduced in South Africa, which enables an effective intermodal freight transportation system, it is critical for road freight to become as sustainable as possible. When considering the criteria for a sustainable transport system, Schreyer et al (2004) lists the following key factors:

- Efficiency,
- Effectiveness (i.e.: in reducing environmental nuisances),
- Long term focus,
- Practicability for the users, and
- Consideration of sensitive areas.

A sustainable concept, therefore, has three main pillars, which are critical to the success of a structure (Schreyer et al, 2004):

- An improved pricing system that takes into consideration the external costs of different modes (user pays principle),
- Additional non-pricing instruments, which support the reduction of environmental and accident costs, and
- An institutional framework which facilitates sustainable investment decisions on infrastructure provision.

In addition to the above, a critical note is that an integrated approach to developing a Sustainable Freight Strategy (SFS) is required to ensure overall success. For example, if a SFS focuses on pricing only, the full benefits intended through this implementation will not be achieved, as there could be unintended adverse effects elsewhere in the transportation system. However, if one SFS measure (such as pricing) is introduced in conjunction with another SFS measure (such as a time related ban for road freight on major freeways), then these two measures/policies could result in a greater good than if implemented separately. It is also important to consider cross-mode strategies in order to avoid 'negative' modal shifts, for example from road freight to air freight. An example of the effectiveness of internalisation instruments is provided in Table 12.

Table 12: Effectiveness of various methods on road freight sustainability

Method	Type of instrument	Effectiveness	Cost effectiveness ranking
Congestion			
Congestion pricing	Economic	High	1
Infrastructure operation management, telematics	Technical	High	2
Accidents			
Education	Organisation / Institutional	Medium	1
Change of insurance / liability	Economic	High	2
Limitation of alcohol limits	Command and Control	High	3
Speed limits	Command and Control	Very High	4
Courses for driving styles	Organisation / Institutional	High	5
Local measures	Infrastructure	Local High	6
Noise			
New brake systems rail	Technical	High	1
Motor caps for HDV	Technical	Low	2
Speed limits	Command and Control	Medium	3
Special tyres for road	Technical	Low	4
Noise walls / windows	Infrastructure	High	5
Air pollution			
Alternative motors for busses	Technical	Low	1
EURO IV+ norms	Command and Control	High	2
Km-tax (emission dependent) fuel tax	Economic	High	3
Urban parking policy	Economic / Infrastructure	Medium	4
Urban road pricing	Economic	Medium	5
Urban traffic bans	Command and Control	High	6
Speed limits	Command and Control	Medium	7
Climate change			
Driving courses	Organisation / Institutional	Medium	1
Kyoto Mechanisms (Emission trading, clean development mechanisms)	Economic	High	2
Fuel tax, Kerosene tax	Economic	High	3
Renewable energies for electricity production (rail)	Technical	High	4
Alternative fuels (Bus/HDV)	Technical	High	5
Feebates road	Economic	Low	6
Fuel standards / alternative fuels	Command and Control	Medium	7
Speed limits	Command and Control	Medium	8

Source: Schreyer et al, 2004

There is the ability to introduce these strategies on a national level, and international examples of internalisation strategies for freight traffic include (Schreyer et al, 2004):

- Swiss Heavy Delivery Vehicle (HDV) charge - with the initial charge based on external accident and environmental costs. This charge resulted in a decrease of road freight volumes by 3% and has motivated the use of freight rail as the alternative. The revenues from the charge are used to finance rail infrastructure – an example of cross modal funding.
- German and Austrian approaches - introduce a kilometre based HDV charge on highways. The German charge relates solely to infrastructure costs with a differentiation according to emission criteria. Revenues are used to cross finance rail investments.

Pricing measures are becoming introduced more frequently as a method to internalise costs within the road freight sector. The most important short term effect is the increase in HDV efficiency, with modal shift expected in the longer term. The main methods to reduce the impact of road freight include (Schreyer et al, 2004):

- Reducing emissions by implementing new vehicle technologies and changing driver behaviour, and
- Policy changes that encourage sustainable solutions.

7.1.1 Emission Reduction Strategies

There are a number of ways to reduce emissions of road freight. These include, but are not limited to (Baker et al, 2009):

- Decrease aerodynamic drag,
- Driver behavior,
- Hybrid and electric vehicles, and
- Automated Manual transmissions (AMT) and Dual Clutch transmissions (DCT) transmissions.

7.1.1.1 Decrease Aerodynamic drag

The drag experienced by a vehicle results in increased fuel consumption and, hence, increased emissions. Additional add-ons to trailers can assist in reducing aerodynamic drag and, therefore, improve fuel consumption. These are indicated in Figure 70.

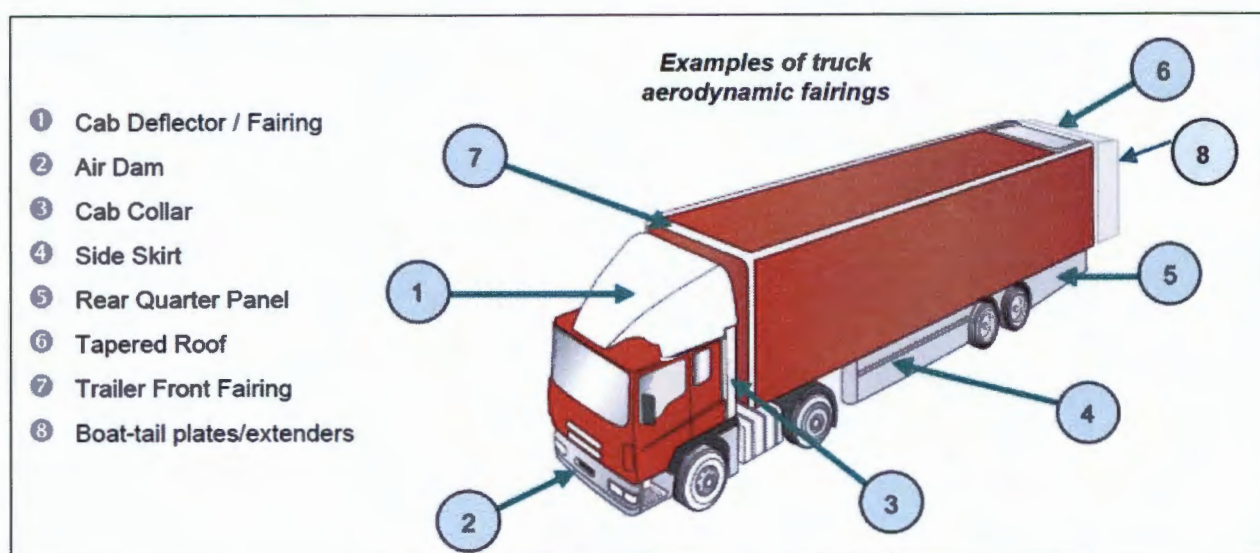


Figure 70: Trailer add-ons to reduce aerodynamic drag

Source: Baker, et al, 2009

Low rolling resistance tyres are also known to improve fuel efficiency, with no additional purchasing costs. These tyres are designed to minimise rolling resistance whilst still maintaining the required levels of grip.

One drawback of this is that the lifespan of the tyre is reduced. In addition to this, automatic tyre pressure adjustment monitors and adjusts tyre pressures to improve tyre safety and reduce fuel consumption (Baker et al, 2009).

7.1.1.2 Driver behaviour

The typical driver behavior in South Africa, which has often been described as quite aggressive, can impact on the efficiency of a vehicle. By attempting to assist or better control driver habits it is possible to improve safety and reduce emissions. Examples include predictive cruise control, vehicle platooning and driver training/education.

7.1.1.3 Hybrid and electric vehicles

Baker et al (2009) provides an overview of the benefits that can be attained through the use of hybrid and electric vehicles. These benefits are summarised in Table 13.

Table 13: Various hybrid and electric vehicles

Vehicle type	Stop-Start	Mild Hybrid	Full Hybrid	Electric
Description	Up-rated starter motor. Shuts off vehicle when stationary, restarts on pull away	Small motor that supplements engine power	1 or 2 electric motors of significant power. Wheels can be driven either by IC engine or electric motor	Vehicle driven by electric motor, where energy is from a battery that must be plugged in to charge.
Benefits	Low cost	Enables engine downsizing	Enables engine downsizing and better performance	Zero emission vehicle at tailpipe
	Minimal change from baseline	Improved refinement and performance	Best balance in fuel consumption and emissions savings	Low noise
	Good fuel consumption benefit in heavy urban traffic	Increased generating power	Electric only mode possible	

Source: Baker et al, 2009

The majority of these technologies are applied to light motor vehicles, but as development continues these will become available for use in heavy vehicles.

7.1.1.4 AMT and DCT transmissions

Automated Manual transmissions (AMT) combine the best features of manual and automatic transmissions. An AMT does not require clutch actuation or shifting by the driver. Dual Clutch transmissions (DCT) have twin clutches and twin input shafts. The DCT works with one clutch controlling gears 1, 3, 5 and 7 and the other 2, 4 and 6. The handover between clutches means that there is no interruption of the torque and improved shift comfort.

7.1.2 Policy Changes

The purpose of policy is to provide overarching direction and guidance across multiple sectors. Policy is backed up by legislation and, as such, can be enforced. There are, therefore, a number of policies which can be prepared or amended in order to minimise or mitigate the impact of road freight.

Policies that can be implemented and make an impact over the short to medium term are most likely to succeed in South Africa, because they are associated with less uncertainty, lower risk, often lower costs and greater ease of implementation. It appears that the South African transport system is better suited towards measures that aim to remove excess in the system, than those requiring new investment, infrastructure or radical thinking (Vanderschuren, Lane and Korver, 2009).

7.1.2.1 Diversified energy for transport

High oil prices coupled with rising concerns regarding climate change have meant that many countries are being driven to consider the use of biofuels. Letete and von Blottnitz (2009) stated that in South Africa, the potential for the use of biofuels is also linked to a need to stimulate economic development and to alleviate poverty through the promotion of farming in areas previously neglected by the apartheid system. Addressing concerns about food security, the environment, land-use, benefits for small farmers and quality control, the South African government's initial target for the market penetration of bio-fuels in liquid road transport fuels was lowered from 4.5% to 2%, to be achieved within 5 years (DME, 2007).

7.1.2.2 Modal Shift Policies

Many South African cities have seen a rise in the number of vehicles on the roads, leading to increasing levels of congestion and as a result increasing pollution. There has been a significant increase in the use of cars to get to work. According to the NDoT (2005), between 1997 and 2004 the national percentage of people who used cars rose from 30% to 45%. Land-use policies established during the apartheid era have resulted in the creation of large distances between residential areas and places of work. These distances are significantly bigger than international values, severely limiting the potential for NMT (Vanderschuren, Lane and Korver, 2009).

When developing the strategic actions for rail it is important to ensure that these actions are aligned with customer needs and strategies. With this in mind, the Rail Road Association (n.d.) suggests that the strategic business operations could be split into different client needs, such as bulk freight and general freight. In addition to this, general freight lines, which should be core lines must be identified to ensure sustainability. This approach will ensure client satisfaction that in the long term will improve rail utilisation.

7.1.2.3 Overtaking bans

HGV overtaking restrictions are already in place along certain sections National roads. It is, however, common for these to be ignored as enforcement is limited. Limiting the opportunities for HGV overtaking is likely to have a positive outcome for light vehicles, whilst the opposite is the case for heavy vehicles. Having said this, the proportion of light to heavy vehicles means that overall there is likely to be a more positive effect.

Many European countries have HGV overtaking bans in place during specific period (such as morning peak). These vary in terms of the length of road covered (from 2.4 km up to 229 km), the HGV weight

categories included and the times of operation (some are permanent, most are fixed time, a few are dynamic, i.e. traffic responsive). Using the results from existing schemes, TRL Limited (2010) estimated that an HGV overtaking ban rolled out across 15 of the EU countries (for which data was available) could produce annualised benefits of up to 1500 million euro.

