The assessment of improvements made in the freight logistics costing methodology in South Africa from a macroeconomic perspective

by

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Declaration

I, the undersigned, hereby declare that the work contained in this dissertation is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

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Signature Date

Summary

In 2006 F.J. Botes, C.G. Jacobs and W.J. Pienaar from the University of Stellenbosch published an article on the Logistics Cost Model titled "A model to calculate the cost of logistics at a macro level: a case study for South Africa". Back then already the model proved to be groundbreaking work in South Africa, and led to the publication of the first State of Logistics survey for South Africa through the Centre for Scientific and Industrial Research (CSIR).

Since then the methodology of the Logistics Cost Model has been improving every year, especially during 2008 update when new ways of modelling the road transport costs of the country on a highly detailed level were applied, as well as new ways of modelling inventory carrying costs like never before. It is these and other improvements made in the Logistics Cost Model since the previous publication by Botes et al that is highlighted in this research, as well as the shortcomings in the current methodology, coupled with ways of possibly improving it in future. It is felt that this is important work to document since the Logistics Cost Model outcome is used by the Centre for Supply Chain Management (University of Stellenbosch) for consulting to Transnet, the CSIR, and other freight logistics service providers. The State of Logistics survey for South Africa publication is also read by public and private industry and is used in making strategic business decisions.

This research also highlights the outcome of the 2008 Logistics Cost Model update, as well as how the outcome can be interpreted by industry in making key strategic decisions in future on a macroeconomic scale.

Opsomming

In 2006 het F.J. Botes, C.G. Jacobs en W.J. Pienaar van die Universiteit van Stellenbosch ŉ artikel gepubliseer oor die Logistieke Koste Model getitel "A model to calculate the cost of logistics at a macro level: a case study for South Africa". Die Logistieke Koste Model was op daardie stadium al baan breek werk gewees in Suid Afrika en het gelei na die publikasie van die eerste "State of Logistics Survey for South Africa" deur die Wetenskaplike en Nywerheidsnavorsingsraad (WNNR).

Sedertdien is die metodologie in die Logistieke Koste Model oor die jare verbeter, veral in 2008 toe nuwe metodes van padvervoer koste berekening op ŉ baie gedetailleerde vlak toegepas is, asook nuwe metodes van voorraad drakoste. Dit is hierdie en ander verbeteringe in die Logistieke Koste Model sedertdien die vorige publikasie deur Botes et al wat in hierdie tesis uitgelig word. Tekortkominge en moontlike metodes om die model te verbeter word ook uitgewys. Dit is van mening dat hierdie dokumentasie belangrik van aard is aangesien die Logistieke Koste Model deur die Sentrum vir Voorsieningskettingbestuur (Universiteit van Stellenbosch) gebruik word om te konsulteer aan Transnet, die WNNR en ander vragvervoer diens leweransiers. Die "State of Logistics Survey for South Africa" publikasie deur die WNNR word ook deur publieke asook private ondernemings gebruik in die maak van makro-ekonomiese strategiese besluite.

Hierdie navorsing lig ook die uitkomste van die 2008 Logistieke Koste Model opdatering uit. Maniere waarop hierdie uitkomste geïnterpreteer kan word deur industrie om wyse strategiese investeringsbesluite te neem van ŉ makro-ekonomiese aard word ook uitgewys.

Acknowledgements

To Kasia Rytel for all her love and support, which without the writing of this dissertation would not have been possible.

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1 Introduction

Logistics costing on a macroeconomic level has become more and more of a necessity in South Africa. According to Ittmann[1] pressures on reducing logistics costs internationally are even more acute in the South African context, given our geographic location, and therefore it is important to focus on logistics value and cost drivers. The world economy is in a deep recession and it will take a number of years to get out of this slump. In fact things are possibly going to get even worse before there is a real turn around. Governments are doing their utmost to limit the damage by introducing various measures to minimize job losses and to invest in projects that will assist and strengthen the upturn whenever that happens. The South African economy lags behind this downturn although more and more industries are feeling and experiencing what has been happening globally. According to Trevor Manual[2] the projected growth rate for South Africa for 2009 is now down to 1.2%, the lowest rate since 1998.

Five principles that have informed the South African budget planning for 2009 are: protecting the poor, creating employment, investing in infrastructure, promoting competitiveness and fiscal sustainability. The emphasis on infrastructure investment and improvement must be welcomed and will have direct benefit on the state of logistics in the long term. In this regard the situation in South Africa is not unique.

If South Africa wants any chance of competing in the global marketplace in future, it will need to pay serious attention to our domestic logistics challenges, some of which are:

- Continual increasing fuel costs
- Deteriorating infrastructure countrywide
- No transfer of suitable freight to rail

[1] Ittmann 2008, p. 9
[2] Budget Speech by the then Minister of Finance, Trevor Manual, 11 February 2009

Continual increasing fuel costs

Increasing fuel costs has really been a problem globally, and South Africa is no different, as can be seen in Figure 1. This is a factor that worsens the domestic logistics costs problem we face and, to further complicate things, it is a matter that remains out of the country's control. What the country can control however is to what extent it is dependent on this factor, and this should be managed properly.

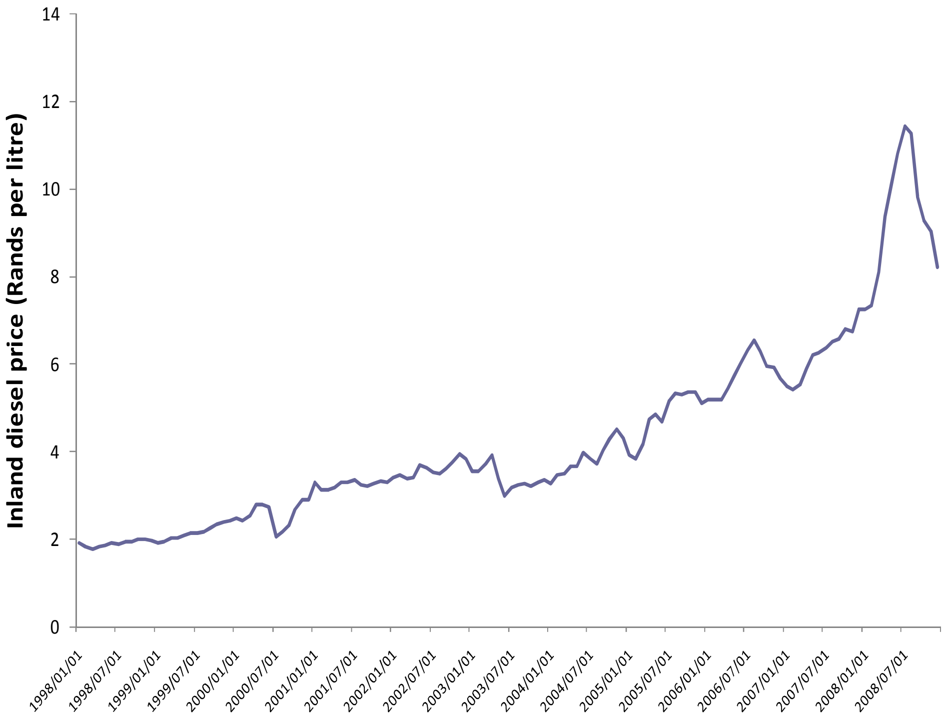

Figure 1: Growth in inland diesel price[3]

Methods of saving fuel on road by either new technology, better route scheduling, or to find a way of using cheaper modes of freight transportation (like rail for instance) are some of the possibilities. If modal shift is to be considered, it is necessary that a decent trade-off analysis is done to ensure that extra investment would result in even higher saving in fuel costs. Different modes of transport are not mutually exclusive however, and should be able to function together as a unit properly (inter-modality).

[3] www.sapia.co.za

Deteriorating infrastructure country wide

According to Mitchell[4], until the mid-80s, the emphasis on primary road infrastructure development was on handling the rapidly growing traffic demand between the main cities of the country. However under the influence of transport policy studies between 1976 and 1985, increased emphasis was also placed on the development of export-related freight movements, together with increasing mobility in the metropolitan areas. At the same time the government tried to maintain efficient and safe linkages between the main cities in the country.

Towards the end of the 1970s, less and less funds became available for road infrastructure investment, partly because the country experienced rapid increasing costs in other sectors.

This decline in investment in road infrastructure in South Africa ultimately had disastrous consequences for the road network and its users. This was combined with a sharp growth in road traffic, primarily because of the inability of rail to offer an acceptable service to shippers, but also because of deregulation in the movement of road freight. Road deregulation was a consequence of the national transport policy studies.

The extent of the disinvestment in the road sector during this period is validated by the fact that the total expenditure on rural roads in South Africa in 1990 was half the amount it was in 1975. This was a period when the country faced rampant inflation which had a severe effect on the price of building roads. However, even during a period of greatly reduced inflation between 1997 and 2005, expenditure in real terms on roads has remained nearly static, growing only by approximately 10% for this 8 year period, according to Mitchell[5].

This had an especially bad impact on the country's provincial road network, as can be seen in Figure 2.

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[4] Mitchell, M.(2006) p.2
[5] Mitchell, M. (2006) p.2

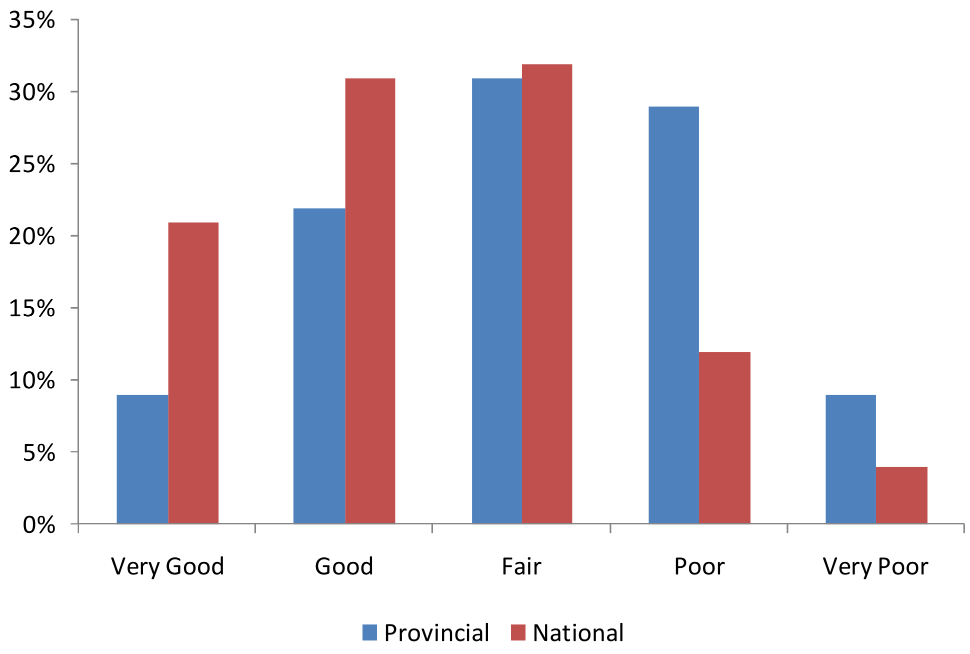

Figure 2: South African road condition in 2005[6]

As is clear, only around 50% of South African national roads are in a good, or very good state, whereas the figure is around 30% for provincial roads.

A possible strategy to deal with the poor state of provincial roads in South Africa was provided by Havenga and Naudé[7]. The possible strategy was stated as the following:

- Organise traffic around the dense long-haul corridors (the first network and primarily the first economy demand) on rail, with intermodal facilities at the origin and destination nodes. This will relieve corridor congestion, provide more efficient transport solutions and release funds for the secondary network.
- Use these released funds to provide world-class access roads in rural areas that connect rural areas internally and with the main corridors. The areas to focus on should be previously disadvantaged communities, nodes where subsistence farming will develop into commercial farming and where development should be facilitated: primarily the second economy.

[6] DoT 2005. p.17
[7] Havenga and Naudé (2006) The third annual state of logistics survey for South Africa p. 8

- Allow provincial government to deal with urban congestion, but provide back-up research and policy/regulatory support.
- Manage mining commodity transport systems as ring-fenced commercial transport solutions that are self-funded, world class and do not cross-subsidize the rest of the world.

No transfer of suitable freight to rail

What is meant by suitable freight is low value, long haul product (e.g. coal) or containerized long haul (to protect high value commodities and enable door-to-door intermodal service). A big problem is that high volumes of freight in this country with those characteristics flow by road, the major reason being the unavailability of rail capacity.

To prove this point, a quote from Premier Thabang Makwetla on the 26th of October 2007 at the Coal Haulage Conference, Gert Sibande District Municipality, Secunda will be provided[8].

"The growth of the South African economy has been coupled with growing demand for energy inputs to support the economy. Energy demand and supply to households has also been growing exponentially. All this has created a need for the expansion of Eskom's production capacity to cater for the growing national energy needs. Increased growth in coal demand by Eskom and the re-commissioning of previously mothballed power stations has seen the increase in the volume of coal transported by road to the power stations. The rapid increase in coal hauling by road for power generation has resulted in a significant deterioration in the road conditions and this has had a negative impact on road safety in the province. The degradation of coal haulage routes has forced users to use alternative longer routes to reach destinations thereby placing an unnecessary premium on the cost of coal. A consequent effect is that the alternative routes are suffering the same degradation as the preferred routes."

[8]http://www.search.gov.za/info/previewDocument.jsp?dk=%2Fdata%2Fstatic%2Finfo%2Fspeeches%2F2007%2F07110111151001.htm%40SpeechesandStatements&q=(+((makwetla)%3CIN%3ETitle)+)+%3CAND%3E(+Category%3Cmatches%3Es+)&t=T+Makwetla%3A+Coal+Haulage+Conference+during+Transport+Month

As is clear from the speech, road transportation is seen as the answer for transporting the increased demand of coal, whereas rail should be able to handle the growth in this commodity. The outcome means one thing: an increase in the cost of energy. This is one example but there are other examples of commodities, which are transported by road instead of by rail, thereby driving up the cost of logistics for the economy. And as is clearly stated by the Premier, if the logistics costs are going to maintain their increase and infrastructure continue to deteriorate, the economy will feel the impact through an increase in the costs of basic needs, and the worse it gets, the harder it will become to rectify. Incentives should start at an early stage.

Industry will need to have the ability to make smart decisions regarding improvement of these above-mentioned factors, and it is felt that costing the macro logistics activities in a proper manner could seriously aid in pointing towards solutions for alleviating these problems, by fully understanding where the problems lie. And, the reality is that these investment decisions will not only have an economic impact on South Africa alone, but on most of the SADC region too. It is therefore critical that the right decisions are made.

The objective of this study is to create an understanding of all the past improvements made in the Logistics Cost Model methodology, as well as offering some clear propositions on improving it even further in future. The study will also create an understanding of how the current model functions as a whole with all its inputs and outputs. The model outcome and how it should be interpreted will also be explained. It is important that an understanding around the importance of studying the methodology of the Logistics Cost Model to the logistics system of South Africa is understood. Because the Logistics Cost Model is a tool that is used in macroeconomic decision making in South Africa, it is all the more important to carry on studying the methodology and developing it further.

One important limitation to this study that is needed to be mentioned is that it will focus purely on freight logistics. By definition logistics is considered, according to Botes et al[9] to be that part of the supply chain process that deals with the transportation, warehousing, and inventory administration and management of commodities between the origin (that is, where they are produced, mined or cultivated) and the destination (that is, the point of delivery to the consumer either as input to further production processes or for consumption). By definition, this excludes the cost of passenger transport, costs such as transport, storage, packaging and handling of mail and luggage, as well as the storage and transport tasks that occur during the production, mining or cultivation process. Only the elements that fall within the definition of logistics mentioned will be studied in this dissertation.

1.1 Chapter summary

Logistics costing on a macroeconomic level has become more and more of a necessity in South Africa. If South Africa wants any chance of competing in the global marketplace in future, it will need to pay serious attention to its domestic logistics challenges. Costing the macro logistics activities in a proper manner could aid in pointing towards solutions for alleviating these problems by fully understanding where the problems lie.