7.1.2.4 Road Pricing

The costs associated with transportation, whether it is for private or commercial purposes, is a controversial issue, because it is a very tangible cost and impacts every sector. The issue of road user charges has been hotly debated for years. The concept of road pricing is that the user is required to pay for the portion of road travelled. Road pricing is aimed at fully recovering the costs of infrastructure, maintenance and externalities, whilst at the same time providing road users with a level of service that is on par with the cost. This is necessary to restore the economic balance between the various modes within the system, particularly in terms of externalities. This approach will promote long-term sustainability, reduce negative externalities and create a self-supporting system within a competitive environment. The correct pricing strategies will help transport authorities control congestion and pollution (Rail Road Association, n.d.). Whilst the user pays principle has been applied in South Africa over a number of decades, there has recently been lengthy discussions as a result of SANRAL's implementation of Open Road Tolling (ORT) initiatives in the process of implementation in Gauteng.

Up to the 1980's, road users in South Africa by and large paid for the construction and maintenance of national and provincial roads through a dedicated fuel levy (National Road Fund (NRF) received part of the total fuel levy), licences, etc, whilst in cities and towns the construction of roads were largely financed from property taxes. At that time, it was found that road users were contributing significantly more than the expenditure on all roads. By July 1987, government stopped earmarking funding and the NRF disappeared. Funds for road-building would only be allocated from the central fiscus (Stander and Pienaar, 2002).

Should the fuel levy be considered a general tax such as VAT or income tax, then the only road user charge would be the contribution to the Road Accident Fund, license fees and tolls. Then the argument that road users do not cover road construction and maintenance costs, would be true.

The important role of transportation has been discussed previously. Without an extensive and well maintained road network it would not be possible for society to function. The construction and maintenance of the infrastructure is, therefore, fundamental and is reliant on the availability of funding. As road infrastructure cannot in all cases be provided at an acceptable profit - government as agent of communities and the private business sector has to manage and supply road infrastructure. The supplier must be remunerated for this capital good and user charges dedicated to financing the costs of roads, are applied all over the world.

Similarly to other utility providers (electricity, water, etc.) who are paid directly by users, so should road users be paying for the road utility that they receive? The case for at least part of the fuel levy to be considered a user charge, is clear (Stander and Pienaar, 2002).

The prevailing market structure and the nature of competition is an important factor in the determination of prices (Rail Road Association, n.d.). The number of competitors is a major driver behind the market conditions. Although there is free competition in road transport, rail is much different. Large initial capital outlays (for rolling stock) mean that it is not common to find small rail companies and the modern trend is to amalgamate into larger organisations. In the general road freight sector, there is no absolute monopoly.

In the past, long-haul freight was transported via rail however the introduction of air, road and pipeline transport has created strong competition.

The demand for transport at a high rate will disappear if competitors start to quote lower rates, whilst still providing a similar service. Competition is, therefore, a limiting factor when setting rates, which should be related more closely to actual costs. It is in this grey area where road and rail now compete on unequal terms and to the detriment of the national economy and long-term interests of South Africa.

The road transport industry, in the past, could correctly complain that the rail mode was heavily subsidised, even though it was expected to provide socio-economic services. It appears now that the road mode is highly subsidised, since it does not pay for the full costs of the road infrastructure provided by the government and ultimately taxpayer – be he a private individual, industrialist or general businessman (Rail Road Association, n.d.).

7.1.2.5 Lessons learnt from international road freight trends

If the roads are going to be better managed, then it is important to know what is currently causing damage to them and how this can be decreased on an on-going basis. It is also important that investigations set up a database or baseline against, which all these other impacts can be measured.

The Haulage Industry Task Group, established by the UK Department for Transport in December 2005, decided that a freight data feasibility study is required in order to establish this baseline (Department for Transport, 2012).

The task group suggested a vignette scheme (a time based charge for the use of the road), but noted that it would be important that the legislation is amended first, to back up this approach and then that there is suitable enforcement to ensure that the scheme is not only taken seriously but is effective. Some enforcement measures suggested included (Department for Transport, 2012):

- All Heavy Goods Vehicles (HGV's) are required to register with a central database/organization as part of their daily operating permit,
- Teams are deployed to 'police' areas where HGV's are known to frequent (port, N3/N2 truck stop, M13, etc),
- Automatic number plate recognition (ANPR) for more widespread enforcement, but concluded that it would be of limited value and at substantial cost,
- Spot checks, and
- Mobile patrols.

There will be large initial costs (capital outlay), which will then turn into operational costs and these will need to be weighed up against the improved road conditions (less maintenance, better level of service, decreased travel time, etc). Experiences from other schemes suggest that a penalty of six times the evaded fee is effective in encouraging compliance (Department for Transport, 2012).

The M13 runs parallel to the N3 and is, frequently, used by heavy vehicles who are attempting to avoid toll fees payable at Mariannhill Toll Plaza. This road is also a major commuter route from the western suburbs and, hence, there is often congestion during peak periods. In an effort to combat this congestion, heavy vehicles are not permitted on this route during the morning peak period and daily enforcement ensures heavy vehicles obey this rule.

7.1.2.6 Intermodal Freight Transport Systems

The Railways have become increasingly discredited as an effective transport mode because of poor service delivery in the past in South Africa. The increased road transport, while providing a more consumer-friendly service, has contributed to road congestion and has raised safety and cost issues.

In an international context, however, the development of sophisticated intermodal freight systems has demonstrated the long-term value of co-operation between the modes. The transport industry has been a leader in motivating technological development. Increasingly, and with enlightened and motivated management, both road and rail operators can provide improved service delivery at more cost-effective prices to individual users and the country as a whole (Rail Road Association, n.d.).

Introducing intermodality in South Africa will be a challenge. The country presently has clear freight corridors, but the bulk of the freight is transported by truck. Only the traditional mining corridors still transport bulk via rail. There are virtually no intermodal facilities at present (Hesse and Rodrigue, 2004). Trucks and rail operate in parallel. In terms of customer expectations, trucks are the preferred choice, due to their speed and reliability advantages. A recent study recommended that the Department of Transport convert the Durban Gauteng Corridor to first class rail services (ASPO et al., 2008d). Improving intermodality will require infrastructure development, as well as a paradigm shift in transport operations.

The 10th Annual State of Logistics Survey notes that rail-friendly freight must get back onto rail in order to minimise the country's logistics costs, preserve the road network, reduce congestion and generally make South Africa more globally competitive (CSIR, 2014). According to Transnet Freight Rail (TFR) export products such as iron ore, coal and manganese are a 'captured' market. Where bulk commodities are still transported via road it is likely due to insufficient rail capacity, as reported by cargo owners (CSIR, 2014). Similarly to mining product, the agricultural dry-bulk sector indicates that if reliable rail capacity existed on the long haul and export lines, a shift back to rail from road would happen naturally (CSIR, 2014). There are however challenges ahead, as identified by a World Bank statement that states "*if service delivery is poor, good physical connectivity is not enough*" which is applicable in South Africa (CSIR, 2014).

7.1.2.7 Improved Traffic Management

South Africa has been experimenting with inter-city management systems for about a decade. The first system that was installed on the Ben Schoeman freeway (Gauteng province) never became operational. In September 2006, the second freeway management system became operational. A control centre and variable message signs are some of the systems included. Other systems are still being explored and added. Both Cape Town and Durban also have freeway management systems.

Intelligent traffic management systems that facilitate route optimisation and vehicle scheduling are highly sustainable, because they require little to no new infrastructure, have short implementation periods, are relatively inexpensive, can alleviate pressure on bottlenecks and capacity constraints and are associated with few externalities (Lane, 2009). South Africa should strongly consider setting up a system to provide more accurate navigation signals, combined with ground-based or space-based information. There is currently a tremendous lack of accurate, real-time information available to drivers and planners alike.

Giannopoulos (2009) states that "*Intelligent Transport Systems (ITS) and its related systems and services will be the paramount force for the future development of Freight Transport and Logistics systems*". However, in order to derive maximum benefit from these systems, freight carriers will also have to adapt

with new forms of business and financing practices. They will also have to rely more on the capabilities of integrated, advanced analytic planning and operation decision support systems for their strategic as well as day to day decisions (Giannopoulos, 2009).

It will further be important to ensure that all freight operators have access to increased intelligence in the freight transport operations arena. Giannopoulos (2009) notes that the areas of application of these improvements are widely varied, but that the following main areas will receive the most attention in the coming years:

- City Logistics - the integrated management of freight movements within urban areas,
- Advanced models and methods in order to optimize the design and performance of Freight Transport Operations. Practically all decision issues associated with the design and operations of an advanced freight transportation system must be re-addressed within the framework of ITS and their applications,
- Creating a truly e-business environment for Freight transport, and
- Creating the framework for the full exploitation of capabilities of “intelligent” freight or the e-freight environment of the future.

7.1.3 Alternative fuels and propulsion systems

Tubular freight transportation is a group of unmanned transportation systems in which close-fitting capsules or trains of capsules carry freight through tubes between terminals. Although research and development around tubular freight (and passenger) systems has been emerging for several decades, no final conclusion regarding the feasibility and energy efficiency benefits of such a mode of travel have been reported (Lane and Vanderschuren, 2009).

7.1.4 Energy efficiency improvement measures

Vanderschuren, Lane and Wakeford (2009) reviewed potential energy saving measures in transport. In particular, road freight efficiency measures are displayed in Figure 71.

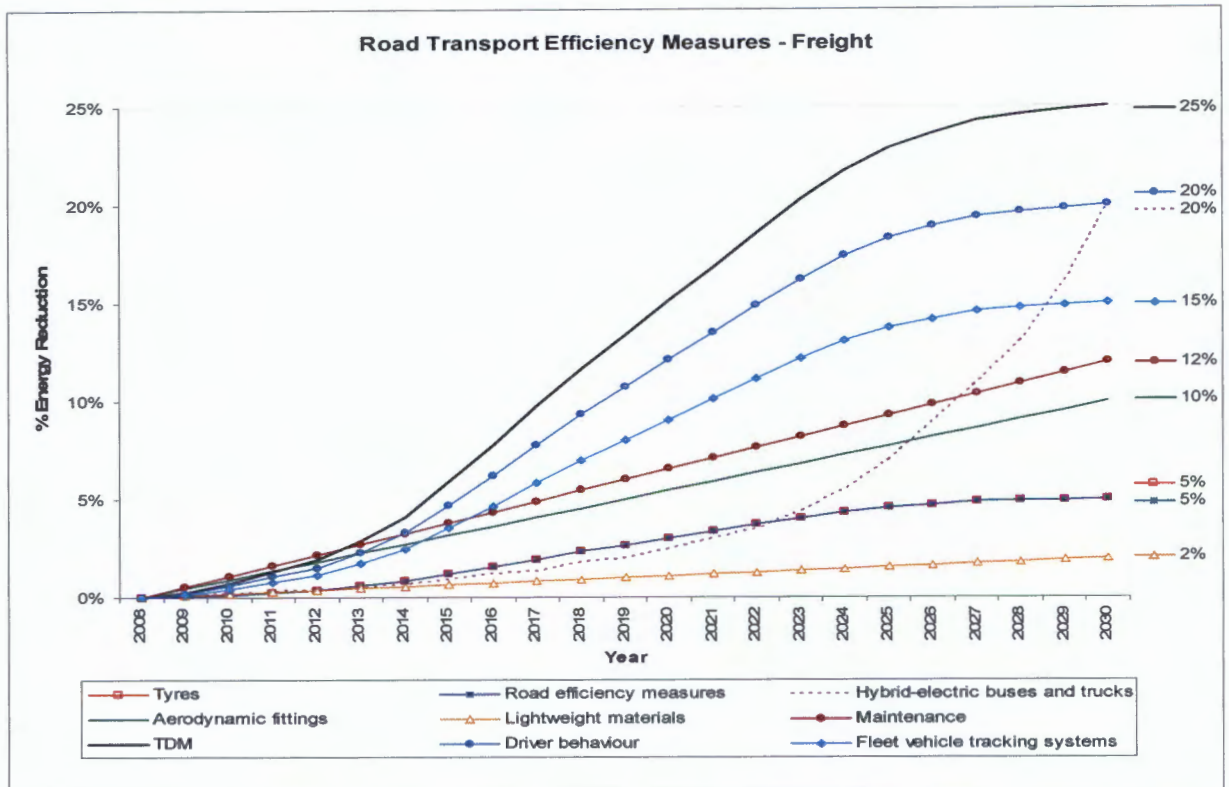


Figure 71: Freight road based transport efficiency measures
Source: ASPO et al, 2008a

In freight transport TDM (25%), driver behaviour (20%) and hybrid-electric buses and trucks (20%) have the largest long term potential impact (Vanderschuren, Lane and Wakeford, 2009). Improving vehicle design increases the distance covered per unit of fuel consumed, by:

- Reducing air and rolling resistance,
- Improving engine technology, or
- Using light-weight materials.