The objective of this study is to create an understanding of all the past improvements made in the Logistics Cost Model methodology, as well as offering some clear propositions on improving it even further in future. The model outcome and how it should be interpreted will also be explained.

[9] Botes et al (2006) p. 4

2 Literature review

2.1 The history of macroeconomic logistics costing

According to Rodrigues et al[10] the first published research for logistical cost estimation was done in 1973 by Heskett et al.[11] A methodology was developed for estimating total logistics cost that was applied to the United States. The methodology was based on the fact that total logistics cost is the sum of four types of commercial activities: transportation, inventory, warehousing, and order processing. A process of direct or roll-up summation methodology was applied to sum all these processes together to estimate total logistics cost.

This basic methodology, with some adjustments, has been used by Cass Information Systems and now the Council of Supply Chain Management Professionals to estimate annual logistical expenditures in the United States[12]. The study combines data related to three key components to estimate logistics expenditures: Inventory Carrying Cost, Transportation Cost, and Administrative Cost. The process includes Warehousing Cost as part of Inventory Carrying Cost.[13] Regarding the South African Logistics Cost Model, a broadband methodology was developed in 2006 by Botes et al.[14].

According to Botes et al,[15] Delaney[16] popularised the quantification of logistics costs, which is presented annually for the United States in the state of logistics report. They mention the original methodology of the Alford-Bangs formula of 1955[17] that was used and popularised by Delaney in the development of the United States' state of logistics survey (the 20th edition has recently been issued). Delaney uses Smith's approach[18] for transportation, but Alford-Bangs for the rest. Delaney's use of Alford-Bangs is usually quoted from Alford and

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[10] Rodrigues et al (2005) p.2
[11] Heskett et al 1973
[12] Wilson (2004)
[13] Rodriques et al (2005) p 2
[14] Botes et al (2006) p. 1-18
[15] Botes et al (2006) p. 3
[16] Delaney (2003)
[17] Alford and Bangs (1955) p. 396-397
[18] Smith (1986) p.4

Bangs's work of 1955 (probably because when Delaney himself sets out his approach, he quotes the 1955 version).

The original work, published in 1944, almost certainly contained the formula, but only the 1946 edition could be located. In the 1946 edition, the formula is described and the authors initially estimated an inventory carrying charge of between 10% and 20%. Alford and Bangs then continue to question this wide range and eventually put forward a figure of 25%, based on a previous discussion of Alford in a book on Industrial Management, of which the oldest reference that can be found is a 3rd edition, published in 1941. Furthermore, according to Alford and Bangs, the previous work of Alford in deciding on the inventory charge was based on the work of Parrish, which obviously predated Alford's 1941 work by at least one year. (No further information on Parrish could be found.)

It is therefore safe to assume that the Alford-Bangs formula dates back to at least 1940 (if not earlier) and is still applied, to some extent, in its original form by Wilson today. (Delaney passed away after the publication of the 14th annual state of logistics report and Rosalyn Wilson, his earlier collaborator, is continuing the work, with the latest report, the 18th, published on 6 June 2007).

The historic context of the Alford-Bangs formula is important because it highlights the fact that researchers in the world's largest economy will not hesitate to use reasonably broad estimates to determine trends, as long as assumptions are applied uniformly and work is repeated on a regular basis. The objective for South Africa was to achieve both repeatable results and the highest possible detailed refinements[19].

2.2 Macroeconomic logistics costing issues – the denominator

The total logistics cost outcome of the United States (and for South Africa) is published as a percentage of Gross Domestic Product (GDP) in order to track efficiency in the national logistics system. It is however important to mention an issue regarding national logistics cost measurement relating to the denominator (GDP).

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[19] Havenga and de Jager (2009) p. 2

A position paper by Macrosys[20], prepared for the US Department of Transport's Federal Highway Administration, cites numerous issues in calculating logistics costs in an economy and comparing these with GDP. The difficulty in comparing logistics (or any industry) with GDP is in the way "logistics" is classified and calculated. Which elements are included in the estimation of "logistics" can significantly change the meaning of any comparison. In any comparison, GDP is the constant – it always has the same definition. Simply stated, it is the total value of final goods and services produced for consumption within a country's borders in a given time period (usually a year.)

GDP = private consumption + government consumption + investment + net exports

Where: net exports = exports – imports

GDP does not include intermediate goods and services, only final goods and services.

The problem lies in the calculation of logistics costs because it contains:

- intermediate goods and services, and
- internal business operating costs unrelated to logistics.

When firms outsource logistics activities they are purchasing not only the services produced by the logistics providers, but also the intermediate inputs used in the production of the services. When firms run in-house logistics operations, their "logistics costs" also include internal business activities and purchases that are not strictly logistics functions. Furthermore, logistics costs include inventory-carrying costs, which include opportunity cost of capital, which is not a component of GDP.

The first important point that flows from these concerns is that it is incorrect to say that logistics "accounts" for x percent of the GDP or that logistics "contributes" x percent to GDP. Rossouw[21] illustrates this point clearly in his article *Tripping over the denominator*. The critical issue is that the GDP only

[20] Macrosys (2005)
[21] Rossouw (2006)

includes the value added from sector to sector and is not a summation of turnover of all business activities in the economy. One could therefore make a statement that logistics costs are equal to a percentage of GDP but it is simply a statement of their relative sizes, not a statement of how much one is dependent upon the other. Comparing relative sizes will benchmark the economy as a whole to other economies in the world but, for industry-level benchmarking, logistics costs must be related to the turnover of the applicable industry.

It is important to mention however that this dissertation will focus on macroeconomic logistics cost modelling methodology, and industry level logistics costs will not be compared to GDP.

2.3 Chapter summary

The earliest logistics costing methodology was based on the fact that total logistics cost is the sum of four types of commercial activities: transportation, inventory, warehousing, and order processing. A process of direct or roll-up summation methodology was applied to sum all these processes together to estimate total logistics cost.

The total logistics cost outcome of the United States (and for South Africa) is published as a percentage of Gross Domestic Product (GDP) in order to track efficiency in the national logistics system. One should remember however that making a statement that logistics costs are equal to a percentage of GDP is simply a statement of their relative sizes, not a statement of how much one is dependent upon the other. Comparing relative sizes will benchmark the economy as a whole to other economies in the world but, for industry-level benchmarking, logistics costs must be related to the turnover of the applicable industry.

3 The freight logistics environment of South Africa

3.1 The National Freight Flow Model

In order to give a very realistic representation of the volume of road freight that flows in South Africa, a very accurate and effective model is used to calculate the road freight volumes for South Africa, namely the National Freight Flow Model (NFFM)[22]. It must be noted that the volumes that result from this model are not the figures used as an input into the calculation of the cost of logistics for the country. The model used as an input for calculating the cost of logistics in South Africa is the Freight Demand Model (FDM). The reason that the NFFM cannot be used for costing lies in the methodology. The way the model works is by counting and weighing trucks on the highway. It is unknown what the trucks actually carry so there is no commodity connection with the freight volume data. The result is that no costing on a commodity breakdown level is possible. However, the NFFM remains a very important model that can give a great understanding of the road freight logistics environment in the country since it has one complexity that the FDM lacks. This complexity lies within the metropolitan road traffic.

The NFFM indicates all road traffic in the metropolitan areas (including traffic originating from elsewhere on the corridors), whereas the FDM, due to its methodology, only indicates metropolitan traffic whose origin and destination are in the metropolis. The result is that all freight flowing in the metro poles of the country is not visible in the FDM (how this problem is overcome in the logistics costing process will be explained at a later stage); thus the NFFM is a better model for depicting the freight volume environment of the country. It is important to mention, however, that there were correlation tests done between the NFFM and the FDM, by eliminating the methodological differences between the two and correlating the outcomes, and a R^2 result of 99.99% was achieved[23].

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[22] Havenga (2007) “Dissertation” pp.124-134
[23] Havenga et al (2008) The fifth annual state of logistics survey for South Africa p.20

A graphical depiction of the processes within the NFFM is shown in Figure 3.

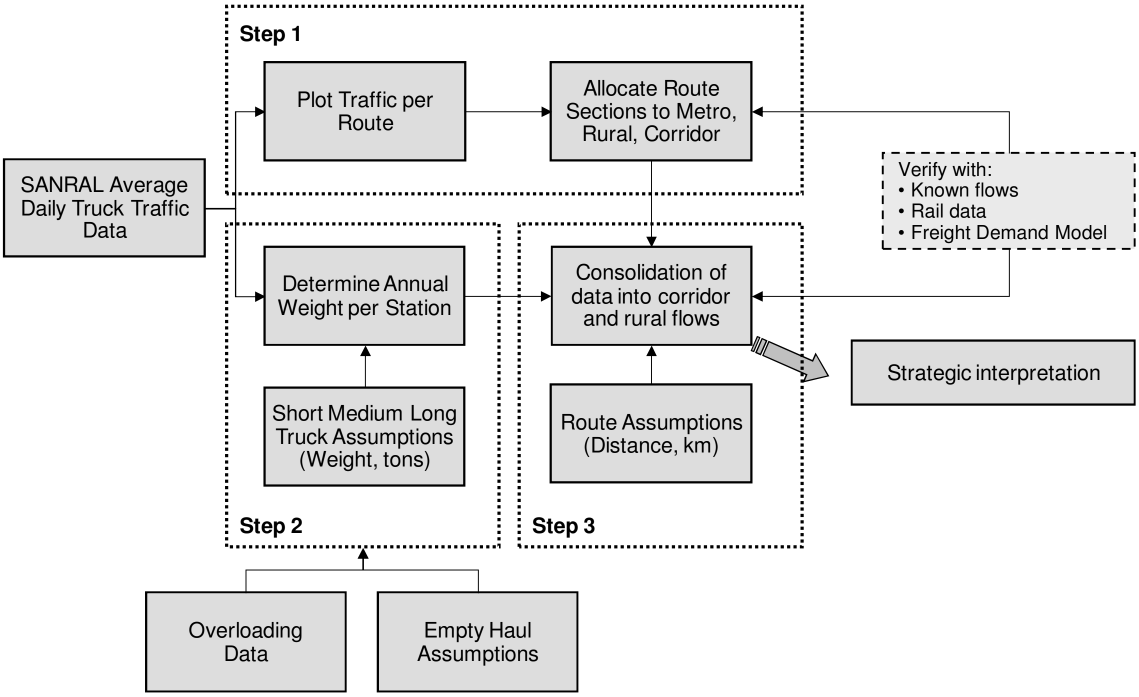

Figure 3: A graphical depiction of the National Freight Flow Model[24]

As is clear, SANRAL's average daily truck traffic data is used as an input to this model. This data is then plotted on routes, and sections of the routes are allocated to metro, corridor and rural typologies, based on the geographical location of the route section. The annual weight of each truck counting station is then determined (through the use of some short, medium and long truck assumptions) and this, together with the allocated route traffic plotted in step 1, will then be consolidated into corridor and rural flows (using some route distance assumptions). Currently this model is annually updated by Zane Simpson[25].

3.2 Freight volumes

Road and rail volume:

Now that the model used to depict the road freight flows of the country is better understood, the outcomes of this model can be portrayed. The outcome of the NFFM is depicted in Figure 4.

[24] Havenga (2007) PowerPoint presentation for PhD oral examination
[25] Zane Simpson is a researcher at the Centre for Supply Chain Management, Department of Logistics, University of Stellenbosch

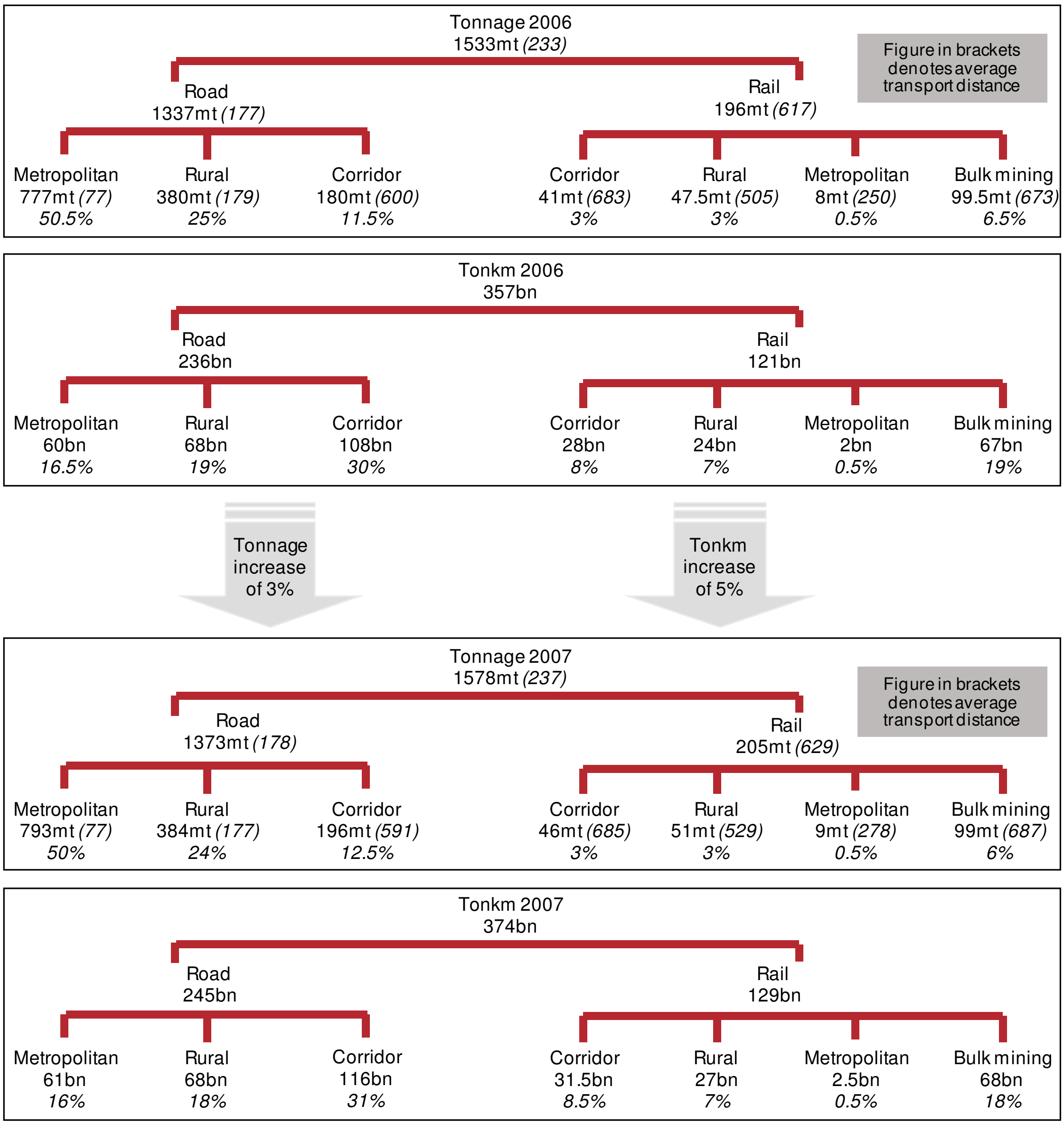

Figure 4: Modal distribution of road and rail freight in South Africa[26]

The figure depicts the tons carried, as well as the tonkm generated for both road and rail in the years 2006 and 2007. What is clear at first glance is the complete domination of road freight logistics in the country. Most of the tonkm freight in the country is generated on the corridors by road. What is also visible is the large average travel distances (ATD) on the corridors. The reason for this is the spatial imbalance that exists in South Africa (section 4.3), with the ports situated far away from the economic hub (Gauteng), causing high volumes of freight flowing long distances on the corridors.

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[26] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p. 22

This is one of the reasons why domestic logistics cost is a problem in South Africa. One should expect that, with an ATD on road of 591 km on the country's corridors, most freight should be on rail (the reason being that rail transport is cheaper over long distances, with more capacity capabilities, and lower running costs), but it is not. Another problem caused by road corridor volumes of that scale is that it puts a lot of strain on the country's two main (and busiest) corridors, Natcor and Capecor (Natal–Gauteng corridor and Cape–Gauteng corridor respectively). With growth in freight traffic a real possibility for this country in the not too distant future, the road corridor capacity could be pushed past its capacity, and quite frankly by that time it could possibly be too late.

The difference in freight volume between road and rail on the South African corridors is clearly depicted in Figure 5.

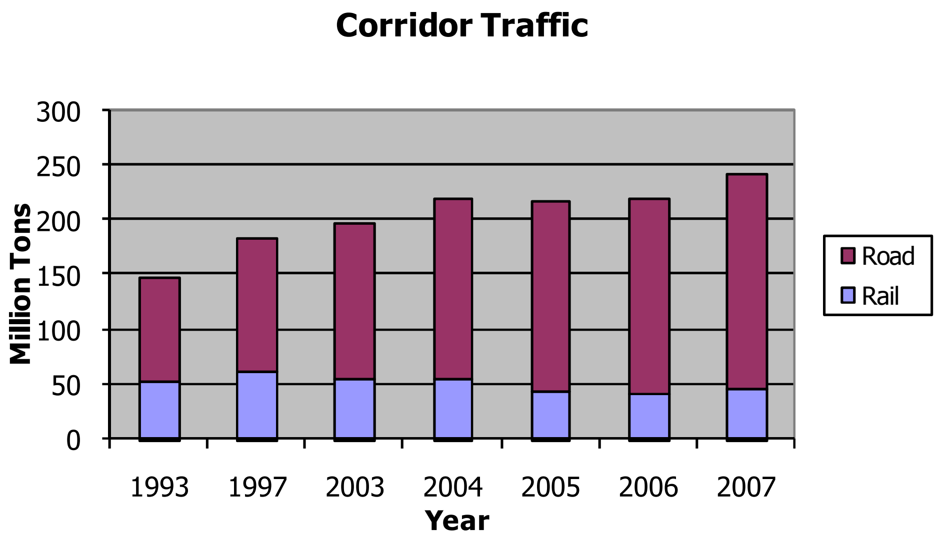

Figure 5: Historical corridor traffic volumes in South Africa[27]

It clearly indicates that road freight volumes completely dominate the corridors. Factors like congestion (a clear reality, as corridor volumes have increased steadily since 1993) and future diesel price hikes could seriously turn this into a real problem for the economy.

[27] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p. 23

It is not only corridors that experience such high road volumes. Rural traffic has the same trend, as can be seen in Figure 6.

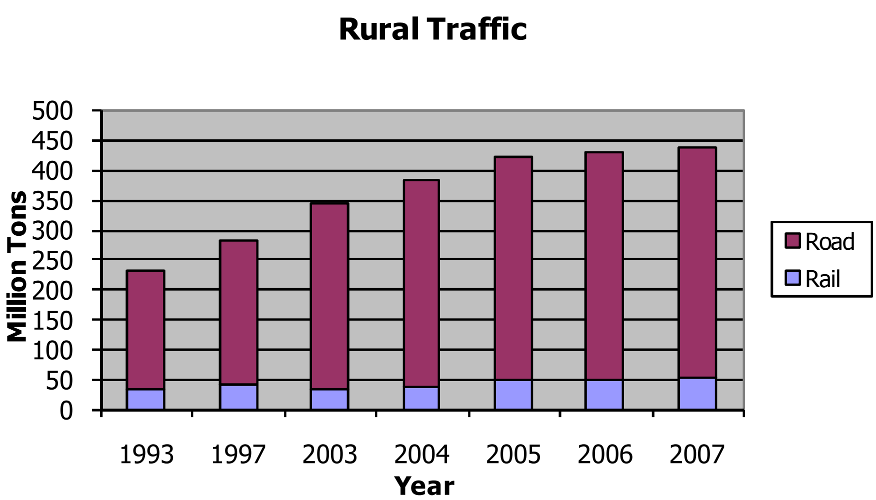

Figure 6: Historical rural traffic volumes in South Africa[28]

Figure 4 indicates that rural road ATD is 177 km, whereas the rail ATD is 529 km. This clearly indicates that most of rural traffic volumes flow short distances, and that clearly explains why most traffic within this typology would naturally be flowing on road (since rail is more fitting to larger distances). Another reason for the road freight domination lies in low rail line availability in the rural typologies in South Africa. Roads in South Africa are very widespread, and therefore the only available mode in many rural areas.

Metropolitan freight traffic volumes are depicted in Figure 7.

[28] Havenga et al (2008) The fifth annual state of logistics survey for South Africa p. 24

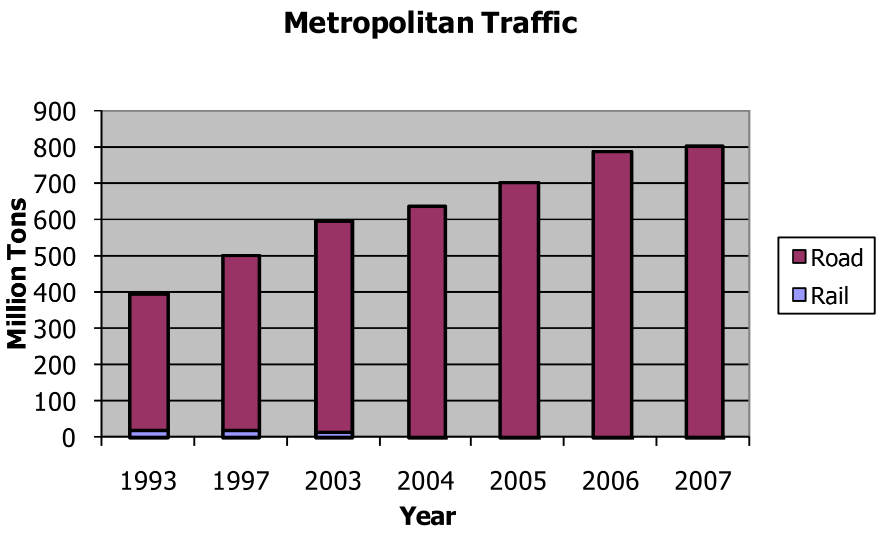

Figure 7: Historical metropolitan traffic volumes in South Africa[29]

As can be expected, just about all the freight that flows in the metropolis is by road, since most metropolitan freight would be distribution oriented (fast door-to-door service).

Air volume:

Now that the road and rail freight volume environment of South Africa is better understood, it is time to take a look at the air freight environment. Other than increasing road and constant rail volumes over the past 15 years, air freight volumes seem to be indicating a downward trend over the last decade, as is indicated in Figure 8.

[29] Havenga et al (2008) The fifth annual state of logistics survey for South Africa p. 25

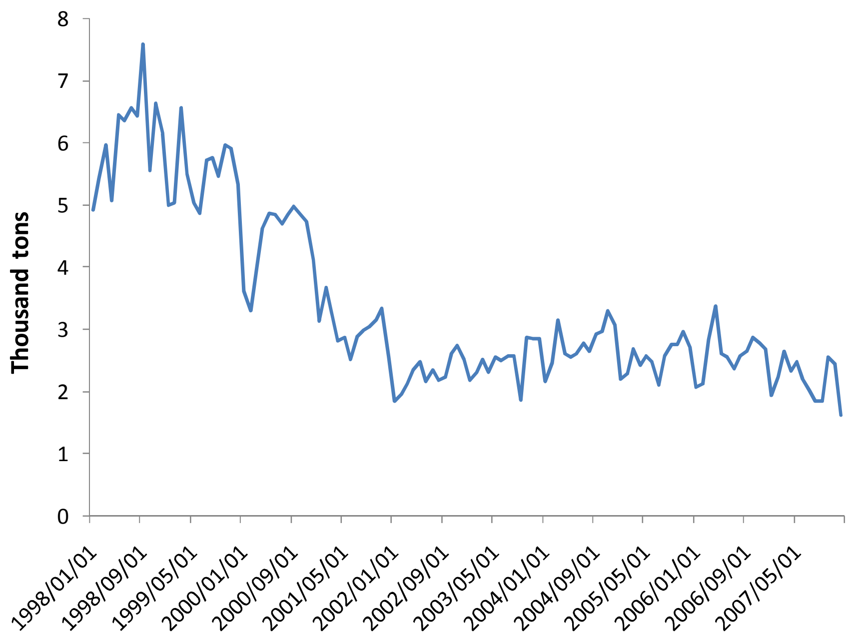

Figure 8: Historical domestic air freight volumes in South Africa[30]

Less freight forwarders are turning to air as a means of transporting goods within South Africa, quite possibly because of the cost, and are turning to road trucking as a cheaper alternative.

According to the International Air Transport Association (IATA) figures, international freight volume growth also looked bleak between 2003 and 2007 (except for the sharp spike during 2004), although the overall trend does not appear to be as bad as in South Africa (Figure 9).

[30] ACSA database

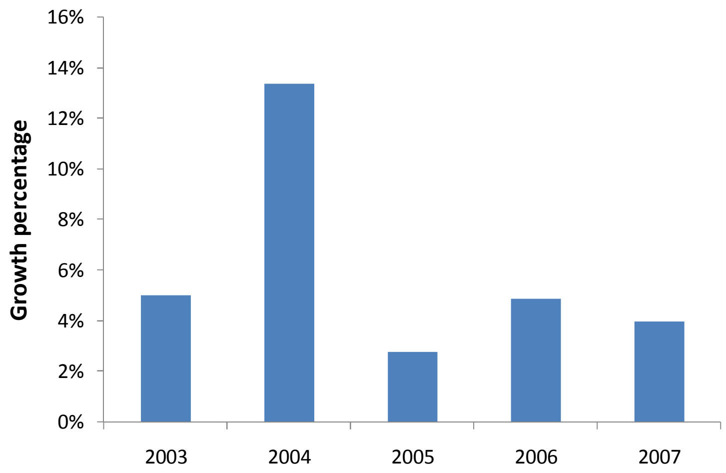

Figure 9: The growth in international air freight tonkm traffic[31]

Pipeline volume:

The four commodities that are pumped in pipelines in South Africa are petrol, diesel, avtur (a type of aviation fuel designed for use in aircraft powered by gas-turbine engines) and crude petroleum. The volume of each is depicted in Figure 10.

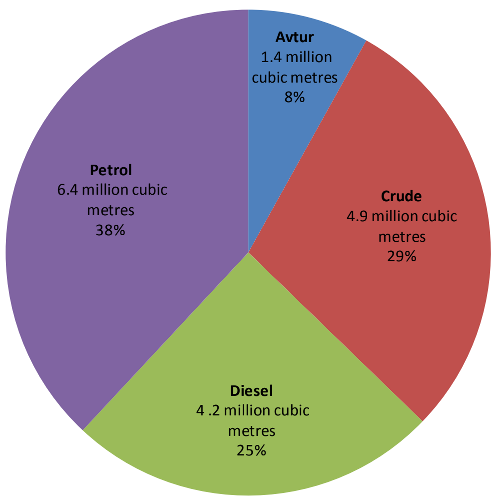

Figure 10: Volume of product pumped in Transnet owned pipelines in South Africa in 2007[32]

Clearly petrol is the most commonly piped when it comes to finished product pumped in the country, followed by diesel and avtur.

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[31] http://www.iata.org/pressroom/facts_figures/traffic_results/
[32] Transnet pipeline database

Coastal shipping

Shipping volumes included in the Logistics Cost Model are only the volumes shipped up and down the coast of the country (domestic shipping). No commodities are shipped inland in South Africa since none of the rivers here are navigable. Petrol and petroleum gas is the dominant commodity type shipped coastwise in South Africa, as is depicted by Figure 11.

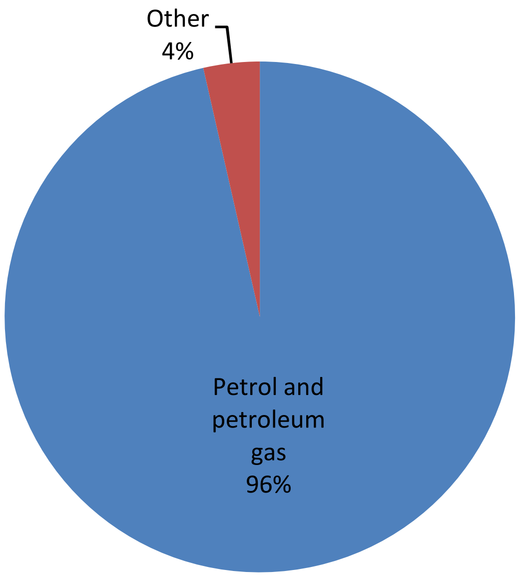

Figure 11: South African domestic coastal shipping commodity breakdown[33]

It is clear that petrol and petroleum gas are by far the largest volume of product that is shipped up and down South Africa's coastline (96% of the whole). In total, 2.68 million tons of freight was shipped coastwise in South Africa in 2007 of which petrol and petroleum gas represented 2.58 million tons.

Now that the freight volume environment of the country is understood better, it is time to take a closer look at the logistics cost environment.

3.3 Logistics costs

In a report published by the World Bank (Connecting to Compete)[34] the logistics performance of 150 countries were benchmarked across seven different sets of criteria, namely:

[33] National Ports Authority database

- Clearance efficiency by customs and other border agencies
- Quality of transport and information technology infrastructure
- Ability to deal with international shipments
- Capability of the local logistics industry
- Tracking and tracing of international shipments
- Domestic logistics costs
- Timeliness of shipments reaching destinations

South Africa ranked 24th overall and 1st in its income group. The overall ranking would have been much better had it not been for its domestic logistics cost problems. South Africa ranked 124th in respect of its domestic logistics costs, making it one of the most expensive countries in the world for domestic freight movement. In 2007 the total logistics cost of South Africa amounted to R317bn, 15.9% of GDP[35].

3.4 Spatial perspective

South Africa is spatially challenged due to agglomeration of major industries in the centre of the country[36]. This presents quite a problem since large volumes of international freight would be entering or exiting the country at the ports or borders, and given that South Africa's economic hub (Gauteng) is situated far from the country borders, large volumes of freight have to move long distances.

The result is very high domestic logistics costs, as mentioned in section 3.3. And since most of this freight movement occurs on the road, it places immense strain on the road corridors of the country, since no real alternative is presented by rail at this stage.

3.5 Chapter summary

South Africa is spatially challenged with the major industries situated in the centre of the country, far from its ports. The result is that South Africa has a very high demand for long distance transportation. This high demand for long distance transportation, coupled with the fact that the transport sector is

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[34] World Bank 2007
[35] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p. 16
[36] Havenga et al (2007) The fourth annual state of logistics survey for South Africa, p.6

completely dominated by road transport, caused that South Africa has one of the highest domestic logistics costs in the world relative to the size of its GDP (15.9%).

4 History of logistics costing in South Africa

An input into the Logistics Cost Model, the South African Freight Demand Model, was developed by Dr Jan Havenga and Ilse Hobbs during 1995 to 2006.[37] This model, with major inputs from Joubert van Eeden who is the current project leader, is receiving its fourth update[38]. This model allowed, for the first time, the visibility of multi-modal freight flows in the South African economy as a whole. The model indicates, in detail, the volume of freight (divided into 62 different commodity classifications) that flows between 354 magisterial districts in South Africa, plus Lesotho and Swaziland (making it 356 regions).

This knowledge created the possibility of connecting costs to these flows and therefore modelling the cost of logistics for the country as a whole. The first attempt at building a Logistics Cost Model for South Africa through Dr Havenga and Ilse Hobbs delivered some preliminary results (Figure 12)[39].