New cars consumed approximately 10% less fuel in 2002 than they did in 1990 and this trend is expected to continue. Airlines are aiming for a 25% fuel efficiency improvement through vehicle design by 2020. Railways can realise large potential savings from light-weighting (up to 20%) and cutting drag and friction (up to 10%). Technology options for reducing energy use in the shipping industry include hydrodynamic improvements and machinery; these technologies could reduce energy use by 5% to 30% on new ships and 4% to 20% on retrofitted old ships (Lane and Vanderschuren, 2009).

Vehicle maintenance is very influential in terms of fuel efficiency. According to estimations, fitting appropriate tyres and maintaining proper tyre pressure can improve vehicle fuel efficiency by more than 5%. Keeping engines properly tuned can save 4%, checking and replacing air filters regularly up to 10% and using the recommended grade of motor oil can save up to 2%. Flight Sciences International indicates that improved maintenance reduces aviation energy consumption between 5% and 10% over the long term (Lane and Vanderschuren, 2009).

Another key area to improving energy efficiency is vehicle renewal practice. This affects the average age of the vehicle fleet, as well as the average size and efficiency of vehicles. Old vehicles should only be replaced with newer, more efficient technologically developed vehicles. The majority of new heavy vehicle engines are electronically controlled, providing a 7% to 15% improvement in fuel economy (Lane and Vanderschuren, 2009).

Vehicles with smaller engines are more fuel efficient, especially in urban areas. It is estimated that the move towards smaller vehicles will reduce total fuel consumption by between 10% and 20%. In freight transport, matching engine size to the required task will give the best fuel economy (Lane and Vanderschuren, 2009).

Economic instruments (taxes, charges or emission trading schemes) can encourage transport users to switch to cleaner vehicles or modes, to use less congested infrastructure or to travel at different times. Price signals are the most effective when the market offers realistic alternatives (e.g. cleaner vehicles at an affordable price or appropriate levels of service in other modes). Fuel prices can influence consumer choice, both in terms of the quantities and the type of fuel purchased (Lane and Vanderschuren, 2009).

7.2 Alternatives to Road Freight Transport

This research has aimed to provide indicative indirect costs for the movement of goods by road freight. The importance of the Johannesburg to Durban Road Corridor, both in terms of the movement of goods and people is critical for the continued socio-economic growth of the South African economy. This section aims to identify possible alternatives to road freight along the N3 freight corridor. Moving freight by rail or water instead of road can help to reduce the environmental impact of logistics, but this may also require large capital expenditure on new facilities.

7.2.1 Rail

Under the right circumstances, freight transport by rail is more economic and energy efficient than by road, especially when carried in bulk or over long distances. Freight trains are less flexible than road transport, and as a result much freight has been transferred from rail to road. The main disadvantage of rail freight is its lack of flexibility. For this reason, rail has lost much of the freight business to road transport.

The volume of freight transported, together with the distance between Johannesburg and Durban offers an opportunity for rail. Whilst there are a number of challenges if rail is considered in isolation, these can be offset against the wider impacts of continuing with the current status quo.

The inability for rail to meet the flexibility of road cannot be disputed. However, the researcher believes that there is an important role that rail can play. The transportation of bulk goods, that are not significantly time sensitive, would be a perfect place to start. This could assist in a phased modal transfer from road to rail, allowing rail infrastructure (including rolling stock) to be upgraded whilst the demand for rail increases.

A decision to promote modal shift from road to rail would need to be backed up by political will, relevant policy and importantly market sustainability. In line with the National Development Plan and South Africa's vision for 2030 it is important to stimulate socio-economic growth and improve business efficiency. The Gauteng– Durban Corridor has received significant attention in recent years and the author believes that sufficient traction currently exists to drive the modal shift forward. Figure 72 presents an extract from the brochure that has been prepared for the 2050 Vision for the Durban – Gauteng Freight Corridor.

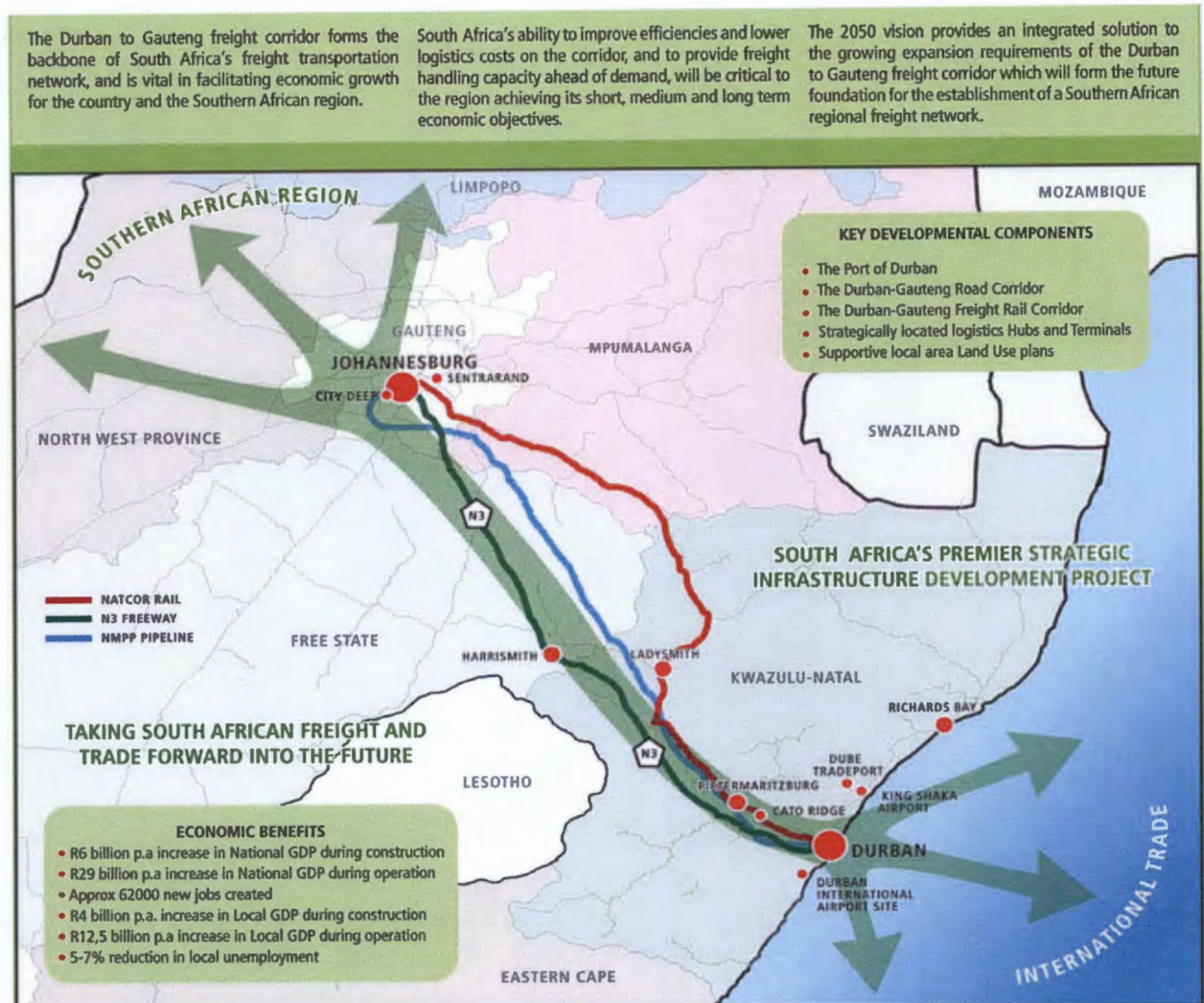


Figure 72: 2050 Vision for the Durban – Gauteng Freight Corridor

Source: NDoT, 2012

In the 2050 vision (NDoT, 2012), rail capacity upgrades are recommended together with possible new rail alignments. In addition to the 2050 vision, the Presidential Infrastructure Coordinating Commission (PICC) has identified 17 Strategic Integrated Projects (SIP's), of which SIP 2 is the Durban- Free State– Gauteng Logistics and Industrial Corridor. The objectives of SIP 2 are to:

- Strengthen the logistics and transport corridor between SA's main industrial hubs,
- Improve access to Durban's export and import facilities,
- Raise efficiency along the corridor,
- Integrate the Free State Industrial Strategy activities into the corridor, and
- Integrate the currently disconnected industrial and logistics activities as well as marginalised rural production centres surrounding the corridor that are currently isolated from the main logistics system.

These high level and strategic objectives provide an important catalyst for the improvement of rail and ultimately the encouragement of a modal shift from road to rail along the N3 freight corridor.

7.2.2 Sea/River Transport

The Port of Durban is the busiest port on the African continent, as it handles the largest number of vessels per annum in comparison to all other African ports (eThekweni Transport Authority, 2005). The port offers a combination of port facilities and services. Transnet Ports Authority, formerly known as the National Ports

Authority (NPA), is the custodian of all the national ports, managing the most vital conduits of the country's imports and exports.

The efficiency of the country's ports and the sustainability of their operating methods are central to the country's larger economy. As the primary conduit for trade, the ports serve as a gateway between Southern Africa and world economies. The Port of Durban is strategically placed on the world shipping routes. The port plays a pivotal role in the life of the city. Forty four per cent of South Africa's break-bulk cargo and 61 % of all containerised cargo flows through the Port of Durban (eThekweni Transport Authority, 2005).

Despite the significant role that the Port of Durban plays within a South African and Southern African context, there is no direct water (river or sea) link between Gauteng and Durban. As such, the viability of a water freight transport system between land locked Gauteng and Durban is not realistic.

7.2.3 Air

The King Shaka International Airport (KSIA), at La Mercy, approximately 30 kilometres north of Durban, was commissioned on 1 May 2010. Adjacent to the King Shaka International Airport is the Dube TradePort. Dube TradePort is a catalyst for global trade and a portal between KwaZulu-Natal and the world. It is the only facility in Africa that brings together an international airport, a cargo terminal, warehousing, offices, a retail sector, hotels, and an agricultural area.

The Dube TradePort Trade Zone is linked to the airport's freight component that provides dedicated space for the imports and exports of high value goods. It is envisaged that the Trade Zone will capture local freight currently utilising the OR Tambo Airport (eThekweni Transport Authority, 2011). In addition, it is forecasted that the freight handling capabilities of the development will attract industries such as motor components, electronics, clothing, textiles and perishables, all of which are dependent on time sensitive travel.

The Dube TradePort is a strategic investment, which intends to serve as a major stimulus for regional economic growth. The key objectives of the Dube TradePort are (eThekweni Transport Authority, 2011):

- To provide new international air services,
- To create platforms for new export supply chains, including high-value manufacturing,
- Support for perishable goods sectors, and
- The establishment of an electronic trading platform and be the incentive for private sector investment in KwaZulu-Natal.