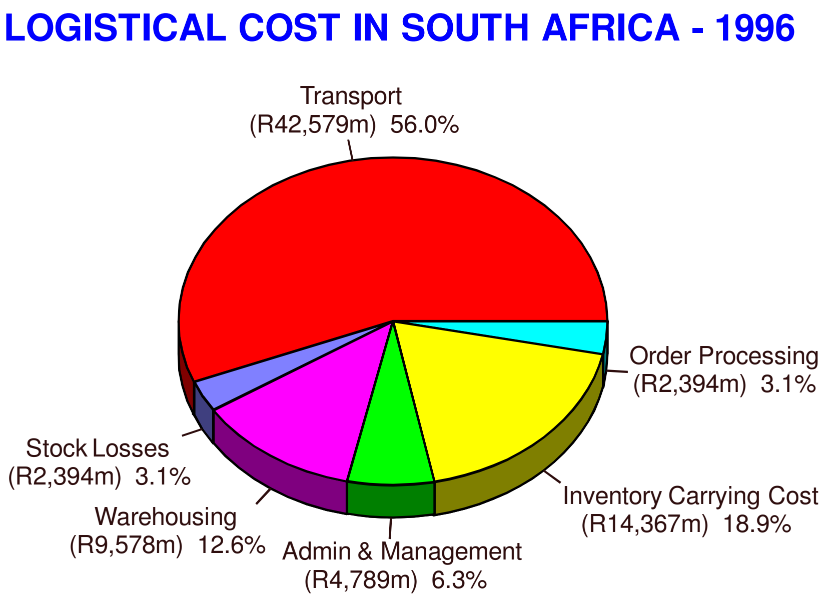

Figure 12: Preliminary results of the Logistics Cost Model in 1996[40]

[37] Havenga (2007) dissertation pp.160-180 and (2008) "Unpublished Transnet report"
[38] A personal conversation with Dr J.H. Havenga
[39] A personal conversation with Dr J.H. Havenga
[40] Havenga (2007) PowerPoint presentation presented for PhD oral examination

The total logistics cost result for the country then was calculated as R76 billion, expressed as 18% of GDP.

A breakdown of the logistics costs into the different industries gave the results in Figure 13.

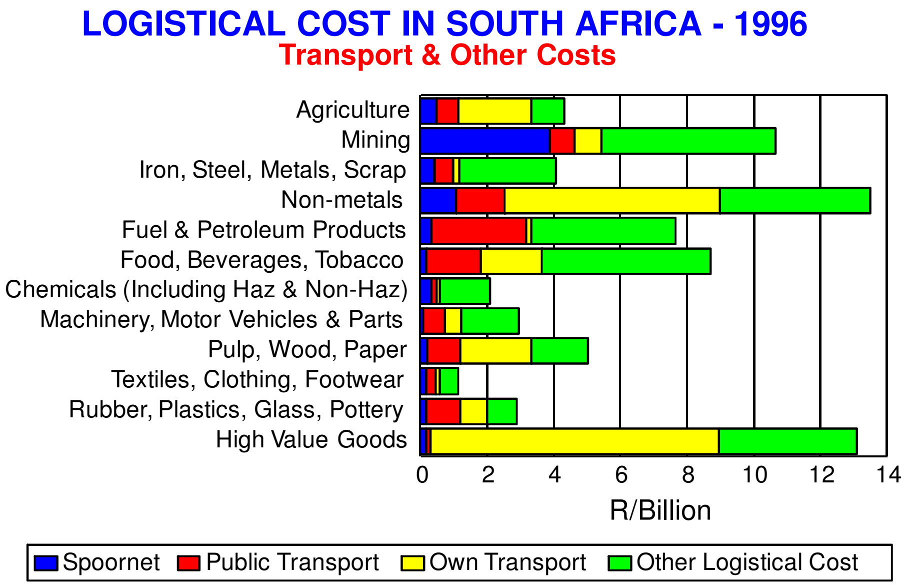

Figure 13: Industry breakdown of the preliminary Logistics Cost Model results in 1996

The methodology however was unclear and not referenced. The first published and referenced work of F.J Botes, C.G Jacobs and W.J. Pienaar in 2004 led to the publication of the first Annual State of Logistics Survey for South Africa in 2004.

Since then the Logistics Cost Model has been updated annually and a summary of the results published in the Annual State of Logistics Survey for South Africa (CSIR). The model outcomes are also used by the Centre for Supply Chain Management (University of Stellenbosch) to provide strategic advice on numerous issues such as infrastructure development to Transnet, the CSIR, the DoT and other freight logistics service providers.

4.1 Chapter summary

The development of the Logistics Cost Model allowed, for the first time, the visibility of multi-modal freight flows in the South African economy as a whole. It has been developed over time and the outcomes have been published annually by the CSIR since 2004. The outcomes and are also used to provide strategic advice on numerous issues such as infrastructure development to Transnet, the CSIR, the DoT and other freight logistics service providers.

5 An overview of the Logistics Cost Model

5.1 The Botes et al model

The Logistics Cost Model itself employs a ‘bottom-up’ approach to the computation of logistics costs by aggregation of detailed commodity-specific data (out of the population), including throughput, transport and storage characteristics, as well as transport and warehousing unit costs. The aggregation of the logistics costs is based on primary input elements (the supply of a specific commodity) and the costs of performing logistical tasks with respect to that commodity[41]. The logistical tasks that are measured are transport, storage and ports and management and administration. Inventory carrying cost is also measured.

In Botes et al’s original work, broad estimates of transport activity were used in two categories only, i.e. road (distribution) and road (line haul). As transport is the largest cost component, an extensive expansion to a much finer detailed cost analysis level was needed.

They also used one static warehousing cost estimate, based on an estimation of inventory delay for one year – which required expansion to include a more robust, year on year, inventory delay comparison.

5.2 Improvements

The broad overview of the methodology behind the current Logistics Cost Model is depicted in Figure 14.

[41] Botes et al (2006) p. 5

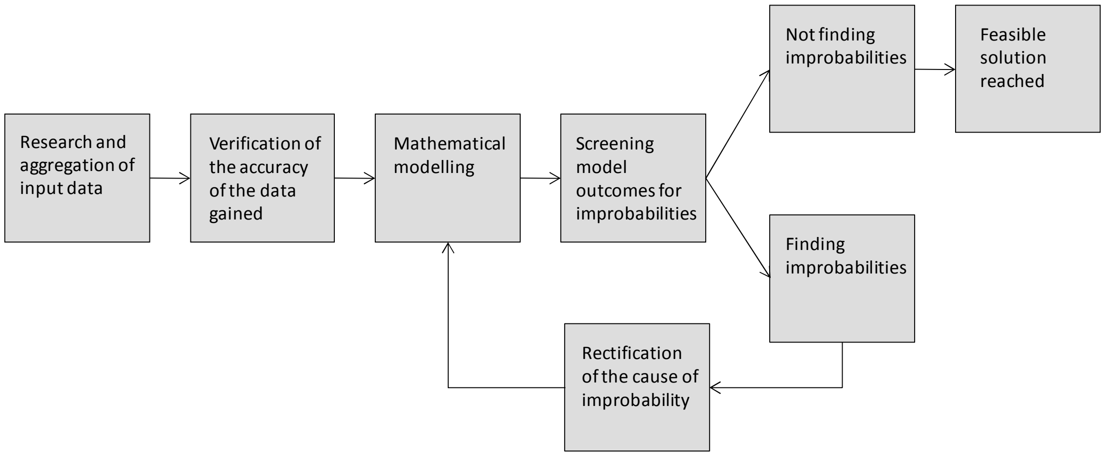

Figure 14: A broad overview of the Logistics Cost Model methodology

Each of the above mentioned processes are key to the enablement of accurate logistical cost calculation on a macro level. Each step is broadly explained next.

Research and aggregation of input data

This step entails the attainment of all macroeconomic supply and demand data within the country on a detailed level for 62 different commodity groupings within 356 different magisterial districts in the country.

Verification of the accuracy of the data gained

Once all supply and demand data is gained, it has to be verified in order to gain confidence that all data is correct and no errors were made. This process is simplified through Pareto analysis techniques (80/20 principle), by which more attention is given first to the larger volume commodities in the economy, and then to the smaller volume commodity groups. This ensures that most of the freight flowing in the country is verified in time. In the verification process itself the data is compared with known flows, rail data (from the national rail carrier) and the National Freight Flow Model results. Once the confidence in the data gained is at a desired level, the process of gravity modelling can be started.

Mathematical modelling

Now that the place and volume of supply and demand is known, it is necessary to allocate flows of these commodities to the different routes of the country. This is needed to calculate the transport cost section of the model. The flow of supply and demand is calculated through the process of gravity modelling. Gravity modelling works on the principle that, when applied to flows of goods between two points, flow increases with the size and proximity of the two points (more detail on this in section 6.1.3).

Once the flows are calculated the Logistics Cost Modelling process begins. All flow data gained out of the gravity model is connected to the researched cost rates for those flows (the connection is done in Microsoft Excel on a very detailed level), leading to the cost of transport for the economy. Storage, inventory carrying cost and overhead costs are also calculated in the Logistics Cost Model.

Screening the model outcomes for improbabilities

Once the mathematical modelling is done, outcomes are analysed to see if anything unrealistic is present. If this is the case, it usually means that a human error was made in the modelling process.

Finding the cause of the improbability, and rectification of the cause

Once it is known that an error exists in the model outcome, these mistakes must be tracked and rectified. The model is then run again until a satisfying feasible solution is gained.

Having understood a very broad overview of how these processes work, a more detailed description of the data inputs into the Logistics Cost Model will now commence.

5.3 Chapter summary

In Botes et al's original work, broad estimates were used when calculating logistics costs for the country, and the methodology needed refining. The current Logistics Cost Model methodology is much more refined, producing much more accurate results.

6 Inputs into the Logistics Cost Model

6.1 The Freight Demand Model

Before giving a detailed description of the entire data acquisition process required to build the Logistics Cost Model, a short overview of the Freight Demand Model (FDM) will be provided. As mentioned earlier, the reason for this is that the outcome of this model forms a major part of the input into the Logistics Cost Model. A graphical depiction of the methodology behind the FDM follows (Figure 15).

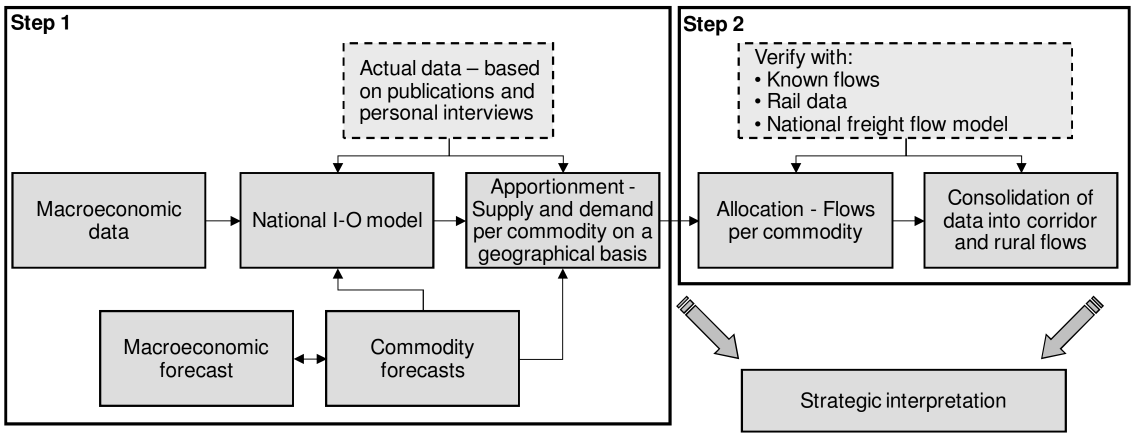

Figure 15: A graphical depiction of the freight demand model[42]

The FDM firstly involves researching the macroeconomic supply and demand data. This data forms the input of the National I-O model[43], which in turn apportions the supply and demand data per commodity on a geographical basis. The outcome of the apportioned data gets forecasted in five-year increments up to 30 years into the future.

The apportioned data is then verified and, once the verification is complete, the data is allocated to flows in the economy. The flow data is then also verified with known flows, rail data and the National Freight Flow Model outcome. Once

[42] Havenga (2007) PowerPoint presentation presented for PhD oral examination
43 The National I-O model is a mechanism used by leading economists in order to apportion supply and demand per commodity on a geographical basis.

confidence in the flow data has been gained, it forms an input into the Logistics Cost Model.

Now that a broad overview of the Freight Demand Model is understood, a detailed description of all the input data into the Logistics Cost Model follows.

6.1.1 Supply and demand

Supply and demand in the economy sparks the modelling process. Accessing knowledge about the volume and physical location of supply and demand puts the whole process into motion.

What is not practical, however, is to use flow data for all different products in the economy separately as an input into the Logistics Cost Model. For this reason products that flow in the economy are grouped into 62 commodity groupings, allowing greater ease in the costing modelling process, but still retaining a level of detail required to cost as accurately as desired. It must also be mentioned once again that a lot of research is done to ensure that all supply and demand data gained is as accurate as desired.

The 62 commodity groupings used in the model together with each grouping's Standard Industrial Classification (SIC) code (this code is internationally standardised and provides information on what is included in the commodity grouping through referring to a SIC code guide[44]) is visible in Table 1.

Table 1: The 62 commodity grouping classification used in the Logistics Cost Model, accompanied by each grouping's SIC codes.

Nr.	Commodity	SIC codes
1	Barley	Under 11110
2	Cotton	Under 11110
3	Deciduous fruit	Under 11130
4	Citrus	Under 11130
5	Subtropical fruit	Under 11130
6	Viticulture	Under 11130
7	Grain sorghum	Under 11110
8	Livestock (slaughtered)	11210

[44] Potgieter et al (1997)

Nr.	Commodity	SIC codes
9	Maize	Under 11110
10	Soya beans	Under 11110
11	Sunflower seed	Under 11110
12	Vegetables	Under 11120
13	Wheat	Under 11110
14	Poultry products	Under 11220
15	Dairy	Under 11210
16	Sugar cane	Under 11110
17	Other agriculture	11 (excl above)
18	Coal mining	210
19	Crude petroleum & natural gas	2210
20	Iron ore (hematite)	Under 24100
21	Magnetite	Under 24100
22	Chrome	24210
23	Copper	24220
24	Manganese	24230
25	Titanium	Under 24100
26	Zinc	Under 24290
27	Other non-ferrous metal mining	242 (excl above)
28	Stone quarrying, clay & sand-pits: granite	Under 25110
29	Stone quarrying, clay & sand-pits: limestone & lime works	25120
30	Stone quarrying, clay & sand-pits: other	251 (excl above)
31	Mining of chemical & fertilizer minerals	2531
32	Other non-metallic minerals	25999
33	Other mining	253 (excl above)
34	Food and food processing	301-304
35	Beverages	305
36	Tobacco products	306
37	Textiles, clothing, leather products and footwear	3111-3170
38	Wood and wood products	321-322
39	Furniture	39
40	Paper & paper products	323
41	Printing and publishing	324
42	Industrial chemicals	3341

Nr.	Commodity	SIC codes
43	Fertilizers and pesticides	3342
44	Pharmaceutical, detergents and toiletries	3353
45	Petroleum refineries and products of petroleum/coal	332
46	Rubber products	337
47	Other chemicals	335 (excl above)
48	Non-metallic mineral products	342 excl brick&3424
49	Bricks	Under 3423
50	Cement	3424
51	Ferrochrome	Under 35101
52	Ferromanganese	Under 35101
53	Other iron and steel basic industries	351 (excl above)
54	Non-ferrous metal basic industries	352
55	Metal products excluding machinery	353-355
56	Machinery and equipment	356-358
57	Electrical machinery	36
58	Motor vehicles	381
59	Motor vehicle parts and accessories	382 - 386
60	Transport equipment	387
61	Other manufacturing industries	392
62	Water supply	420

Knowledge of the place of supply and demand is another facet within the data acquisition process key in putting the Logistics Cost Model into motion. Another trade-off decision needs to be made for the level of detail used here. One could use all recorded supply and demand data within each town in the country separately as an input into the Logistics Cost Model, but the result is a lot of detail that in the end could quite possibly cause confusion and error within the model. How the complexity behind the place of supply and demand is dealt with is by making use of the 354 magisterial districts within the country (including Lesotho and Swaziland, making it 356 regions) and seeing each of these regions as one area of supply or demand (Figure 16).

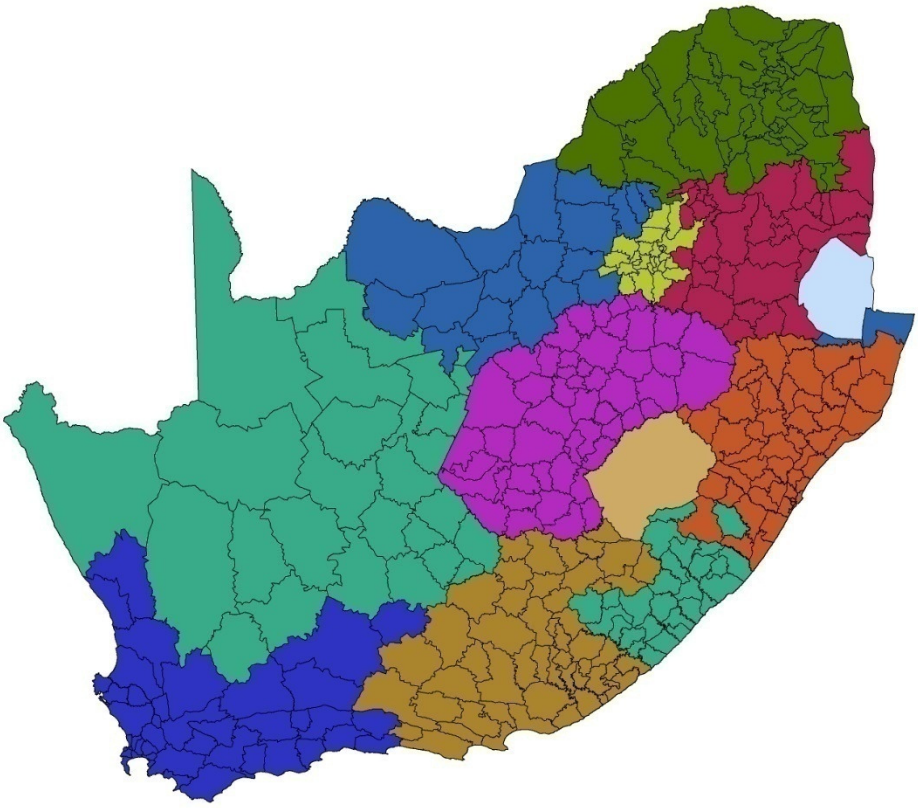

Figure 16: Magisterial district map of South Africa[45]

This might sound quite broad, but if one thinks about it, it really is not. The number of possibilities is quite extensive. That is 62 commodity groupings within 356 districts of supply, and 356 districts of demand, multiplied together gives 7 857 632 possibilities. This really forms the foundation of the cost modelling process, enabling the course to be set in motion.

In the past the model, through Botes et al[46], had a different commodity grouping classification. A much larger group of commodity classifications was used (that did not cover more commodities; it is just that each grouping was smaller in quantity). The commodities were listed in three main categories, depicted in Table 2. The two primary sector categories are mining and agriculture, whereas the secondary sector included all industries (namely, the manufacturing sector). Further commodity breakdowns were in accordance with those of officially published data. In the case of minerals, the Department of Minerals and Energy classification[47] was used; for agriculture the classification of the Department of

[45] Figure was supplied by the South African Department of Transport
[46] Botes et al (2006) p. 10-11
[47] Jonck, Van Averbeke, Harding, Duval, Mwape & Perold (2003)

Agriculture[48] was used; and for manufacturing the Standard Industrial Classification (SIC) as applied by StatsSA was used. The freight volume for each commodity grouping was sourced from the publications mentioned. Some adjustments were necessary in order not to double-count commodities, as more than one source sometimes listed the same commodity line.

Table 2: The past Logistics Cost Model commodity classification used[49]

PRIMARY SECTOR SECONDARY (MANUFACTURED/PROCESSED)		**SECONDARY MANUFACTURED PROCESSES**
MINING	***AGRICULTURE***	IRON AND STEEL-BASED PRODUCTS
PRECIOUS METALS AND		
MINERALS	HORTICULTURE	Basic iron and steel products
	Apples	Basic non-ferrous metal products
ENERGY MINERALS	Apricots	Fabricated metal products
Coal	Grapes (domestic market)	Machinery and equipment
Hydrocarbon fuels	Grapes (export)	Electrical machinery and apparatus
Uranium	Grapes (process)	Motor vehicles, parts and accessories
	Grapes (dried)	Miscellaneous products
NON-FERROUS METALS AND		
MINERALS	Grapes (pressed)	
		CHEMICALS AND PETROLEUM-BASED
Aluminium (metal)	Pears	PRODUCTS
Aluminium (concentrate)	Peaches	Industrial chemicals
Aluminium (refined)	Plums	Other chemical products
Antimony	Prunes, cherries, quinces	Petroleum products
Antimony (processed)	Figs	Rubber products
Cobalt	Strawberries, berries	Plastic products
	Watermelon, melon, other	
Copper	summer fruit	Non-metallic mineral products
Lead	Avocados, bananas	
Lead (refined)	Granadillas, litchis	PROCESSED FOODS AND BEVERAGES
Nickel	Guavas, loquats	Canned and prepared meats
Titanium	Mangoes, pawpaw	Dairy products
Zinc	Naartjies	Canned fruit and vegetables
Zirconium	Pineapples	Fish products and similar foods
Tungsten	Oranges	Vegetable and animal oils and fats
Magnesium	Lemons	Grain mill products
Tin	Grapefruit	Bakery products
	Fruit (dried)	Sugar
FERROUS MINERALS	Vegetables	Chocolates, sugar confectionery and cocoa
Chromium		Roasted peanuts and other nuts
Iron Ore	FIELD CROPS	Coffee roasting, tea blending and packaging

[48] Brouwer (2004)
[49] Botes et al (2006) p. 10

PRIMARY SECTOR SECONDARY (MANUFACTURED/PROCESSED)		**SECONDARY MANUFACTURED PROCESSES**
Manganese	Maize	Food products, not elsewhere classified
Silicon	Wheat	Animal feeds
Vanadium	Grain sorghum	Distilleries and wineries
	Groundnuts	Soft drinks and carbonated water industries
INDUSTRIAL MINERALS	Sunflower seed	
Aggregate and sand	Soya beans	TEXTILE, LEATHER AND WOOD-BASED PRODUCTS
Alumino-silicates	Oats	Wool scouring and combing
Dimension stone	Barley	Spinning, weaving and finishing of textiles
Fluorspar	Rye	Soft furnishings
Limestone and dolomite	Dry beans	Tents, tarpaulins and other canvas goods
Magnetite	Cowpeas, drypeas, lentils	Knitted garments, hosiery and knitted cloth
Phosphate rock	Chicory	Carpets and rugs
Processed phosphates	Sugar cane	Other textiles
Special clays	Chicory	Men's and boys' clothing
Sulphur	Cotton (lint)	Women's and girls' clothing
Vermiculite	Cotton (seed)	Tanneries and leather finishing
Other	Cotton (seed-cotton)	Footwear
	Wattle bark	Sawmilling Ð from round log
	Lucerne, hay	Board Ð laminated, plywood, particle, etc.
	Tobacco	Carpentry and joinery
		Furniture
	LIVESTOCK	Packaging
	Red meat	Stationery
	White meat	Printing, publishing and allied industries
	Butter	
	Cheese	
	Condensed milk, powdered milk	
	Fresh milk	

Although this commodity classification might seem more extensive than the current 62 commodity classification, it lacked one very important detail, and that was the place of supply and demand. Therefore it was impossible to flow the data on a detailed level.

6.1.2 Flow data

The volume and place of supply and demand is now known. The next step is to link distance to the volume in order to calculate tonkilometre (tonkm) flow (tonkm is simply volume times distance, since moving e.g. 10 tons of freight over 10km will cost less than moving that same 10 tons of freight over 100km – 100 tonkm vs. 1000 tonkm).

The distance between magisterial districts is recorded from the centre of each district to another. Once again, this causes a slight error in the model for demand and supply rarely happens in the centre of the magisterial district, but it is an error that is manageable at this stage, and could be improved upon in future.

A technique called gravity modelling (the process is explained in detail in section 6.1.3) is used to determine flows of supply and demand[50]. In the past this process was done manually, but with the new updated model a software program called Flowmap[51]is used to assign the supply and demand data to routes within the economy much faster and more accurately. Once the freight volume is assigned to routes, distance is known and tonkm flow can be calculated.

Botes et al[52] had a less technical way of calculating flow in the economy. The average distance that each commodity is transported was determined from information obtained from operators and practitioners. This average distance was then multiplied with the tonnage to determine a total tonkm per mode. This was a very much aggregated way of calculating flow in the economy, and did not nearly have the detail of current methods.

6.1.3 Gravity modelling

As mentioned earlier, gravity modelling is used to assign the volume of supply and demand to the different routes in the country. Gravity modelling is a robust model that has been widely used for this purpose since it was introduced by Tinbergen (1962) and Linnemann (1966).

Formulation of the gravity model

The formulation of the gravity model was derived from Newtonian Physics and more specifically from the law of universal gravity, where attraction is greater between larger and more closely positioned bodies, according to Zhang and

[50] The whole process of assigning volume to the routes and transforming it into tonkm is administered by Joubert van Eeden, senior lecturer at the University of Stellenbosch and researcher at the Centre for Supply Chain Management, University of Stellenbosch and Zane Simpson, researcher at the Centre for Supply Chain Management.
[51] Developed by Tom de Jong, Utrech University, Netherlands
[52] Botes et al (2006) p. 11

Kristensen[53]. When applied to flows of goods between two points, the model stresses that flow increases with size and proximity of the two points.

According to Porojan[54] the gravity model belongs to the class of empirical models concerned with the determinants of interaction. In its most general formulation, it explains a flow F_{ij} (of goods, people etc.) from an area i to an area j as a function of characteristics of the origin O_i, characteristics of the destination D_j and some separation measurement S_{ij} (Equation 1).

$$F = O_i D_j S_{ij}, \quad i = 1, \ldots\ldots, I; j = 1, \ldots\ldots, J. \tag{1}$$

These separation measurements (also called decay factors) are a factor built into certain branches of the model to enable one to force the flow of that specific commodity volume to increase in distance (since the gravity model naturally finds the closest point of demand). This decay factor, built into the model to force an increase in flow distance, is said to be low. A low decay factor is useful when it is known that a certain commodity will be flowing further than all the closest points of demand. Inversely, a high decay factor is useful if a commodity grouping should flow to closer destination points.

A commodity grouping that will have a low decay factor contains commodities with different unique characteristics (like for example brand names), and each unique brand name is produced in different areas of the country (specialisation). An example of such a commodity grouping is cars. If the Volkswagen car factory in Port Elizabeth had a high decay factor, the whole of the Eastern Cape would drive Volkswagens, because the supply of all Volkswagen cars would be forced to flow to the closest place of demand for cars (which is the principle of a gravity model). Thus a low decay factor has to be built into the flow of this commodity to allow the whole country to drive Volkswagen cars.

Another example is stone quarrying. Stone quarrying will have a very high decay factor, since stone will be used by a building industry in close proximity to the mine. It does not make economic sense to quarry stone far from a building

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53 Zhang and Kristensen (1995) p. 308
54 Porojan, (2001) p. 266

area. The reasons are high transportation costs, the value of the commodity is low and it is not very specialised with different unique characteristics.

6.1.4 Modal flow

Road flow volumes

Now that total flow for the economy is known, it is necessary to break the total flow into flow for the different modes of transport in the country. The reason is quite simply that not all modes of transport cost the same to operate. Luckily, all other modes except for road in the economy are largely regulated, or single owned. Because of this fact, all other known modal data is acquired and then those volumes can simply be subtracted from the total flow answer from the gravity modelling process, thus ending up with road flow. In other words, road flow within the model is calculated by the process of eliminating the known from the unknown.

The reason that no commodity breakdown freight volume data is available for road flow is that most road transport is done by private operators, and firstly they have no obligation to share their information, and secondly there are too many different operators in the country. The other problem is that most domestic road freight rarely goes through a control point where the type of freight on board is recorded. There are only weighbridges that weigh the trucks to ensure no overloading (the system used in the NFFM).

How the other modes of transport in the economy's freight data are acquired will now be explained in brief.

Rail flow volume

Rail transport flow volumes were acquired from the national rail carrier, but also required deconstruction on the same basis as road transport in order to subtract it from total flows in the Freight Demand Model.

Coastal shipping flow volume:

Regarding the coastal shipping volumes, the actual volumes were acquired through the National Ports Authority (NPA) database.

Pipeline flow volumes:

Transnet-owned pipeline volumes on a commodity level were acquired through the Transnet Pipelines database. The lengths of the different pipelines were also calculated, and this allowed the tonkm answer to be gained for the different commodities flowing in the pipelines for the country, as well as where that flow occurs. The volume of product flowing in the pipelines owned by Sasol and Chevron is not included in the model at this stage, and should be researched in future. These pipelines are also relatively recent additions to the national logistics infrastructure compared to the time horizon of this research. Sasol activities started in 2004, Chevron in 1966 and another project by Petroline might become operational soon. Future versions of the model must include these costs as well.

Air flow volume:

The volume for air was gained through phoning the Airports Company of South Africa. They supplied the database containing all domestic freight transported by air during 2007. One problem with the data was that no origins and destinations of the volumes were supplied, nor any commodity detail. The data could therefore not be subtracted from the whole to try and get closer to the volumes that flow on road. It must be understood however that air volume is a very small percentage of total volume (0.0029%[55]) and this does not cause a high level of inaccuracy within the model. It is however an area that could be improved in future.

6.1.5 Improvements on previous modal flow methods

Botes et al[56] had a different and less accurate approach of assigning volume to modes. The modal split and the average distance that each commodity was transported by each mode was determined from information obtained from operators and practitioners. Therefore, an average distance per mode was multiplied with the volume allocated to that mode in order to calculate the tonkm flow. This is once again very much an aggregated methodology for calculating modal flow.

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[55] Calculated by dividing air volumes by the outcome of the Freight Demand Model
[56] Botes et al (2006) p.11

It is clear that the new improved model gave much more detail in the allocation of flow to different modes, and the allocation is very adaptable to economic changes with every annual update of the model.

Now that clarity on modal flow is achieved, the next step is to identify rates for each mode in order to do the calculations and come to a conclusion on the cost of logistics to the economy of South Africa. The processes of acquiring the knowledge of these costs follow.

6.2 Cost rates

6.2.1 Heavy vehicle costs

The level of detail acquired in road transport operating cost data allowed for the calculation of road freight transport costs on a level of accuracy never before achieved. It was, for the first time in South Africa, possible to estimate accurately transport costs on the following levels (each with its own cost breakdown):

- 34 different vehicle combinations each with the following ten cost driver breakdown:
  - Depreciation cost
  - Cost of capital
  - Licence fees
  - Toll fees
  - Cost of insurance
  - Driver fees
  - Fuel cost
  - Maintenance and repair cost
  - Tyre wear cost
  - Overhead costs
- 3 different typologies (metropolitan, corridor or rural)
  - 22 different corridor routes[57] (including directionality)
  - 7 different metropolitan routes

[57] There are not necessarily 22 different corridors within the country, but all routes connecting major towns and cities in the country were classified as corridors

    - 10 different rural areas
- 62 different commodity groupings

This allows the knowledge of what, for example, the petrol costs are to the economy to ship (for example) maize on the Gauteng-Cape Town corridor (Capecor) by road.

This gives a real good indication of what the source of the trucking costs are on many different levels. The operating rates (per tonkm) for the heavy vehicles assigned to the flow of commodity within the model were supplied by a leading specialist[58] in the field of heavy vehicle operating costs in South Africa. The assumptions made with regards to the rate determination are as follow:

Capital cost

Prime movers, superstructures and trailing equipment were all applicable. Where additional information was required, data was obtained from body and trailer builders. Vehicle prices that were needed were drawn from the Dealers' Commercial Vehicle Digest.