The Cargo Terminal and Perishables Centre will have direct air-side access that will allow for rapid export and import of time-sensitive products. It has the capacity to handle approximately 100 000 tons of cargo per annum in 2010. The facility has the potential to increase its capacity to 400 000 tons should the need arise in the future. The specialist freight-oriented Trade Zone will provide an all-new export environment through which tenants, operators and service industries may achieve high levels of productivity, logistics efficiencies and improved competitiveness.

Dube TradePort is seen as an attractive location for both manufacturing and service-based investment by businesses requiring quick access to air cargo and passenger services, particularly those conducting their business within global value chains.

Similarly to certain goods being better suited to road or rail, air freight transport is a quick way to transport highly time sensitive goods. As such, there is the potential for air freight transport between Gauteng and

Durban to continue to grow given the world class facilities at both airports. However, an increase in the total goods transported via air is not likely to make a significant impact (or decrease) in the volume of goods transported on the N3 corridor due to the niche air freight market.

7.2.4 Pipeline

Transnet Pipelines, formerly known as Petronet, are the custodians of the national pipeline network. The pipeline network is a bulk transporter of liquids and gases. The three major national pipelines that emanate from Durban are (eThekweni Transport Authority, 2011):

- The Refined Products Pipeline from Durban to Sasolburg,
- The Crude line that conveys crude oil from Durban's offshore mooring buoy to the Reef storage and inland refinery, and
- The Gas line from Secunda, via Richards Bay to Durban.

Due to an increase in demand and coupled with the capacity constraints of the existing aging infrastructure, Transnet Pipelines are in the process of constructing a New Multi-Product Pipeline (NMPP) to convey petrol, diesel and jet fuel between Durban and Gauteng. The new pipeline will augment the parastatal's ability to serve the transport needs of the refined petroleum products industry. The NMPP will provide additional capacity to meet forecasted fuel needs of the inland market up to 2030 (eThekweni Transport Authority, 2011).

Pipeline transport is the safest mode for all bulk petroleum products and it is envisaged that this new pipeline will remove a significant volume of road tankers off the road network as these fuels will be transported by the NMPP pipeline.

7.2.5 Rolling Road

In addition to the traditional transport modes in South Africa, rolling road is a possible alternative that combines both road and rail. With this concept, entire trucks are able to drive onto a train and cover large distances by rail thus reducing emissions and enabling drivers to rest. Whilst the concept may be new in South Africa, it is a viable mode elsewhere in the world. One such example is the Okombi. At the Okombi terminals, the trucks are loaded onto special low-loading wagons and then transported by rail. During the ride, the truck drivers can relax in a "recreation wagon" staffed with service personnel.



Figure 73: An example of Rolling Road

Source: Okombi, 2010

Some of the advantages of this intermodal freight transport in a European context are (Okombi, 2010):

- Reduction of fuel and transport mileage,
- Reduction of highway tolls and special tolls,
- Circumvention of night driving bans,
- Circumvention of the 60 km/h speed limit at night,
- Observance of the rest times for drivers without transport interruption,
- Prevention of time losses due to traffic jams,
- Reduction of environmental stress,
- Vehicle tax refund, and
- Positive image in public.

In times of rising fuel prices, there are potential savings that can be achieved from rolling road trips. These include toll charges. In addition, this intermodal freight travel enables the truck driver to rest, whilst the freight travels towards its destination without any time loss. Traffic jams and congestion are also avoided, which further adds to improved travel times for not just freight traffic but also commuters.

Whilst rolling road appears a viable option, it would require significant infrastructure investment, as well as a mind shift. The existing narrow rail gauge is not likely to be suitable for rolling road wagons. Clearance in terms of both height and width would also need to be considered for tunnels and bridges along the route. Additional studies are required to determine the cost of additional infrastructure. However, the results from this study in terms of externality costs could be used to cross subsidise required infrastructure investment.

8 ANALYSIS OF THE ESTIMATED IMPACT ON THE JOHANNESBURG TO DURBAN FREIGHT CORRIDOR

The estimated future impact of indirect costs on the corridor will now be discussed. For comparison purposes, 2012 will be used as a base year and a 31 year horizon period will be considered (i.e. up to 2043). This aligns with the projected demand estimated by Transnet in the SIP 2 demand book. The costs of indirect impacts are directly linked to the amount of freight transported, which in turn is linked to economic growth and activity. As such, the estimated cost of indirect impacts will be directly linked to freight growth projections.

As discussed, transport costs are a significant portion of overall logistics costs. Both total logistics and transport costs are often compared to the GDP of a country to highlight the significance. The indirect costs of road freight on the Johannesburg to Durban corridor will therefore also be compared to the estimated transport costs of the corridor and the GDP of South Africa.

8.1 Current Indirect Costs of Road Freight on the Corridor

The GDP of South Africa in 2012 was R3 136 billion. According to the 10th Annual State of Logistics Survey, the total logistics costs for South Africa in 2012 were R 392 billion, of which the transport costs were R 240 billion (61%). In relation to GDP, logistics costs were 12.5% and transport costs were 7.6% of South Africa's GDP in 2012. In this same document, the total freight tons transported in 2012 were 1 733 mtpa and this amounted to 430 billion ton-km. In order to determine the total estimated transport costs of road freight on the corridor, the estimated total ton-kms transported via road freight on the corridor (21.3 billion ton-km) will be divided by the total ton-kms transported in the country (430 billion ton-km) to obtain a ratio (5%) that can then be applied to estimate transport costs for solely road freight on the corridor. This equates to an estimated transport cost for road freight of R11.9 billion for the corridor. In comparison, the estimated indirect costs of road freight on the Johannesburg to Durban corridor amount to R 9.72 billion over the same period.

These are merely the estimated costs of indirect impacts at present (2012), and it is important to know how future scenarios will affect this value.

8.2 Predicted Indirect Costs of Road Freight on the Corridor for Future Scenarios

To demonstrate the significant impact of indirect costs, a few scenarios have been proposed which consider three factors, namely; modal share, ton-kms transported and road freight improvements. Six scenarios are discussed in which each of these three factors are manipulated to demonstrate the financial impact of indirect costs associated with road freight transport on the Johannesburg to Durban corridor. The six scenarios are summarised in Table 14, and discussed further in the remainder of this chapter.

Table 14: Summary of Scenarios Considered to estimate future financial impact of indirect costs of road freight on the Johannesburg to Durban corridor

Scenario name	Factor A (% annual change in ton-km modal share for road)	Factor B (% annual change in ton-km (road + rail) - linked to GDP)	Factor C (Targeted ultimate % reduction in annual impact of indirect costs)
1). Business as usual	56/44 road/rail to start, with 0.5% p.a growth trends	2.3% p.a	10% reduction as technologies improve
2). Mitigate against impacts	56/44 road/rail to start, with 0.5% p.a growth trends	2.3% p.a	30% targeted reduction in certain indirect impacts due to policy interventions, innovation and green technologies
3). Increase in road freight modal share	56/44 road/rail to start, with 1.0% p.a growth trend assuming rail does not receive required intervention	2.3% p.a	10% reduction as technologies improve
4). Transnet vision	56/44 road/rail to start, with 31/69 road /rail by 2043 (approx. -0.82% p.a)	3.6% p.a	10% reduction as technologies improve
5). Improved economic growth, investment in rail and policy amendments	56/44 road/rail to start, with 40/60 road/rail by 2043 (approx. -0.50% p.a)	2.7% p.a	15% reduction as technologies improve, with targeting of key improvement areas
6). Economic growth in line with NDP targets (5%), investment in rail and policy amendments	56/44 road/rail to remain constant throughout period	5.0% p.a	15% reduction as technologies improve, with targeting of key improvement areas

In determining the estimated indirect costs of road freight on the Johannesburg to Durban corridor, the following general notes and assumptions were considered:

- The total freight transported via road on the corridor in 2012 is 77 mtpa (Transnet, 2014)
- The total freight transported via rail on the corridor in 2012 is 27 mtpa (Transnet, 2014)
- The average trip distances for road (277km) and rail (625km) on the corridor were determined using the corridor's freight distance distribution in the Transnet SIP2 Demand Book. For calculation purposes, it was assumed that all rail trips were over the entire length of the corridor (average of 625km). The remaining tonnage (all via road) was then apportioned according to the distance distribution for volumes and an average trip distance determined.
- It should be noted that ton-km is used for comparison purposes for modal splits rather than total tonnage as the indirect costs are based on a value per ton-km.
- Proposed % reduction in impacts (Factor C) is proposed due to numerous initiatives, some of which are ongoing like green technologies and other which may need to be targeted, such as policy. It is assumed that the impact of this reduction will increase over time, and as such, an end horizon period goal or target is set. The incremental improvements (equivalent to an overall reduction in indirect road freight costs) were compounded annually.

A summary of the relevant indicators for the final year in the horizon period (2043) is provided in Table 15 for each scenario.

Table 15: Comparison of base year (2012) to final year (2043) for each Scenario

Description	Base Year	Year 2043					
	2012	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Total (road + rail) ton-km on corridor (billion)	38	77	77	77	114	87	173
% ton-km modal share (road)	55.8%	71.3%	71.3%	86.8%	30.5%	40.3%	55.8%
Road ton-km on corridor (billion)	21	55	55	67	35	35	97
Indirect cost of road freight on the corridor at 2012 Rand value (R billion)	9.7	25.1	25.1	30.6	15.9	16.0	44.1
% reduction target over period on indirect impacts	0%	10%	30%	10%	10%	15%	15%
Indirect cost of road freight on the corridor at 2012 Rand value (R billion) after adjustment for technological advancements / improvements	9.7	22.6	17.6	27.5	14.3	13.6	37.5
Estimated GDP at 2012 Rand value (R billion)	3 136	6 346	6 346	6 346	9 387	7 162	14 231
Road freight indirect costs on corridor as a % of GDP	0.31%	0.36%	0.28%	0.43%	0.15%	0.19%	0.26%

The output of the various scenarios over the time period (2012 – 2043) is provided in Figure 74.

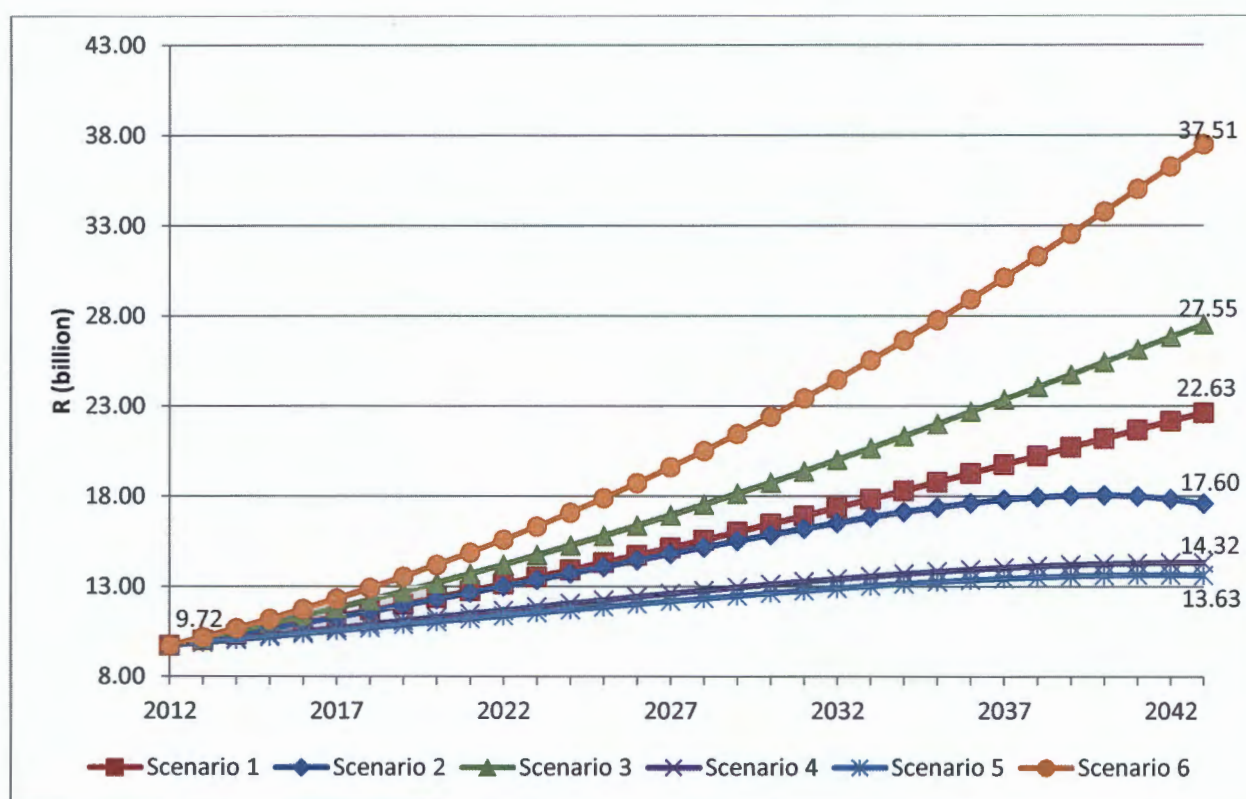


Figure 74: Projected costs (R billion at 2012 prices) of indirect impacts of road freight on the Johannesburg to Durban corridor for various scenarios

From a base year cost of R 9.72 billion in 2012, the indirect impacts of road freight transport on the Johannesburg to Durban corridor are estimated to range between R 13.63 billion up to R 37.51 billion in 2043.

8.2.1 Scenario 1 – Business as Usual

The business as usual scenario considers that there will be minimal investment in infrastructure (rail in particular) together with no major policy changes, and as such modal shift trends are likely to remain as they currently are. From a starting point of 56/44 (road/rail), this scenario assumes a growth in road freight modal share of 0.5% per year.

The growth in total ton-km of freight transported is similar to GDP and comparable to total growth in ton-kms as reported by the latest available Annual State of Logistics Survey (CSIR, 2014). A value of 2.3% per annum is allocated to signify a growth in total freight transport on the corridor. Road continues to be the dominant mode and increases its modal share.

Factor C signifies the industry (and in fact global trend) for all business to be more efficient and effective over time. Whilst it is very difficult to identify a specific value for these improvements, the savings over an extended period can be significant and as such must be considered. Over the 31 year period, Scenario 1 assumes that natural market improvements will lead to a 10% reduction as technologies improve and the green economy receives greater importance.

For every ton kilometre of freight transported via road, there is an additional externality cost of 45.61 South African cents which is not accounted for by the road freight industry. If the current situation continues as is, and assuming minimal change in existing modal share by 2043 the total indirect cost arising due to road freight on the Johannesburg - Durban Corridor alone would be in the order of R 22.63 billion annually, in 2012 prices.

By 2043, the modal share (in ton-km) of road freight has increased to 71.3% which equates to an estimated 55 billion ton-km of road freight. The significance of the indirect road freight costs is demonstrated by the estimated percentage in comparison to GDP, which in this instance is 0.36% for the Johannesburg to Durban road freight corridor alone.

8.2.2 Scenario 2 – Mitigate Against Impacts of Road Freight

This scenario is similar to business as usual; however it specifically targets a reduction in the indirect impacts. These impacts could include some if not all of the interventions discussed in Chapter 7 of this document. It is also accepted that it will take time for the overall industry to participate in these mitigation measures and as such the target at the end of the horizon period is 30%. In order to ensure this achieves success, it will require amendments to existing policies and potentially new policy that addressing multiple challenges currently facing the road freight sector.

Through targeted improvements there can be a significant reduction in indirect costs of road freight. If 30% (with all else remaining equal) can be achieved by 2043, the indirect cost of road freight on the corridor could reach R 17.6 billion per year in 2012 prices, which equates to 0.28% of GDP.

8.2.3 Scenario 3 – Increase in Road Freight Modal Share

This scenario is similar to the business as usual case; however it assumes a more aggressive growth (1% p.a.) in modal share for road freight. This could take place if sufficient improvements are not made on the rail network, together with increased operational efficiencies.

Over the horizon period, the modal share of road freight on the corridor increases to almost 87% or 67 billion ton-km. This is in excess of three times the current levels on the corridor. The total estimated indirect cost of road freight in 2043 on the Johannesburg to Durban corridor is R 27.5 billion, in 2012 prices, which equates to 0.43% of estimated GDP.

8.2.4 Scenario 4 – Transnet SIP 2 Demand

The Transnet SIP 2 Demand book proposes a likely scenario, as discussed in Section 3.3.9. Whilst this is termed 'likely' by Transnet it has major assumptions on modal split and looks to not only balance tons moving in either direction, but also increases the total tons moved by rail. A total of 241 mtpa are projected to move on the corridor, 120 mtpa via road and 121 mtpa via rail or a 50/50 split in terms of tons. This translates to a modal share in terms of ton-kms for road freight of 30.5% or 35 billion ton-km. This represents a decrease over time in comparison to what is currently experienced on the corridor. Whilst there is a significant decrease in modal share (-0.82% p.a.), a higher estimated economic growth path results in more total freight being moved and as such still a substantial increase (64%) in actual ton-kms of road freight on the corridor. The estimated total indirect cost of road freight in 2043 is R 14.3 billion in 2012 prices, which equates to approximately 0.15% of the estimated GDP in 2043.

8.2.5 Scenario 5 – Improved Economic Growth, Investment in Rail and Policy Amendments

This scenario considers a marginal increase in GDP from 2.3% (Scenario's 1, 2 and 3) to 2.7% coupled with a modal shift from road to rail. The modal shift to rail is indicated as a negative growth factor of -0.5% p.a. for road. Over the 31 year horizon period this results in a modal share for road freight of 40.3% on the Johannesburg to Durban corridor by 2043. An increased focus on targeted efficiency improvements indicate a target of a 15% decrease in indirect costs over the horizon period. All of this culminates in a total indirect cost of road freight on the Johannesburg to Durban corridor of R 13.6 billion in 2043, in 2012 prices. This is estimated to be approximately 0.19% of the estimated GDP in 2043.

8.2.6 Scenario 6 – Economic Growth Achieves NDP Targets

This scenario is the most aggressive in terms of projected economic growth and is related to the national targets of 5% per year as identified in the National Development Plan. Whilst economic growth is key to drive job creation and a number of other social impacts, it does lead to increased strain on the transport network. To demonstrate this impact, the current modal share of 56/44 road/rail is maintained constant over the horizon period. It is estimated that road freight on the corridor will reach a total of 97 ton-kms by 2043. The estimated indirect cost, in 2012 prices, is R 37.5 billion in 2043, and equates to 0.26% of the estimated GDP in 2043.

9 FINDINGS

9.1 Current Indirect Costs

Chapter 8 identified that the current estimate of the costs associated with the indirect impacts of road freight on the Johannesburg to Durban Freight Corridor are R 9.72 billion. When compared to the estimated direct costs of R 11.9 billion along the corridor, the indirect costs are significant at 82% of the direct costs. Furthermore, the cost of the indirect impacts equate to 0.3% of South Africa's GDP.

The 10th Annual State of Logistics Survey noted that externality costs amounted to a total of R40 billion in 2012 for the entire Country. Based on the research undertaken, this is deemed to be a very conservative estimate as the road freight transported on the corridor is 4.4% of the Country's total ton kilometres, yet is accountable for 24.3% of the Country's external transport costs.

The main differences between the value estimated in the 10th Annual State of Logistics Survey and this study, is that more indirect impacts have been considered (i.e. overloading and decline in rail infrastructure), and the cost per ton kilometre of exhaust emissions and air pollution has been increased to be more in line with European literature, as it is assumed that South Africa will begin to value this indirect impact higher in future.

These are merely the estimated costs of indirect impacts at present (2012), and it is imperative to consider what effect future growth scenarios will have on the costs associated with the indirect impacts

9.2 Predicted Indirect Costs

At present the 2012 scenario estimates that the indirect costs are R9.7 billion, which comprise 0.31% of GDP. Table 16 summarises the results of the analysis presented in Chapter 8.

Table 16: The current and future costs and percentages of GDP for the corridor's indirect impacts based on growth scenarios

Scenario name	Indirect cost in 2043 (R billion in 2012 prices)	Percentage of projected GDP in 2043
1). Business as usual	22.6	0.36%
2). Mitigate against impacts	17.6	0.28%
3). Increase in road freight modal share	27.5	0.43%
4). Transnet vision	14.3	0.15%
5). Improved economic growth, investment in rail and policy amendments	13.6	0.19%
6). Economic growth in line with NDP targets (5%), investment in rail and policy amendments	37.5	0.26%

The following findings are noted:

- **Scenario 1:** It is clear that a do-nothing/business as usual approach will only see the current scenario worsen in terms of the ability to transport goods effectively and efficiently. The indirect costs increase by 12.9 billion over the 31 year horizon at a compound annual growth rate (CAGR) of 2.8%, while the percentage of GDP increases at a CAGR of 0.5%.
- **Scenario 2:** The mitigation of impacts results in a lesser increase, in comparison to Scenario 1, of the indirect costs at a CAGR of 1.9%.
- **Scenario 3:** The increase in road freight modal share has a significantly worse impact on the indirect costs, with an increase to R 27.5 billion in 2043, at a CAGR of 3.4%.

- **Scenario 4:** The Transnet vision results in a lesser increase of R 4.6 billion over the 31 year horizon, at a much lower CAGR of 1.3%. This scenario also has the lowest share of GDP at 0.15%.
- **Scenario 5:** This scenario results in an increase of R 3.9 billion in indirect costs, the lowest of all scenarios, at a CAGR of 1.1%.
- **Scenario 6:** This scenario results in the highest increase in indirect costs; R 27.8 billion at a CAGR of 4.5%. However, the percentage of GDP reduces to 0.26%.

It is apparent when comparing the scenarios that the mitigation of impacts will reduce the indirect costs, as identified by Scenario 2. The biggest mitigating factor of all is the modal shift from road to rail, as modelled in Scenarios 4 and 5. However, it is imperative to note that Scenario 4, which is based on the SIP 2 Demand Book, is unconstrained and therefore assumes that sufficient products and infrastructure exist to achieve this scenario. Furthermore, the large increase in indirect costs in Scenario 6 can be attributed to the NDP's higher economic growth rate target of 5% for GDP, and the reliance on increased freight movements to achieve this target. However, the indirect costs as a percentage of GDP decrease, and this is due to investment in rail as well as policy amendments.

10 CONCLUSIONS AND RECOMMENDATIONS

This chapter discussed conclusions and recommendations of the study. The initial research questions as identified in Section 1.4 are first discussed. Concluding remarks on the research is then provided, together with recommendations on the application of this investigation and further research areas are also identified.

10.1 Research Questions

In order to achieve the objectives of the study, research questions were posed. This section provides conclusions and recommendations for each research question.

What is the status quo of freight transport in a global, South African and Johannesburg to Durban Freight Corridor context?

As the largest freight transport system in the world, the United States transportation network serves more than 300 million people and 7.5 million businesses across almost 10 million square kilometres of land. The freight network enables the movement of raw materials and finished product between production and consumption centres and is a vital component of commerce in the United States. Between 1998 and 2008, world merchandise freight exports nearly tripled in value from \$5.4 trillion to \$16 trillion. During the same period, US freight exports almost doubled from \$682 billion to \$1.3 trillion (US Department of Transportation, 2010).

The rising trend in world exports indicates the strong connectivity among countries and the increased globalisation of economic activities that generate freight movements. Almost all countries export goods, and the United States receives exports from more than 200 countries; however, the overwhelming majority of global exports are concentrated in only a few countries. In 2008, the concentration of world exports among the top trading nations was significant (US Department of Transportation, 2010):

- More than half (51%) of the exports were from 10 countries,
- Three-quarters (76%) were from 25 countries, and
- Approximately 91% were from the top 50 countries.