The choice of vehicle configurations was limited to 34 in eight different categories. This was a necessary compromise to ensure the typologies could be completed in time (as the time available to attain the heavy vehicle rate data was quite limited). The following factors should be noted:

- Only vehicles above 3 500kg gross vehicle mass were considered
- 4x2 rigid vehicles were included at a minimal level with almost 100% deployed in metropolitan areas
- The following vehicles were excluded:
    - 4x2 rigid tippers and articulated tippers
    - 6x2 freight carriers and articulated vehicles
    - 8x4 bulk carriers and cement mixers
- Car carriers were divided between locally manufactured and imported. The imported versions were applied to the larger corridor movements.

[58] Max Braun Consulting Services

- Pantechnicons[59] – very few were included due to the lack of detail or access to commodity codes and unrealistic segmentation in transport terms

The average interest rate for the year has been applied to all calculations of capital cost.

Driver wages

Driver wages were based on the National Bargaining Council (NBC) agreement (an annual event). Where indicated, a driver assistant has been included.

Insurance

Insurance was based on 6.5% of the capital cost. Goods in transit (GIT) has not been included.

Depreciation

This factor was based on the average depreciation (after taking into account the useful life of prime movers and trailing equipment as well as fridge units where applicable) less the estimated residual value.

Fuel

The average price for inland and coastal diesel (5% sulphur) for the period January to December 2007 as published by SAPIA[60] applied. Consumption was based on a typical km/litre for each segment.

Maintenance and tyres

This is based on the average for the year as published in Max Braun's Operating Cost Benchmarks.

Overhead and administrative expenses

The estimated cost has been broadly based on the Road Freight Association suggested factor for each vehicle category.

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[59] Pantechnicon has become the generic name for vehicles specially designed and constructed to transport furniture (wikipedia.org)

[60] www.sapia.co.za

Vehicle license and toll fees

Toll charges were levied on corridor vehicles only. Licence fees were applied on the basis of direction of travel where applicable – i.e. Gauteng/Cape Town corridor was assumed to be licensed in Gauteng.

Operating criteria

Annual kilometres and work days were estimated for the various vehicle configurations based on the typical nature of the operation.

The estimates of payload and load factors were not based on any specific criteria but did, however, relate positively to the tonkm cost factors that can be expected for the various typologies.

As can be noted, the research done on heavy vehicle rates was very extensive, and only a few uncertainties remain, which is a very big improvement on previous modelling techniques. Now for the first time, thanks to the road transport costing work done above, road costs could be modelled on a highly detailed level.

6.2.2 Rail rates

Rail rates were available from the national rail carrier (Transnet Freight Rail).

6.2.3 Coastal shipping rates

Coastal shipping rates were acquired by intensive research done within the industry[61]. Only rates for container and petroleum shipping could be acquired thus far. Break-bulk shipping rates are lacking in the Logistics Cost Model at this stage. To overcome this, container rates are applied by using assumptions of an average weight per container and applying it to the break-bulk (more on this later). It must be understood that break-bulk coastal shipping is a very small portion of the overall logistics market, but efforts must be put in place to acquire break-bulk shipping rates in future.

[61] Container shipping rates was provided by the South African Association of Ship Owners (Saasoa) and petroleum shipping rates were provided by petroleum shipping agents.

6.2.4 Pipeline rates

After speaking to Transnet Pipelines, it was understood that all Transnet pipeline rates in this country are regulated by the National Energy Regulator of South Africa (Nersa). On the Nersa website an article was found on the decision made for all the Transnet pipeline rates in the country[62].This then allowed the very accurate calculation of the exact cost of a large portion of pipeline activity to the economy. Private pipeline rates (Sasol and Chevron) have not been acquired at this stage, and should be researched in future.

6.2.5 Air rates

South African Airways (SAA) cargo rates were applied for calculating air costs[63].

6.2.6 Improvements on previous methods of transport cost and rate acquisition

Botes et al[64] researched and applied an average cost per mode of transport to carry each commodity grouping. This was far less detailed than current methods, especially with regard to road transport. Only one average rate was applied for distribution, and one for line haul. Currently 34 different vehicle combinations in eight different categories are used, each with its own rate broken down into different cost drivers (capital cost, driver cost etc., as mentioned earlier). This level of detail was never before attained. Detailed costing is a major improvement since it gives a much more realistic overall logistics cost answer for the country. Most commodity groups would require different vehicle combinations for line haul and distribution transport on road, and each of these vehicles would have its own unique cost structure.

The issue of rate and cost, however, still remains. Rail rates can be calculated by access to the rail database. This access is provided by Transnet, but can only be used to calculate very specific rates actually charged in a specific year.[65] This means that the logistics cost model includes the exact rates charged to industry for the provision of a transport service by the railroad. This

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[62] Nersa (2008)
[63] http://ww2.flysaa.com/saa_cargo/
[64] Botes et al (2006) p. 11
[65] Transnet provides a complete database, but the detail is subject to a strict confidentiality agreement. Only summaries that are not commercially sensitive can be published

is a great improvement on a broad assumption based approach, but it also means that actual costs for operating a railroad cannot be calculated. This state of affairs is also true for pipelines. For road transport the converse is true. The researcher wanting to calculate the overall road transport rate charged to the economy on a detailed level will not be able to obtain individual trucking rates. This is because:

- A myriad of different rates are charged by a large number of operators. Many of these rates have strategic marketing significance and do not relate to cost anyway
- None of the operators will divulge these rates, nor for obvious reasons are they available on a central database such as for the railroad
- A large portion of road costs (82%[66]) are "in-house" or ancillary. Transfer costing is seldom used to the extent that it would be correctly available, even if all freight owners are consulted

Costs, on the other hand, for road freight movements can be calculated in great detail according to the cost model methodology. This means that 91% of the model describes costs and 9% describes rates. If rates reflect costs to a 90% degree of accuracy (meaning that a cost of R1.00 will carry a tariff between R0.90 and R1.10) the total model's accuracy to describe costs will still be close to 91%. (It could be hypothesised that a lower than 90% representation will not be possible due to the major distortion that it could cause in the market place.)

Now that all inputs into the current Logistics Cost Model has been explained, and all improvements on previous methods understood, a detailed description of the mathematical modelling process itself can commence.

6.2.7 Storage and handling rates

The rates for storage and handling per ton are still done in accordance with the method proposed by Botes et al[67]. Unit costs of storage in terms of Rand per ton per day were collected for each individual commodity line. The following six main types of storage are identified:

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[66] Havenga et al (2009) The fifth annual state of logistics survey for South Africa, p. 26
[67] Botes et al (2006) p.13

- Hard standing outside (dry commodities)
- Bulk warehouse (dry commodities)
- Silo (dry commodities)
- Shelved warehouse (dry commodities)
- Cold storage (dry commodities)
- Bulk tankard (liquid commodities)
- Specialised tanks (liquid commodities)
- General storage inside (dry commodities)
- Cold storage (dry commodities)
- Storage tanks (liquid commodities)
- Cold storage tanks (liquid commodities).

Storage cost is allocated for each commodity type according to the type of storage associated with the commodity. The rate includes storage and handling rates for the specific commodity per ton.

The average researched storage duration for each commodity grouping was also included in the storage rate per commodity grouping. Botes et al[68] identified two reasons for storage in the logistics chain, namely storage for freight consolidation purposes and intra-seasonal storage. Freight consolidation takes place when commodities are accumulated at a certain location for onward transport in order to optimise the utilisation of the transport modes delivering to and collecting from the accumulation point. A distinction was also made between consolidation for collection as opposed to consolidation for distribution.

The second reason for storage in the logistics chain (intra-seasonal storage) is necessitated by the seasonality of production of certain commodities and the delayed consumption thereof. The intra-seasonal storage duration of commodities that are produced and consumed evenly throughout the year has been assumed to be zero. The duration of storage of all commodities that have non-zero, intra-seasonal storage duration was calculated by determining the difference between the weighted mean time of production and the weighted mean time of consumption.

[68] Botes et al (2006) p.13

The problem in the storage and handling rate calculation methodology by Botes et al is that the same storage delay is assumed year on year when calculating the rates. The methodology has been developed recently to eliminate this static delay in storage. More on the detail of this will be explained in section 7.3.

6.3 Chapter summary

Botes et al[69] researched and applied an average cost per mode of transport when calculating the cost of logistics for the country. This was far less detailed than current methods. The current Logistics Cost Model uses detailed cost inputs for road, and actual rates charged for rail, pipeline, air and coastal shipping. The Freight Demand Model is used as a freight flow data input, where the data is used to calculate cost on a very detailed level, in all areas of the country, using all modes of transportation.

Regarding storage and handling rates, the methodology as proposed by Botes et al is still in effect, except that the static storage delay is adjusted.

All researched rates used are supplied by either industry or knowledgeable professionals.

[69] Botes et al (2006) p. 11

7 The Logistics Cost Modelling process

7.1 Total logistics cost calculation methodology

Before the methodology behind the mathematical modelling of the total logistics cost for the economy is explained, a graphical depiction of the Logistics Cost Model process is presented that recaps the entire process. (Figure 17).

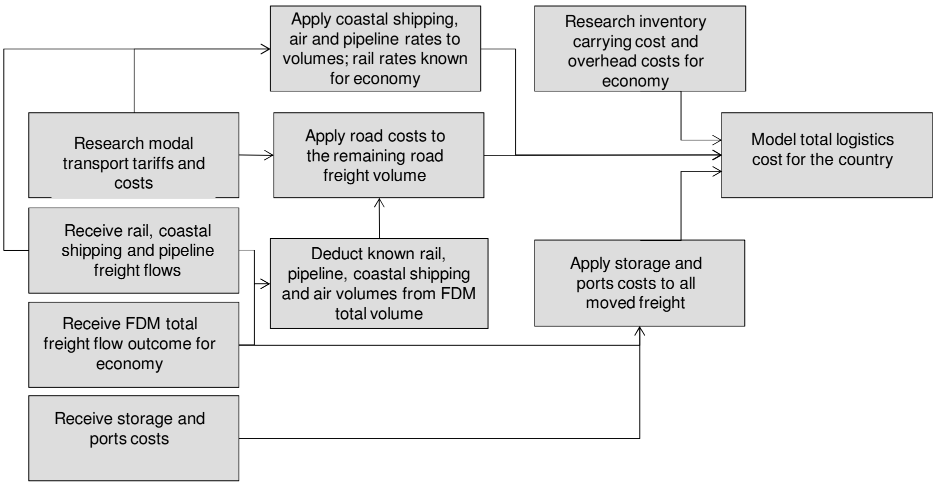

Figure 17: A graphical depiction of the Logistics Cost Model process

As is clear, the researched costs for road transport and rates for other modes of modelled modal freight flows (mentioned earlier) form the inputs into the Logistics Cost Model. Now focus will be placed on the process labelled; “Model total logistics cost for the country”.

In accordance with the method used by Botes et al[70] total logistics cost is a summation of four different elements of logistics (Equation 2)[71].

$$TLC = TC + SC + MAP + ICC \qquad (2)$$

$TLC = Total\ logistics\ cost$

$TC = Transport\ cost$

$SC = Storage\ and\ ports\ cost$

$MAP = Management, admin\ and\ profit\ cost$

$ICC = Inventory\ carrying\ cost$

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[70] Botes et al (2006) p.6
[71] Havenga and de Jager (2009) p. 5

These four different elements are summed together to calculate the total cost of logistics for the country. How each of these elements is calculated will be explained next.

7.2 Transport costs calculation methodology

7.2.1 Total transport cost

Total transport cost is the summation of all different modal costs used in South Africa for freight transport purposes, depicted in Equation (3)[72].

$$TC = L + D + R + A + S + P \tag{3}$$

$TC = total\ transport\ cost$

$L = road\ line\ haul\ cost$

$D = road\ distribution\ cost$

$R = rail\ transport\ cost$

$A = air\ transport\ cost$

$S = coastal\ shipping\ cost$

$P = pipeline\ transport\ cost$

Botes et al[73] summed the same modes together to calculate total transport cost, although the level of detail used as an input into the mathematical modelling was less detailed, as explained in section 7.2.7.

7.2.2 Road transport cost

It is important to mention that two different legs of road transport services exist: road line haul and distribution. The line haul part of the service is the long leg done, usually over a corridor, from warehouse to warehouse. The distribution part of the service is when the goods are either converged at the origin warehouse, or distributed from the destination side warehouse to the retailer.

The equation for computing the country's road line haul freight transport cost appears in Equation (4)[74]

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[72] Havenga and de Jager (2009) p. 6
[73] Botes et al (2006) p.11
[74] Havenga and de Jager (2009) p. 7

$$L = \sum_{i=1}^{n} \sum_{j=1}^{p} \sum_{k=1}^{s} xy_{ijk} [(\mathrm{d} + \mathrm{c} + \mathrm{l} + \mathrm{q} + \mathrm{e} + \mathrm{f} + \mathrm{m} + \mathrm{z})_{\mathrm{ijk}} + \mathrm{t_k}] \quad (4)$$

$L = total\ road\ line\ haul\ transport\ cost$

$i = commodity\ grouping$

$j = typology$

$k = route$

$n = number\ of\ commodity\ groups$

$p = number\ of\ typologies$

$s = number\ of\ routes$

$x = tons\ of\ flow$

$y = distance\ flow\ in\ kilometres$

$d = depreciation\ rate\ per\ tonkm$

$c = cost\ of\ capital\ per\ tonkm$

$l = licence\ fee\ per\ tonkm$

$t = toll\ fees\ per\ tonkm$

$q = insurance\ per\ tonkm$

$e = driver\ fees\ per\ tonkm$

$f = fuel\ cost\ per\ tonkm$

$m = maintenance\ and\ repair\ costs\ per\ tonkm$

$z = tyre\ wear\ cost\ per\ tonkm$

As is clear, the equation involves the summation of all the different cost elements of transport within a typology, on a specific route, carrying a specific commodity. The cost of overheads is left out of the equation, as it is calculated as a separate cost element in the model[75].

It is important to remember that the different cost drivers in Equation (4) represent a specific vehicle type. What is meant by this is that, given the commodity type, typology and route of travel a certain vehicle is assigned to do the haulage. Operating that specific vehicle on that route costs a certain rate, broken down into all the cost elements in Equation (4). The unit of rate is calculated as Rand per tonkm because, as explained earlier, volume and distance have an influence on haulage rates.

[75] Overheads cost is included in the management, admin and profit section of the model

Once all the road line haul flows in the economy have a vehicle allocated to them, the total road line haul cost can be calculated for the entire economy.

The equation for computing the cost of the country's road distribution appears in Equation (5)[76]

$$D = 2[\sum_{i=1}^{n}\sum_{j=1}^{p}\sum_{k=1}^{s} x_{ijk}[(\mathrm{d}+\mathrm{c}+\mathrm{l}+\mathrm{q}+\mathrm{e}+\mathrm{f}+\mathrm{m}+\mathrm{z})_{\mathrm{ijk}}+\mathrm{t_k}]\mathrm{w}] \tag{5}$$

$D = total\ distribution\ cost$

$w = average\ distribution\ distance$

$Refer\ to\ equation\ (4)\ for\ clarity\ on\ other\ symbols$

As was mentioned earlier, road distribution transport is not covered in the methodology of the Freight Demand Model, and for this reason an average distribution distance is researched. This average distribution distance is then multiplied with the tonnage freight on the corridors to calculate the tonkm distribution. The tonkm distribution can then be translated into cost by applying the vehicle rates per tonkm. The reason for the equation to be multiplied by two is that it is assumed that distribution will happen at both ends of line haul, as freight gets converged at one end and distributed at the other.

7.2.3 Rail transport rates

Rail transport cost rates are received from the national rail carrier (Transnet Freight Rail). The rail operator provides cost rates per origin-destination pair and total costs are known for the operator which allows market share calculations on a commodity per flow basis. Therefore there is no mathematical modelling done in order to know the total cost of rail transport for the economy on a detailed basis. Terminals and sidings must however be assigned to magisterial districts to allow comparisons with other modes.[77]

7.2.4 Air transport rates

Air freight volume accounts for a very small portion of the total in South Africa. It is still included in calculating the total cost of logistics however, and efforts are put in place to model this part of the costing process as thoroughly as possible.