In 2008, the global economic downturn had a significant impact on freight. This can be justified as freight is generated by economic activity and therefore responds to global financial market fluctuations. Prior to 2008, the main challenge experienced by the freight sector was the significant growth in trade that resulted in capacity constraints within the freight system. From 2009 onwards the challenge has been to manage the excess capacity as a result of freight businesses contracting in tough financial times due to reduced trade volumes. By the end of September 2009, there were an estimated 548 container vessels with a carrying capacity of 1.3 million 20-foot equivalent units (TEUs) that were idle at seaports worldwide due to the decline in global demand for containership services (US Department of Transportation, 2010).

The United States is used as an example of international freight transport. Most goods are moved via truck (in terms of total tonnage as indicated in Figure 75), however the amount of freight moved by rail is comparable when one considers the amount (weight) multiplied by distance as measured in ton-kilometres (pictured in Figure 76). It should be noted that the multimodal category includes the traditional intermodal combination of truck and rail plus truck and water; rail and water; parcel, postal and courier service; and other multiple modes for the same shipment (US Department of Transportation, 2009).

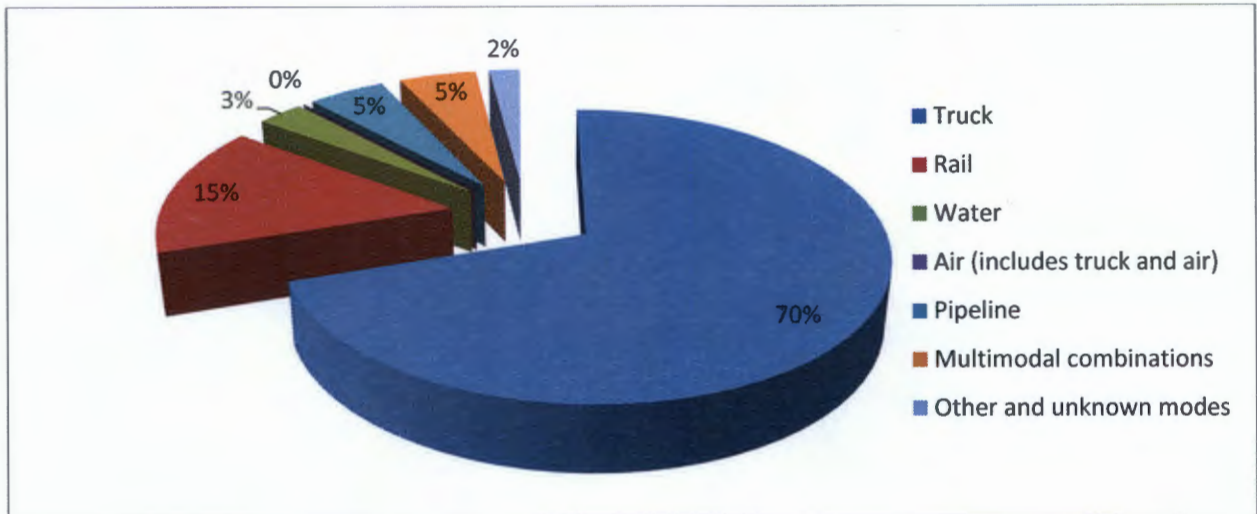


Figure 75: Freight distribution among modes by tons in 2007
 Source: United States Department of Transportation, 2009

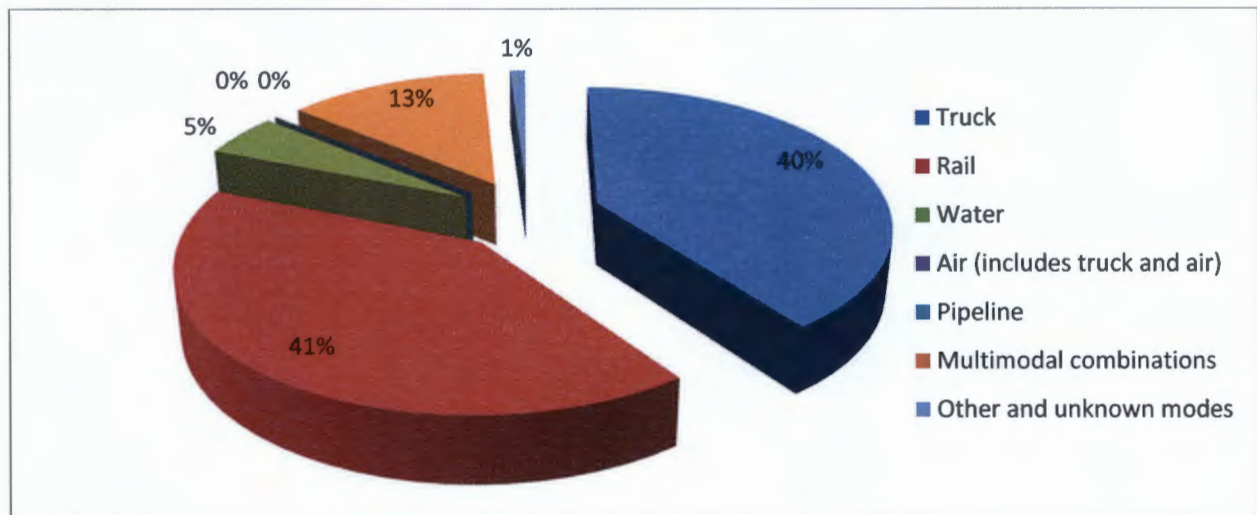


Figure 76: Freight distribution among modes by ton-kilometres in 2007
 Source: United States Department of Transportation, 2009

Between 1993 and 2007, freight transportation (total ton-miles) in the US grew by over 38%. A significant amount of this was due to the increase in truck ton-miles. The increase in road freight is due to cost competitiveness and the advent of just-in-time (JIT) inventory management.

When considering the status-quo of South African freight, the mode structure of the freight transport market is not sustainable, and forecasts indicate that freight transport demand will continue to grow well into the future. In 2008 it was reported that South Africa generates 0.4% of the global GDP, but consumes 2.2% of the world’s ton-kilometre and 6% of maritime ton-miles (CSIR Built Environment, 2008). The current status of freight transport in South Africa has been attributed to the geographical conditions. The possible freight choices in South Africa are still largely dependent on the topology, which will continue to impact on the future strategies for freight transport. Current freight modes include road, rail, sea, pipeline and air.

South Africa’s sea routes are not well developed for domestic shipping; this is due to relatively high terminal costs, limited vessel and terminal capacity, and inclement weather conditions. Air transport is more prevalent in economies that are more advanced, but this is not yet the case in South Africa. Pipeline transport is increasing with the replacement and expansion in capacity of Transnet’s Durban to Johannesburg Pipeline (DJP) which transports refined petroleum products (petrol, diesel and jet fuel) from

refineries in Durban, as well as imports of refined petroleum products from the storage facilities at Island View, in the Port of Durban (CSIR Built Environment, 2008).

The primary alternatives for freight transport in South Africa are therefore road and rail, contributing 99% to all logistics costs. According to the CSIR Built Environment (2008), the remaining 1% of costs is associated with other modes (0.08% with air, 0.29% with coastal shipping and 0.69% with pipelines). Due to this, road and rail freight transport were investigated further in the study due to their significant share in the South African freight industry.

Close to 1.6 billion tons of freight was observed in the four different categories (corridor, rural, metropolitan and bulk mining) in South Africa in 2007 (CSIR Built Environment, 2008). A comparison of the road and rail categories for tonnage and ton-kilometre in 2007 are displayed in Figure 77 and Figure 78. Almost 1.4 billion tons was observed on road at an Average Transport Distance (ATD) of 178 km, delivering 245 billion ton-kilometre. Rail only contributed 205 million tons at an average transport distance of 629 km, delivering 129 billion ton-kilometre (CSIR Built Environment, 2008). The market share split for road and rail by tons transported thus stands at 87/13. This is an unsustainable situation, and alternative viable intermodal solutions are required.

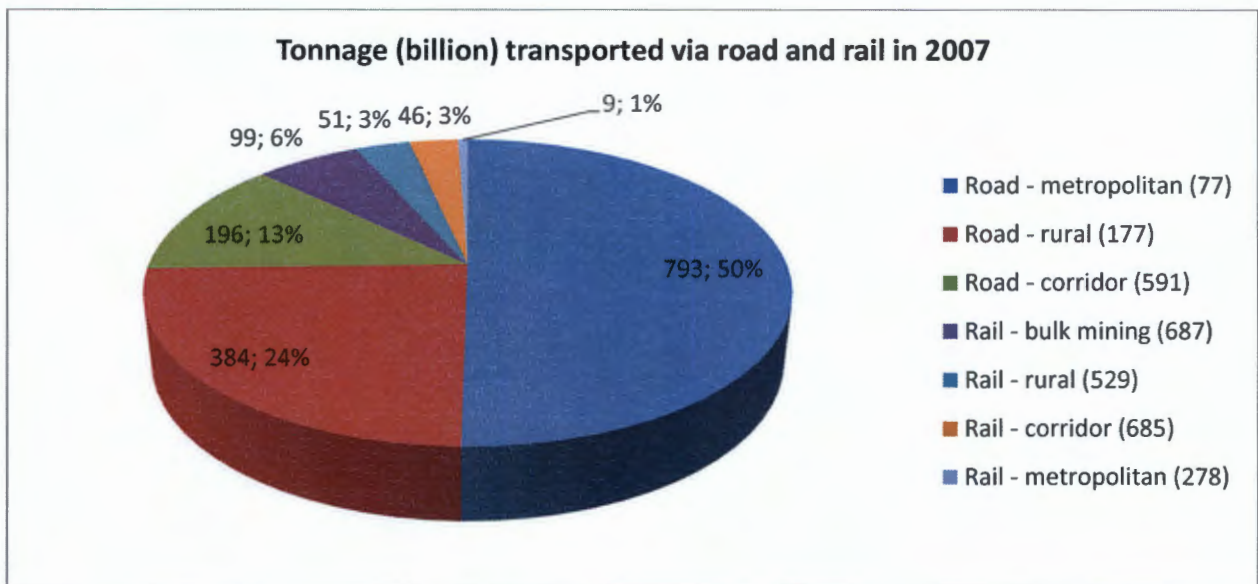


Figure 77: Tonnage (billion) transported via road and rail in 2007, (*) indicate average transport distance (km)
 Source: CSIR Built Environment, 2008

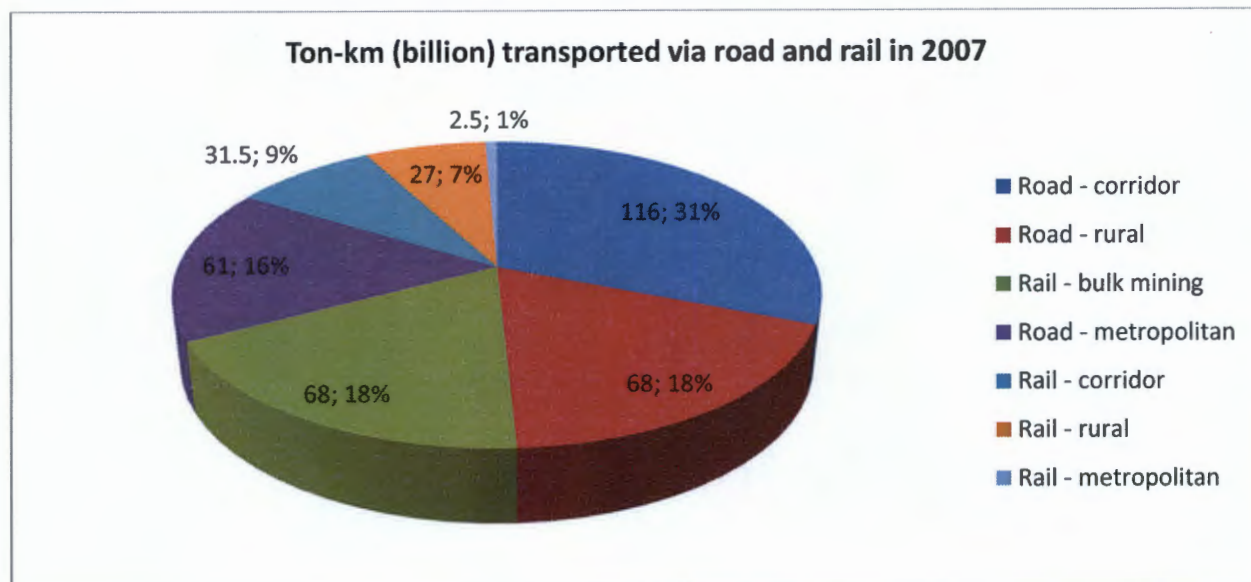


Figure 78: Ton-km (billion) transported via road and rail in 2007

Source: CSIR Built Environment, 2008

The Johannesburg to Durban corridor connects the land locked and major economic node of Gauteng to the strategic Port of Durban. This route is therefore of significant economic importance to the country. In addition to freight transportation, it also creates a transport linkage for commuters. As a result of Gauteng being land locked, the significant trends focus only on road and rail freight modes. The following trends on the Johannesburg to Durban Freight Corridor were reported by the Department of Transport in the National Freight Logistics Survey (2005):

- The required capacity for the Johannesburg to Durban corridor was projected to reach 57 million tons in 2020. However by 2004, the corridor was already operating at 53 million tons and given recent growth rates, was expected to grow by a further 38% prior to 2020.
- Less than 20% of the goods transported along this corridor can be transferred to other ports. Therefore, 80% of goods destined for Durban are either for local consumption or it would not be economically efficient to export from an alternative port. With the serious implications of this high freight load on the sustainability of this corridor, alternative strategies are required to provide additional capacity.
- The operational capacity of rail was estimated at 20% of the installed capacity, with delays at marshalling yards on route to the port of Durban impacting severely on the competitiveness of rail. Other infrastructure constraints, such as different electric currents, which require four locomotive changes and the age of rolling stock, continue to reduce efficiency and increase operating costs.
- Traffic flows are not balanced in each direction, with greater demand on the infrastructure for the Johannesburg to Durban journey, than from Durban back to Johannesburg.

The KZN DoT has stated that certain sections of the N3 corridor between Johannesburg and Durban are relatively congested and in some locations there is a high vulnerability to lengthy delays for example through Van Reenen's Pass, due to accidents and poor weather. The rail network parallel to this route is, however, operating at approximately 35% capacity (KZN DoT, 2004). With maintenance and improvement efforts on the road network unable to keep up with the growth in freight traffic, investment in the rail network could play an important role in alleviating congestion in major freight corridors.

What are the future growth forecasts for freight on the Johannesburg to Durban corridor?

The SIP2 Demand Book has been specifically developed for the Johannesburg to Durban corridor by Transnet (2014). A summary of the future growth forecasts for road and rail freight on the corridor is provided in Table 17.

Table 17: Summary of projected freight growth on the corridor

Direction	Mode	2012 volume (mtpa)	2043 volume (mtpa)	Average annual change
Johannesburg to Durban	Rail	20	68	8%
	Road	33	49	1.5%
Durban to Johannesburg	Rail	7	53	21%
	Road	44	71	1.9%

Overall, the freight profile shows that all freight flows, irrespective of origin, destination, or distance travelling on the corridor, is forecast to increase by 186% by 2043 (Transnet, 2014). This translates into an average annual growth rate of 3.4%. General freight growth rates are closely linked to economic growth, and as such should the South African economy succeed in growing at a higher rate there is likely to be an impact on the growth in freight volumes as well.

It is evident that volumes moved via road are significantly higher than volumes moved by rail. In the general direction of Gauteng to Durban (and back) road transported about 75% of all freight in 2012. According to Transnet's Freight Demand Model this percentage is forecast to decline to 63% by 2043. In turn, in 2012 there was an uneven spread between rail freight flowing from Gauteng to Durban and vice versa with just more than 72% of rail freight flowing from Gauteng to Durban and less than 28% in the reverse direction. This situation is forecast to become more balanced in 2043. In addition, road freight is more evenly distributed in each direction.

What is the significance of freight transport in South Africa?

The Council for Scientific and Industrial Research (CSIR, 2014) reported that logistics costs in South Africa for 2013 were R423 billion or 12.5% of Gross Domestic Product (GDP). The transportation cost component is 61.6% of the total logistics costs, which is much higher than the world average of 39% (CSIR Built Environment, 2008). Havenga (2010) cites numerous sources which indicate that South Africa's logistics costs, as a percentage of GDP, are high in global terms.

- Bowersox and Closs (1996) calculated an average for industrialised nations of 11.7%.
- According to the United Nations (2002), Japan's logistics costs are about 10% of GDP, while in the USA, the figure was 10.1% in 2007 (Wilson, 2008).
- For some less-developed economies, these costs exceed 30%. Moreover, the differences between countries appear to be widening (Bowersox and Closs, 1996).

Does the reported total cost of road freight transport take into account a holistic approach when determining the costs?

The 2013 logistics costs for South Africa are reported in the 10th Annual State of Logistics Survey (CSIR, 2014). The four components measured are transport; inventory and carrying cost; management, administration and profit; and storage and port handling, as pictured in Figure 79.

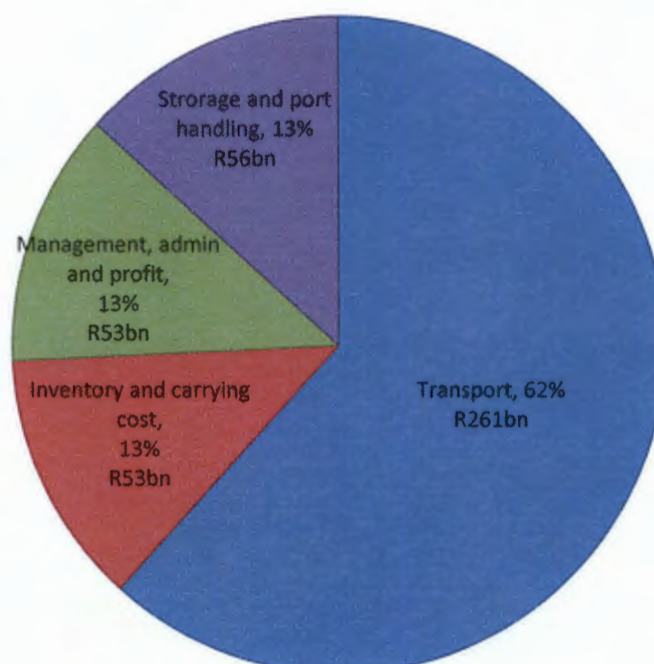


Figure 79: South Africa's logistics cost components in 2013

All modes of transport account for 62% of logistics costs or R 261 billion annually in South Africa. Although the 10th Annual State of Logistics Survey estimated the total cost of transport externalities (indirect costs) would add a further R40 billion to this amount in 2012, the reported total cost of road freight transport does not include this value. Therefore, the reported total cost of road freight transport does not take into account a holistic approach when determining costs

How are direct and indirect impacts of road freight transport defined, and how do they differ?

Direct impacts refer to costs borne by the owner or operator of the freight companies, whereas indirect impacts arise when the social or economic activities of one group of persons (i.e. freight companies) have an impact on another group and when that impact is not fully accounted, or compensated for, by the first group (European Commission Community Research, 2003).

What are the direct and indirect impacts of road freight transport?

The direct impacts of road freight consist of the following elements (Havenga, 2010):

- Transport costs,
- Storage and port handling costs, and
- Management and administration costs.

The indirect impacts identified in this study are:

- Accidents,
- Congestion,
- Energy efficiency and resource consumption,
- Exhaust emissions and air pollution,
- Noise pollution,
- Traffic enforcement, and
- Uptake of land.
- Overloading,

- Social, and
- Decline in rail infrastructure.

Various sources were utilised in determining these impacts, as discussed in detail in Section 5.1.

What method can be used to assess the total indirect costs of all associated impacts?

Not all of the indirect impacts are measured by a monetary value, and as a result, a conversion of these costs into a monetary value is required in order to assess the total indirect costs. This is facilitated through the application of shadow pricing. Shadow pricing has a number of different definitions depending on the application. These include, but are not limited to the following:

- The Australian Graduate School of Management (2006) define that the shadow price method, *“better approximates the true opportunity cost or marginal valuation of a product or resource or service.”*
- A frequently used site for the accounting industry describes shadow pricing as, *“the assignment of a price to an intangible item for which there is no ready market from which to derive a price. Shadow prices are most commonly used in cost-benefit analyses where some elements of the analyses cannot be quantified by reference to a market price or a cost.”* (Accounting Tools, 2015)

For the purpose of this investigation, shadow pricing has been defined as the method whereby monetary costs are associated with the indirect impacts of road freight transport. In order for this information to be meaningful, a standard unit, ton kilometres, has been used.

What are the estimated costs of the indirect impacts of road freight transport on the Johannesburg to Durban Freight Corridor?

Based on the literature sourced during the investigation, the total costs of the various indirect impacts of road freight in South African cents per ton kilometre (base year of 2012) have been determined. These are summarised in Table 18.

Table 18: Summary of road freight costs in South African cents per ton kilometre

Indirect Impact	Cost
Accidents	8.60
Congestion	1.92
Energy efficiency and resource consumption	2.75
Exhaust emissions and air pollution	12.78
Noise pollution	3.92
Traffic enforcement	2.99
Uptake of land	1.00
Overloading	11.43
Social	0.00
Decline in rail infrastructure	0.22
Total	45.61

The total additional cost per ton kilometre for road freight transport has been determined as 45.61 South African cents. This is the cost which is not borne directly by road freight operators. Figure 80 provides an indication of the percentage contribution of each cost factor to additional road freight transport costs.

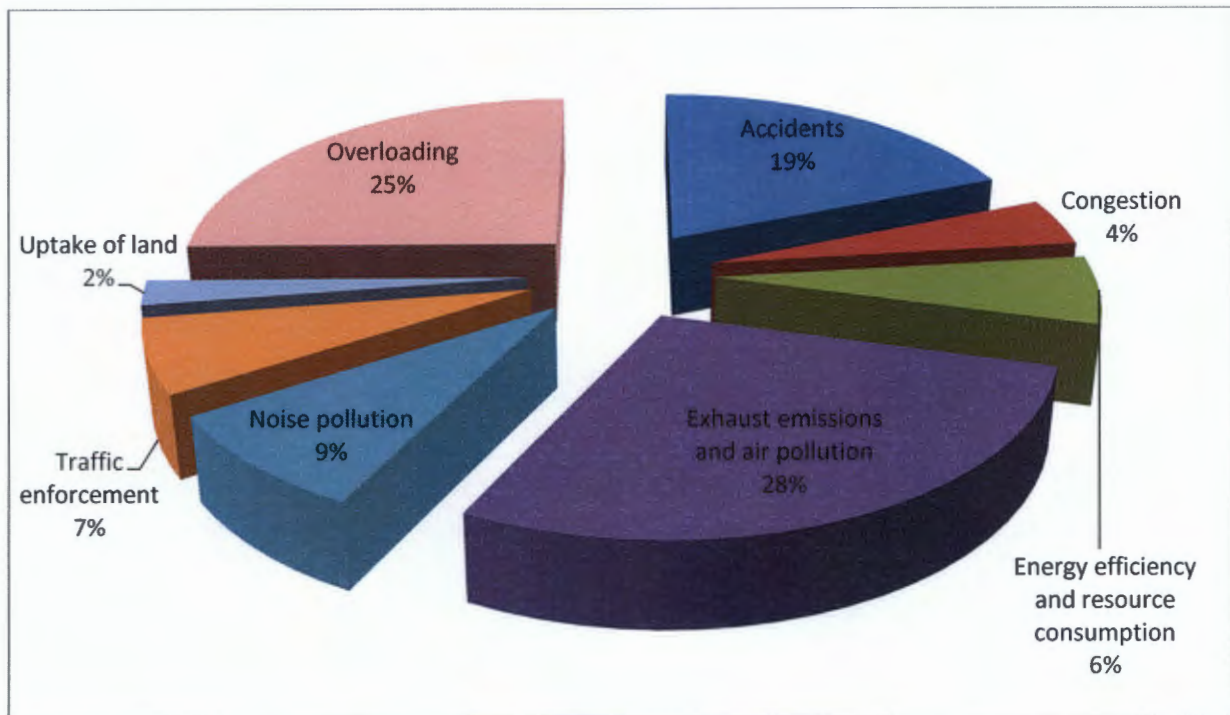


Figure 80: Estimated percentage contribution of each cost factor to additional road freight transport costs

Exhaust emissions and air pollution (28%), and the damage resulting from overloaded heavy vehicles (25%) are the largest contributors to the external impacts of road freight transport. This is followed by accidents (19%), noise pollution (9%), and traffic enforcement (7%). Energy efficiency and resource consumption contributes an estimated 6%, while congestion and uptake of land contribute 4% and 2% respectively.