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[76] Havenga and de Jager (2009) p. 9
[77] Havenga and de Jager (2009) p.9

Air freight volumes are not available on a commodity breakdown level at this stage, and therefore the equation is quite simplified (Equation 6)[78]

$$A = x \times r \tag{6}$$

$A = total\ air\ transport\ cost\ for\ the\ country$

$x = tons\ of\ flow$

$r = the\ average\ tariff\ per\ ton\ to\ transport\ goods\ by\ air$

The volume of cargo in tons transported by air is simply multiplied with the rate per ton for transporting cargo by air to calculate the total air transport cost for the economy. Distance is not a factor, as air transport rates are expressed as a rate per ton. It is impossible at this stage to pinpoint where the costs are geographically incurred.

7.2.5 Coastal shipping rates

Coastal shipping in South Africa consists mainly of three separate parts which are: the shipping of petroleum in tanker ships, the shipping of containers on container ships, as well as break-bulk shipping on general cargo ships. Petroleum is by far the biggest of the three in terms of volume, about 90% of the total. Rates for shipping petroleum and containers could be acquired, and can be updated annually. Shipping rates for break-bulk cargo however is lacking in the Logistics Cost Model at this stage. The rate researched for shipping petroleum is a rate per ton (distance is not a factor in determining the rate of coastal shipping, and therefore the rate is not per tonkm). Regarding the shipping of containers, a single rate per 20 foot container was researched and applied. Coastal container shipping rates were also applied on break-bulk traffic through an assumption that the average 20 foot container would weigh 20 tons (efforts are currently in place to improve upon this assumption). By applying this assumption an estimation was made on the number of containers that would be needed to move all of the break-bulk, and then the container rate was applied to calculate the overall cost for the break-bulk coastal traffic. This was a broad

[78] Havenga and de Jager (2009) p. 9

assumption and should be researched further in future to improve the cost model. The Equation follows (Equation 7)[79].

$$S = r_p x_p + \left(\frac{r_c}{20}\right) x_c + r_c \vartheta \qquad (7)$$

$\mathrm{S} = total\ coastal\ shipping\ cost$

$r_p = rate\ per\ ton\ for\ shipping\ petroleum$

$x_p = tons\ of\ petroleum\ shipped$

$r_c = rate\ for\ shipping\ one\ container$

$x_c = tons\ of\ break - bulk\ freight\ shipped$

$\vartheta = number\ of\ containers\ shipped$

7.2.6 Pipeline rates

The calculation in Equation (8)[80] below was applied to obtain the total Transnet owned pipeline cost for the country.

$$P = \sum_{g=1}^{h} \sum_{i=1}^{n} a_{gi} r_{gi} \qquad (8)$$

$P = total\ Transnet\ owned\ pipeline\ cost$

$g = the\ origin\ and\ destination\ pair\ of\ the\ line$

$i = commodity\ grouping$

$h = number\ of\ different\ origin\ and\ destination\ pairs$

$a = volume\ in\ cubic\ metres$

$r = rate\ per\ cubic\ metre$

The volume of product, as well as the rate charged, differs for each Transnet owned pipeline in the country. Therefore, with each different origin and destination pair, the volumes and rates would differ. This is why it is included in the calculation, for it allows the ability to pinpoint the cost geographically.

The answer achieved out of the methodology could be compared to the total income for the state-owned enterprise for verification.

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[79] Havenga and de Jager (2009) p.9
[80] Havenga and de Jager (2009) p. 10

Sasol also operates gas pipelines between the Panda fields in Mozambique and Mpumalanga. The costs associated with these should be included in the future.[81]

7.2.7 Improvements on previous transport methodology

Botes et al[82] applied different, less detailed methodology for calculating total transport costs for the country. All the different transport modes had each one average researched transport rate per tonkm that was applied throughout. The tonkm for each mode was calculated by applying an average distance travelled per mode, and multiplying this average distance with an average percentage of tonnage carried per mode of each commodity type. It is clear that this was a less accurate and less detailed method than the current transport costing methodology.

7.3 Storage and ports cost calculation methodology

This is the part of the model where all the research regarding rates is calculated through the methodology proposed by Botes et al (2006) as was mentioned earlier. The storage and handling rates for the 132 different commodity groupings (as proposed by Botes et al) are updated annually[83]. The rates for the 132 different commodity groupings are then translated into the 62 commodity groupings used in the Logistics Cost Model. This task is performed by using the SIC code guide[84] to identify where the commodity grouping's rate should be applied. If more than one of the 132 commodity groupings with different rates fell under one of the 62 commodity groupings, the average of the different rates were applied.

The equations used for calculating the total storage and ports cost for the economy follow (equations (9) and (10))[85].

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[81] Havenga and de Jager (2009)p. 10
[82] Botes et al (2006) p. 6-7
[83] The update is performed by Neil Jacobs, senior lecturer at the Department of Logistics, University of Stellenbosch
[84] Potgieter et al (1997)
[85] Havenga and de Jager (2009) p. 11

$$SC = \sum_{i=1}^{n} x_i \, (r_s + r_h)_{\mathrm{i}} \tag{9}$$

$$r_s = \sum_{\mathrm{i=1}}^{\mathrm{n}} (\mathrm{r_b})_{\mathrm{i}} \, d \left(\frac{v_{current\ year} - v_{previous\ year}}{v_{previous\ year}} + 1 \right) \tag{10}$$

$\mathrm{SC} = total\ storage\ and\ ports\ cost$

$i = commodity\ grouping$

$x = tons\ of\ flow$

$r_s = storage\ rate\ per\ ton$

$r_h = handling\ rate\ per\ ton$

$\mathrm{r_b} = static\ storage\ rate\ per\ ton$

$d = static\ storage\ delay\ in\ months$

$v = sectoral\ inventory\ cost$

As is evident, total storage cost is calculated (equation 9) by taking the volume of each commodity and multiplying it with the storage and handling rate for that specific commodity. As was mentioned earlier, the storage rate per ton already includes the average storage period that each commodity grouping would normally spend in storage annually, and the handling rate already includes all the times each commodity grouping would be handled on average. It is therefore not necessary to multiply the handling or storage rate by more than one in the equation to try and take multiple handling and storage into account. Domestic freight movement will be handled and stored at warehouses, where imported and exported goods will be handled at the ports as well as inland before and after storage. There is however one shortcoming in the storage rate calculation methodology.

As was mentioned earlier in this dissertation, with each annual update the same static average storage delay for each of the different commodity groupings are assumed, and therefore only the cost of storage is updated. Therefore a second equation was derived.

Equation (10) takes the static storage delay in inventory as proposed by Botes et al and then multiplies it with the researched percentage change in inventory costs[86] from the previous year (per sector of the economy) in order to adjust the static delay.

Through this calculation, the Logistics Cost Model takes the difference in average storage period year on year per commodity grouping within the economy into consideration. This elimination of static delay is the only recent improvement made in the storage and ports cost calculation for the economy.

7.4 Inventory carrying cost calculation methodology

Inventory carrying cost is calculated by applying the Rand value of inventory levels for the different industries in the economy, as published in the Annual Financial Statistics Survey of StatsSA[87], and then multiplying that value with the weighted average repo rate for the year (equation 11)[88].

$$ICC = \sum_{u=1}^{o} r_i e_r \tag{11}$$

$ICC = total\ inventory\ carrying\ cost$

$u = industry\ type$

$o = number\ of\ industries$

$r_i = value\ of\ inventory$

$e_r = weighted\ average\ repo\ rate\ for\ the\ year$

Inventory carrying cost can further be split into:

- Inventory carried in storage
- Inventory carried while transported

It is important to make this distinction, as the long distances of freight transportation in South Africa does have a significant effect on the inventory delay, and should be analysed.

The methodology for splitting the inventory carrying cost will be explained briefly. The average travel distances (ATD) for freight movement on the corridor

[86] The annual inventory cost in the economy is accessed in Statistic South Africa's Annual Financial Statistics Survey estimates.
[87] AFS (2007), available on www.statssa.gov.za
[88] Havenga and de Jager (2009) p. 11

and rural typologies are calculated by dividing tonkm by tons[89] (metropolitan traffic is excluded from the equation, since the ATD is negligible regarding inventory delay). This ATD is then multiplied with an average travel speed of 75km/h to calculate the average travel time (ATT) in hours. A factor is added to the ATT to take stoppage time into account. This ATT in hours is then converted into ATT in years (by dividing the amount by the number of hours in a year, 8 760). The ATT in years is then multiplied by the value of the goods transported on that specific typology (corridor or rural) to get to the rand-years transported. This rand-year figure for corridor and rural is the multiplied by the average interest rate for the year to get to an amount of inventory delay on road.

Regarding their method for calculating inventory carrying cost, Botes et al[90] multiplied the average annual interest rate with the average value of each different commodity grouping, and then multiplied it with the average ton years spent for each commodity grouping in transit and storage. Primary goods were valued by Botes et al at an average of R290 per ton throughput and secondary goods at R671 per ton throughput. These values were obtained by dividing total throughput by the total value of goods produced as reflected in the national accounts.[91] Transport time was based on the amount transported and the transit time for each mode and commodity type.

The problem with the methodology proposed by Botes et al is that they applied the interest rate to the value-added worth of the aggregated commodities or products for the agricultural, mining and manufacturing sectors. Value added from other sectors was excluded and the final value of the inventory, which would have required detailed industry-level research, was not used (as it was not available). The result was that the inventory carrying cost for the economy was severely understated.

Therefore the current method is superior as it considers the total value of inventory in the country that needs to be financed.

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[89] The FDM data is used for this calculation
[90] Botes et al (2006) p. 8,14
[91] SARB 2004

7.5 Management, Admin and Profit

The methodology proposed by Botes et al[92] is still in effect here. The cost of management and administration is calculated as a percentage of the unit cost of transport and warehousing. This percentage, which varies according to storage type and transport mode, is derived from information obtained from operators and practitioners. Efforts are currently underway to improve this calculation for future model updates.

7.6 Chapter summary

Total logistics cost is the summation of transport, storage, overheads and inventory carrying costs. There were major improvements in the methodology of transport and inventory carrying cost calculations since the methodology proposed by Botes et al. The current method uses much more detailed inputs and far more refined techniques of costing. Storage and overheads are still calculated with the same methodology proposed by Botes et al. except that the static storage delay is removed in the calculation of storage costs.

92 Botes et al (2006) p. 9

8 Current Logistics Cost Model shortcomings and proposed improvements

Now that all the model improvements have been revealed, it is necessary to focus on the shortcomings that are still present in the model. These shortcomings will need to be given attention in order to improve the model even further in future.

8.1 Management, admin and profit

As was explained earlier there have been no improvements since Botes et al in the methodology used in this section of the model. This does not mean that there is nothing at fault with it. The problem is that an average percentage of management and administration is researched, and this percentage is then multiplied with the unit cost of transport and storage per commodity. Using an average, un-weighted management and admin rate makes this methodology not very accurate. Different industry types, as well as the size of the company, will have an effect on its cost of management and administration, relative to the throughput of commodity that it moves around. Therefore, just applying an average percentage for management and administration is far from ideal.

It is felt that there should be further research done in order to:

- Find published data
- Find unpublished sources of data or
- Research and create data of actual management and administration costs spent in a large sample of the logistics sector in the economy.

Until this objective is achieved this section of the model will remain speculation.

8.2 Logistics cost as a percentage of turnover

It is impossible to indicate, with the current model methodology, logistics cost as a percentage of turnover. The reason is that the amount of logistics cost covered by each industry in the economy is unknown. All that is known is the weight of commodity in the economy, where the commodity is moved as well as the cost of moving the commodity. Who is actually covering the costs is a very important question that needs to be answered.

The reason for its complexity is Incoterms. Incoterms are the terms of sale that are used internationally to define the responsibilities of both the buyer and the seller in any contract of sale. According to Coyle et al[93] domestic terms of sale between buyers and sellers are primarily Free on Board (FOB) origin and FOB destination. In total there are thirteen different Incoterms. Developed by the Paris-based International Chamber of Commerce in 1936, these Incoterms are internationally accepted rules defining trade terms.

For exporting, the terms delineate buyer or seller responsibility for:

- Export packing cost
- Inland transportation (to and from the port of export and import)
- Export clearance
- Vessel or plane loading
- Main transportation cost
- Cargo insurance
- Customs duties
- Risk of loss or damage in transit

Because of all these different terms of sale, the job of calculating the logistics cost as a percentage of industry turnover on a macroeconomic scale is complex.

It would be of great use however to be able to tell which industries in the economy spends more on logistical costs as a percentage of turnover, as well as the difference in primary, secondary and tertiary sector spending. This would provide decision makers with the ability to compare their industry's logistical spending to other industries, as well as to monitor the trend in their percentage of turnover spent on logistics.

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[93] Coyle et al (2003)

It is therefore necessary in future that research should be done in order to firstly:

- Determine the Incoterms used by the different industries
- Split the logistics costs per industry of the economy
- Research the turnover per industry in the economy (this is available on www.statssa.gov.za under the Annual Financial Statistics Survey)

Once this is done it will be possible to make the comparison, but the methodology for splitting the logistics cost spending per industry is still missing at this stage.

8.3 Including Sasol and Chevron pipelines in model

With the model methodology as it currently stands, only Transnet-owned pipelines are included in calculating the cost to the country. Sasol and Chevron own private pipelines that still need to be included in the costing methodology. Efforts are currently in effect to gain information on the location of the Sasol and Chevron pipelines, as well as the volumes of product pumped through them.

Currently these volumes are reflected on road, and thus road volumes and costs are slightly overstated at this point.

8.4 Finding origin and destination data for air transport

Air transport data acquired for the model at this stage does not include origins and destinations for the transport of goods. It only indicates volume moved. Therefore it is not possible to pinpoint the geographical area of air transport spending. It is therefore necessary to either:

- Gain origin and destination data withheld at this stage
- Encourage the airports to record this data

8.5 The lack of rail terminal costs in the model

With the cost model as it is at the moment, the terminal handling costs of rail are not included in the costing process. Only storage handling is included. It is felt that this should be included in the model in future, especially if more freight should move to rail and this cost component becomes more important.

The way it should be included is by researching the terminal handling cost per ton at the different rail terminals in the country, and multiplying the tonnage freight that passes through those terminals by the rate.

8.6 Lack of distribution data obtained in the Freight Demand Model

As is known, the Logistics Cost Model uses data from the FDM in order to calculate the cost of logistics in the economy. As mentioned earlier in this dissertation, the problem experienced with the FDM data is that it only includes line haul movement. The distribution of corridor freight on road is excluded at this stage, and therefore assumptions need to be made regarding the average distance of distribution. However, even with these assumptions, the detail within the road transport costing model is far superior to the previous methods proposed by Botes et al, but still needs to be refined even further.

A proposed improvement is to use the NFFM to calculate logistics costs in the metropolis areas of the country. The outcome will not be at a commodity breakdown level, but it will give a clear indication of the difference in total logistics costs in the metro poles obtained from the FDM data (that does not include distribution in the metropolis, and assumptions are made on the average distribution distance) and the NFFM data (that does include distribution in the metropolis). Therefore, the difference in total cost can be used as a weight to adjust the FDM cost outcome on a commodity level within the metropolis. The cost calculated through this methodology will reflect the actual changes in the tonkm of goods flowing in the metropolis year-on-year, and will not only be based on the fixed distribution distance assumption that is currently applied on the FDM corridor tons. The outcome is a model that is more dynamic to changes in the economy.

8.7 Coastal shipping rates for break-bulk traffic

The rate charged by the shipping industry for shipping break-bulk cargo coastwise in South Africa needs to be researched further and added into the model. At this stage an assumption is made on the amount of containers it would take to move the break-bulk cargo, and then container rates are applied to that number. It must be understood however that break-bulk shipping only forms 10% of coastal shipping traffic, and 0.02% of total transport cost, but it is still an improvement that could be studied further.