Transnet (2014) state that a total of 21.3 billion ton-km were transported by road in 2012 along the Johannesburg to Durban Freight Corridor. At a cost of 45.61 cents per ton-km, this equates to R 9.72 billion in unaccounted costs that the road freight sector along the corridor is responsible for on an annual basis. When compared to the estimated direct costs of R 11.9 billion along the corridor, the indirect costs are significant at 82% of the direct costs. Furthermore, the cost of the indirect impacts equate to 0.3% of South Africa's GDP.

What are possible mitigation measures for the indirect impacts of road freight transport?

The research highlights key interventions which will enable road freight transport to become as sustainable as possible, irrespective of policy interventions or significant modal shifts. A sustainable concept is identified as having three main pillars, which are critical to the success of a structure (Schreyer et al, 2004):

- An improved pricing system that takes into consideration the external costs of different modes (user pays principle),
- Additional non-pricing instruments, which support the reduction of environmental and accident costs, and
- An institutional framework which facilitates sustainable investment decisions on infrastructure provision.

The following measures have been identified to mitigate against the indirect impact of road freight:

- Emission Reduction Strategies, including (Baker et al, 2009):
 - Decrease aerodynamic drag,

- Driver behavior,
- Hybrid and electric vehicles, and
- AMT and DCT transmissions.
- Policy Changes:
 - Diversified energy for transport,
 - Modal Shift Policies,
 - Overtaking bans,
 - Road Pricing,
 - Intermodal Freight Transport Systems, and
 - Improved Traffic Management.
- Alternative fuels and propulsion systems; and
- Energy efficiency improvement measures.

In addition to the above, a critical note is that an integrated approach to developing a Sustainable Freight Strategy (SFS) is required to ensure overall success. For example, if a SFS focuses on pricing only, the full benefits intended through this implementation will not be achieved, as there could be unintended adverse effects elsewhere in the transportation system. However, if one SFS measure (such as pricing) is introduced in conjunction with another SFS measure (such as a time related ban for road freight on major freeways), then these two measures/policies could result in a greater good than if implemented separately. It is also important to consider cross-mode strategies in order to avoid 'negative' modal shifts, for example from road freight to air freight.

What will the estimated costs of the indirect impacts of road freight transport on the Johannesburg to Durban Freight Corridor be in over a 30-year horizon, when considering future projections and possible mitigation measures?

To demonstrate the significant financial impact of indirect costs, six scenarios are presented in the investigation and summarised in Table 19.

Table 19: Comparison of base year (2012) to final year (2043) for each Scenario

Description	Base Year	Year 2043					
	2012	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Total (road + rail) ton-km on corridor (billion)	38	77	77	77	114	87	173
% ton-km modal share (road)	55.8%	71.3%	71.3%	86.8%	30.5%	40.3%	55.8%
Road ton-km on corridor (billion)	21	55	55	67	35	35	97
Indirect cost of road freight on the corridor at 2012 Rand value (R billion)	9.7	25.1	25.1	30.6	15.9	16.0	44.1
% reduction target over period on indirect impacts	0%	10%	30%	10%	10%	15%	15%
Indirect cost of road freight on the corridor at 2012 Rand value (R billion) after adjustment for technological advancements / improvements	9.7	22.6	17.6	27.5	14.3	13.6	37.5
Estimated GDP at 2012 Rand value (R billion)	3 136	6 346	6 346	6 346	9 387	7 162	14 231
Road freight indirect costs on corridor as a % of GDP	0.31%	0.36%	0.28%	0.43%	0.15%	0.19%	0.26%

The output of the various scenarios over the time period (2012 – 2043) is provided in Figure 81.

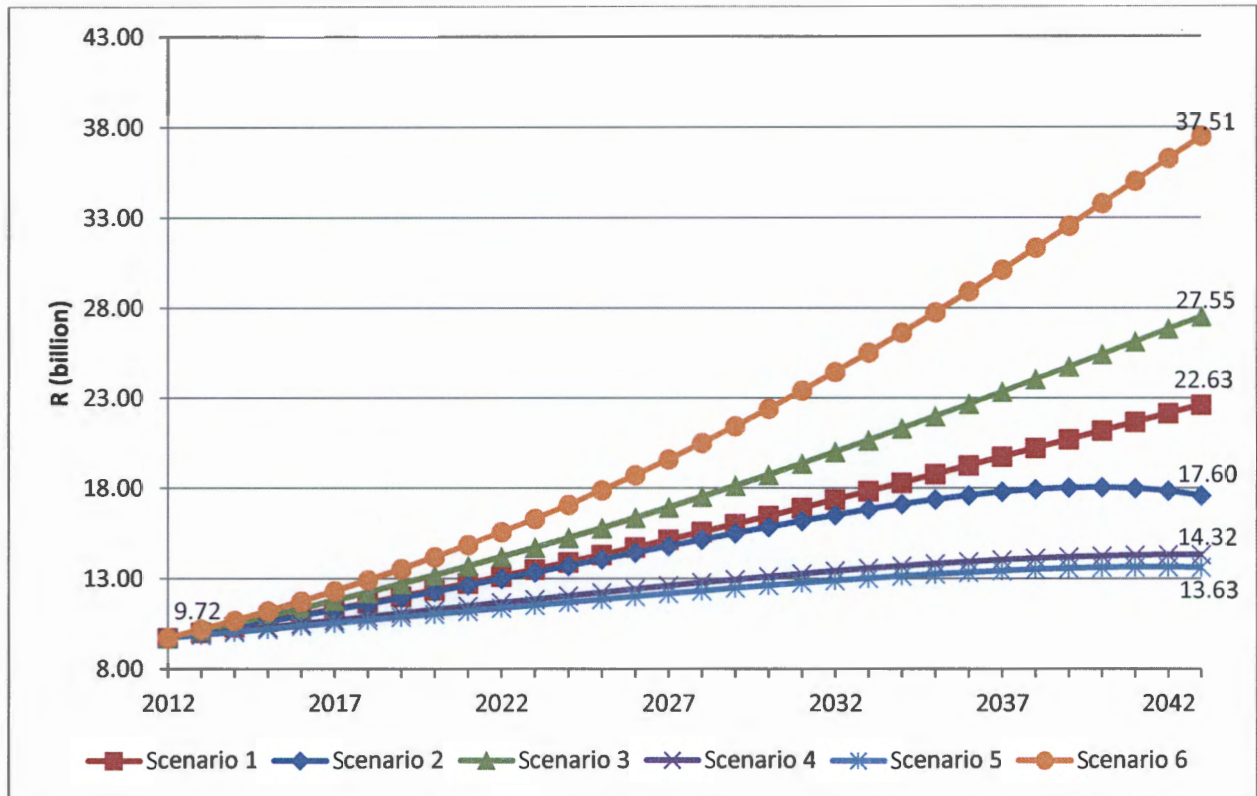


Figure 81: Projected costs (R billion at 2012 prices) of indirect impacts of road freight on the Johannesburg to Durban corridor for various scenarios

It is apparent when comparing the scenarios that the mitigation of impacts will reduce the indirect costs, as identified by Scenario 2. The biggest mitigating factor of all is the modal shift from road to rail, as modelled in Scenarios 4 and 5. However, it is imperative to note that Scenario 4, which is based on the SIP 2 Demand Book, is unconstrained and therefore assumes that sufficient products and infrastructure exist to achieve this scenario. Furthermore, the large increase in indirect costs in Scenario 6 can be attributed to the NDP’s higher economic growth rate target of 5% for GDP, and the reliance on increased freight movements to achieve this target. However, the indirect costs as a percentage of GDP decrease, and this is due to investment in rail as well as policy amendments.

What are the alternative modes to road freight transport on the Johannesburg to Durban corridor?

This research has provided indicative indirect costs for the movement of goods by road freight on the Johannesburg to Durban corridor. The importance of the corridor, both in terms of the movement of goods and people, is critical for the continued socio-economic growth of the South African economy. The following freight transport modes have been considered as an alternate to road:

- Rail;
- Sea/river transport;
- Air;
- Pipeline; and
- Rolling road.

Due to the geographic conditions of the Johannesburg to Durban corridor, together with the type of freight transported there are currently only three primary suitable modes, which are road, rail and pipeline. A combination of these (known as an intermodal solution) could also be effective if applied in the correct conditions and with the appropriate policy interventions.

10.2 Improvements to the Investigation

Improvements to the investigation are centred on the data used in the analysis procedure. In some cases, the data regarding the costs associated with indirect impacts is non-specific to South Africa, or in particular, the Johannesburg to Durban Freight Corridor itself. Other impacts, such as the social impacts, which were excluded from the analysis due to a lack of information, should be further researched and assigned costs using the shadow pricing method.

10.3 Further Application of the Investigation

Given the nature of the investigation, it can be used as a basis for further investigations:

- The investigation can be expanded to include indirect costs associated with rail and pipeline freight movements on the corridor. This expanded investigation could form the basis for a cost-benefit analysis on the Johannesburg to Durban Freight Corridor.
- This investigation could be used to motivate policy reform regarding freight transport, and in particular road freight transport. However, it is noted that the improvements to the investigation discussed in Section 10.2 need to be carried out in order to fully inform policy making decisions.

10.4 Concluding Remarks

The investigation has shown that the estimated cost of the indirect impacts of road freight on the Johannesburg to Durban Freight Corridor is significant at R 9.72 billion in unaccounted costs that the road freight sector along the corridor is responsible for on an annual basis. When compared to the estimated direct costs of R 11.9 billion along the corridor, the indirect costs are substantial at 82% of the direct costs. Furthermore, the cost of the indirect impacts equate to 0.3% of South Africa's GDP.

The importance of road freight to the South African economy cannot be overstated, however, solutions to current road freight transport methods are required in order to develop and maintain a sustainable freight transport industry. In order to be competitive in international trade, the economy (and therefore also the freight transport industry) should be as effective as possible. In view of this, the following is proposed for the way forward:

- A review of National transport policy and legislation in order to determine the most efficient and effective way to ring fence and appropriately charge heavy vehicles in order to recover the costs resulting from externalities.
- Develop a funding model which uses the money recovered by road freight externalities to finance infrastructure investment.

Consensus should be reached on what portion of the road budget should be paid for by road users. Part of the existing fuel levy or additional fuel tax can then be acknowledged as a road user charge, which should be viewed as the price for road usage. This can be agreed upon by industry and the government, and can even avoid the need for additional toll roads.

With the commonly accepted notion that there will always be a need for road freight transportation on the Johannesburg to Durban corridor due to the topography and type of goods transported, it is recommended that mitigation measures be further investigated and implemented in order to reduce the indirect costs.

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The findings have shown that if combined with road freight transport improvements, the reduction in road modal share will reduce the cost of indirect impacts. In order to encourage this modal shift, the road freight industry could be required to pay for the externalities, in addition to an improvement to the rail network and operations, and the amendment of relevant policies. The outcomes of this investigation have the potential to assist in reducing the indirect costs associated with road freight transport.

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