8.8 Chapter summary

Even though there have been significant improvements achieved in the recent history of the Logistics Cost Model, there are still some shortcomings that exist within the methodology. It is important to take note of these shortcomings, and to focus on improving it in future. It will aid in making the model all the more accurate. Accuracy is important, as the model plays an important role in macroeconomic decision making and consultation in the country.

9 Analysis of the current Logistics Cost Model results (2007 update)

9.1 Overview

Now that the whole process behind the Logistics Cost Model has been thoroughly explained, understanding the outcomes and what they mean becomes all the more important to decision makers. This section will unveil the outcomes of the cost model, as well as what these outcomes mean and how they must be interpreted in order to understand fully the current situation of the domestic logistic environment in South Africa, as well as what decisions can be made in order to alleviate some of the challenges the country might face.

9.2 Logistics Cost Model results

Logistics activity seems to have increased steadily since 2003, with a sharp increase towards 2007, as is clearly evident in Figure 18, an indexed nominal growth graph of the different logistics activities. It is clear that transport, inventory carrying cost and storage costs all experienced sharp growth. This does provide clear evidence of increased freight flow in the country.

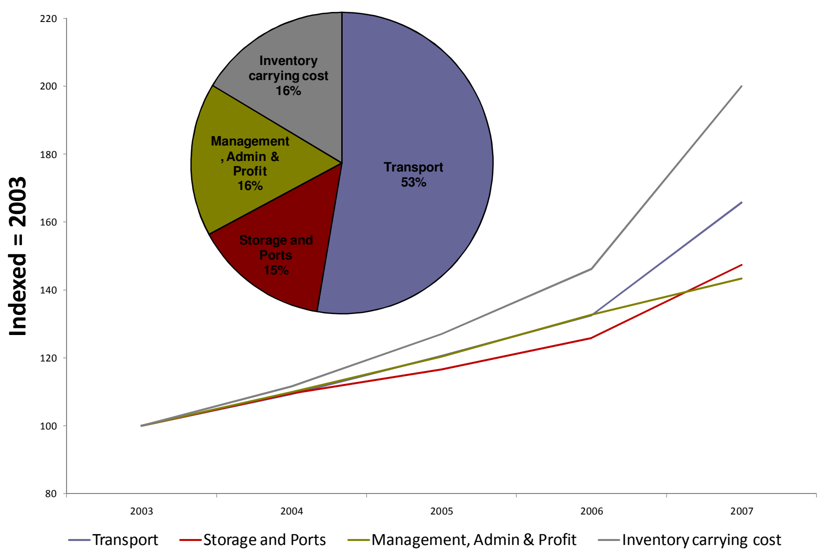

Figure 18: Logistics cost growth at current prices (nominal) and 2007 cost contribution[94]

What is also evident is that inventory-carrying costs in the economy had a sharper increase than the rest of the economy, followed by transport costs. One of the key reasons behind the increase in inventory carrying cost was the sharp increase in the Reserve Bank's prime lending rate, especially during 2007, as is depicted in Figure 19. This increase caused tied up capital to become much more expensive to finance during 2007.

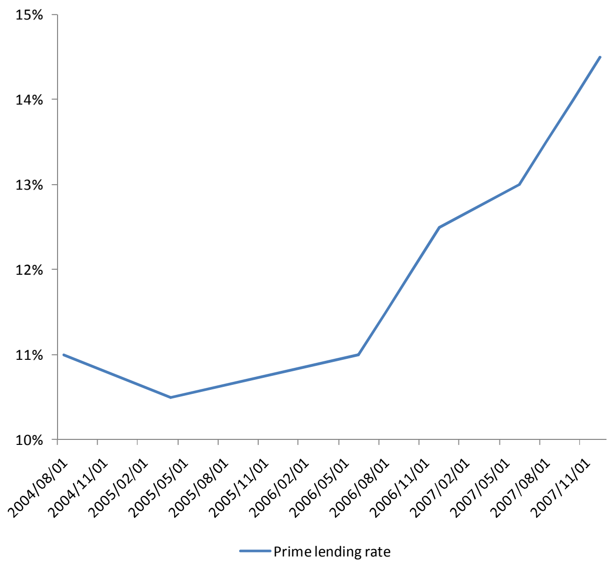

Figure 19: Historical prime lending rate growth[95]

Another factor that led to this increase in inventory-carrying cost is the fact that, because of the growth in logistics activity mentioned earlier, more stock was kept in storage in the economy (R393 billion versus R332 billion in 2006[96]). Higher inventory levels coupled with the sharp increase in the prime lending rate (mentioned earlier) caused the inventory-carrying cost to increase the way that it did.

The growth in Figure 18 was in nominal terms (in other words, it includes inflation). Figure 20 shows the real growth in the logistics cost elements.

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[94] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p. 15

[95] http://www.reservebank.co.za/internet/Historicdata.nsf/Mainpage?OpenPage&Click=42256DA4002CFF0E.29d44b91ee5b4df442256d860053d613/$Body/0.DF0

[96] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p.16

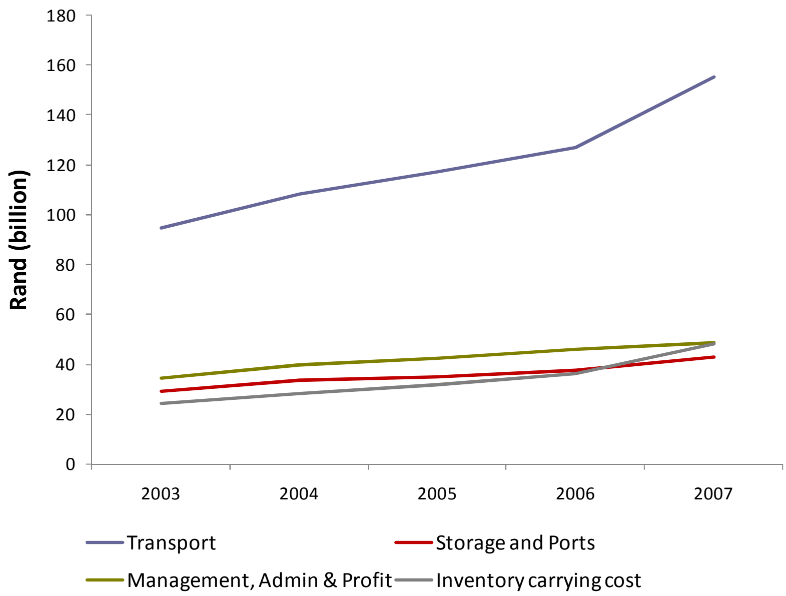

Figure 20: Logistics cost growth at constant prices [97]

Even with inflation taken out of the equation, sharp growth is still evident in the transport and inventory-carrying cost elements of the economy.

To gain a better understanding of how the total cost of logistics in South Africa is compiled, as well as the mix of these different elements, Figure 21 was compiled.

[97] Havenga et al (2008) The fifth annual state of logistics survey for South Africa p. 15

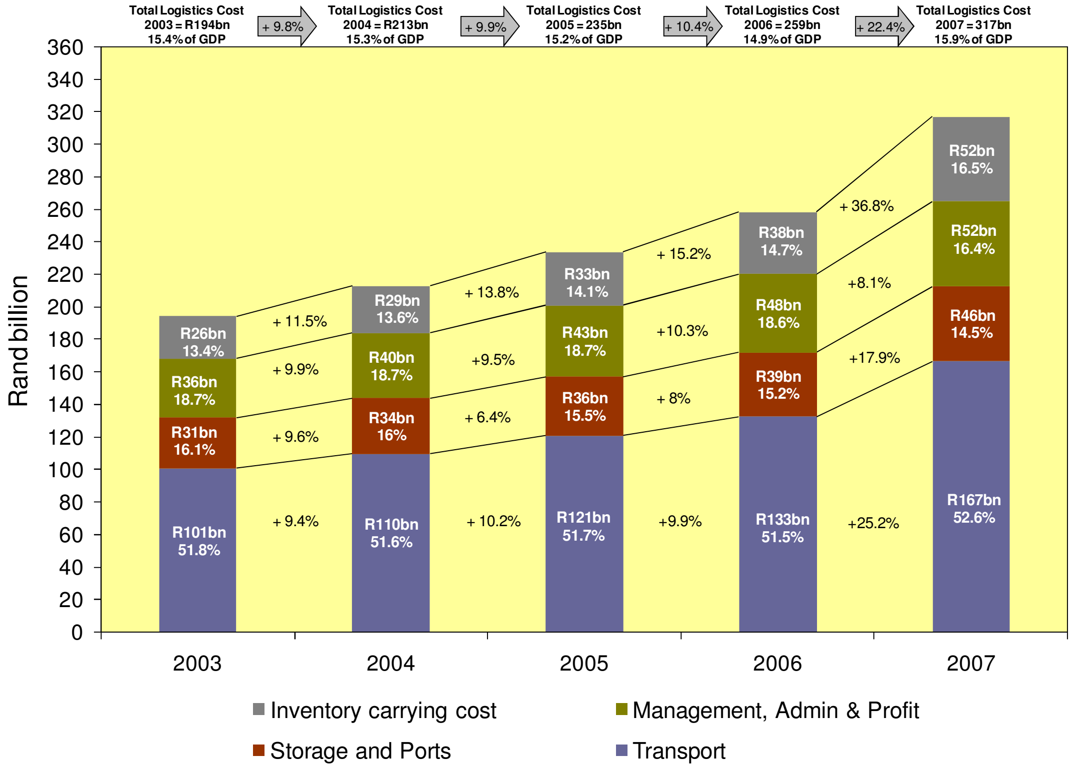

Figure 21: Actual logistics cost figures for South Africa[98]

The South African domestic freight logistics cost, expressed as a percentage of GDP, is at its highest, reaching 15.9%, since the inception of the cost model. If this figure should be compared to the USA historical trend, it becomes clear that it is quite high (Figure 22).

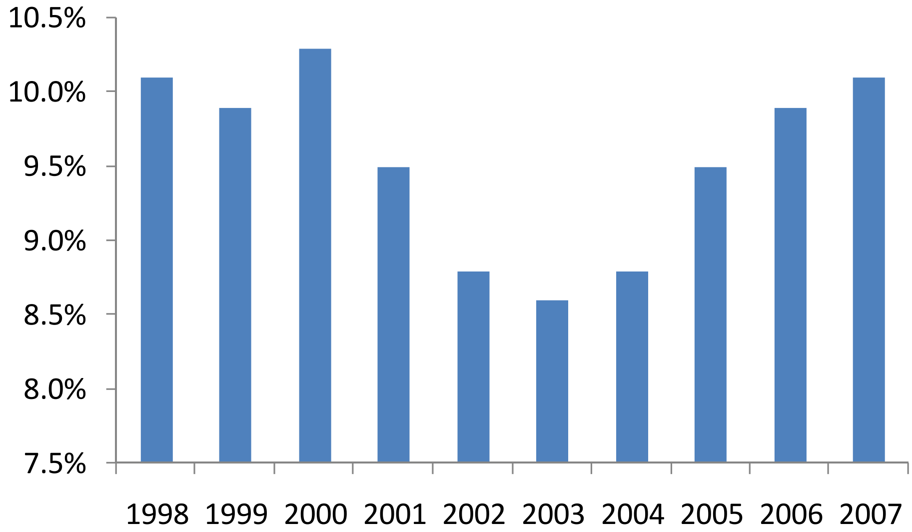

Figure 22: The trend in USA logistics cost expressed as a percentage of GDP[99]

[98] Havenga et al (2008) The fifth annual state of logistics survey for South Africa p.16

The highest level of logistics cost reached in the USA was in the year 2000, and it was still under the 10.5% mark (expressed as a percentage of GDP). It is slightly concerning that South Africa's domestic logistics cost is one and a half times that figure. To place South Africa's domestic logistics cost further into perspective, Table 3 was created.

Table 3: Logistics cost expressed as a percentage of GDP of selected regions[100]

Region	Logistics cost as percentage of GDP (2002)
North America	9.9%
Europe	13.3%
Pacific Rim	15.7%
South America	14.3%

It is clear that South Africa's domestic logistics costs are comparable to South America and the Pacific Rim. It would be preferable to be closer to Europe or North America.

Domestic transport cost is the largest contributor to South Africa's high domestic logistics cost, responsible for over half of the costs (Figure 21).

Domestic transport cost expressed as a percentage of GDP is depicted in Figure 23.

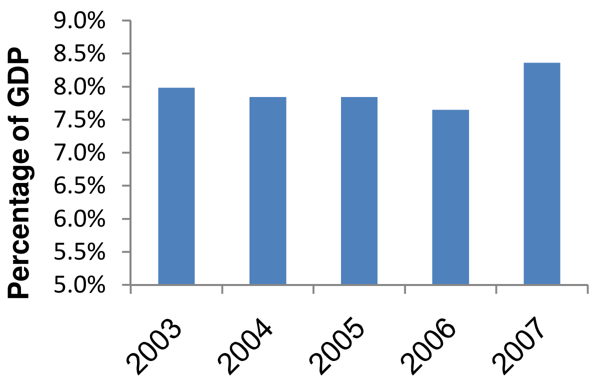

Figure 23: Transport costs as a percentage of GDP[101]

[99] Wilson (2007)
[100] Rodrigues et al (2002)

It is a disturbing sight to see transport costs indicating such a sudden increase in 2007. Much can be blamed on the 32% diesel price increase during 2007 and, since fuel contributes 32% of road transport costs (and with road transport having an 87% volume market share over rail), this would have a significant effect on transport costs in the country. Furthermore, it also highlights South Africa's vulnerability to fuel price fluctuations.[102]

The monthly price of diesel during 2006 and 2007 is depicted in Figure 24.

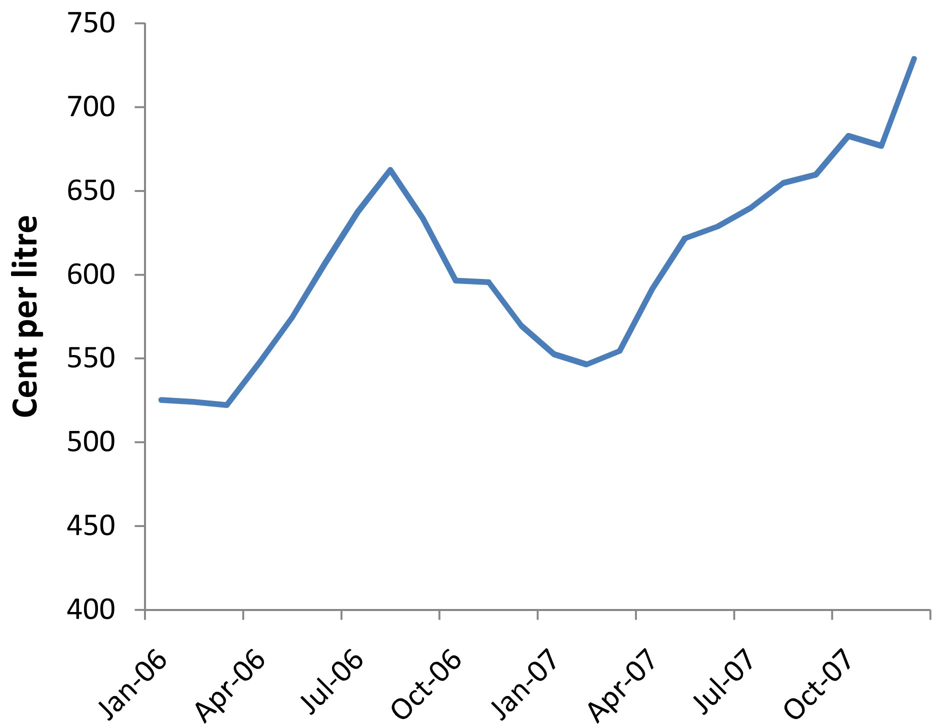

Figure 24: The monthly price of diesel (inland)

A comparison between the primary and secondary sector logistics cost is also possible, as is depicted in Figure 25.

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[101] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p.18
[102] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p.18

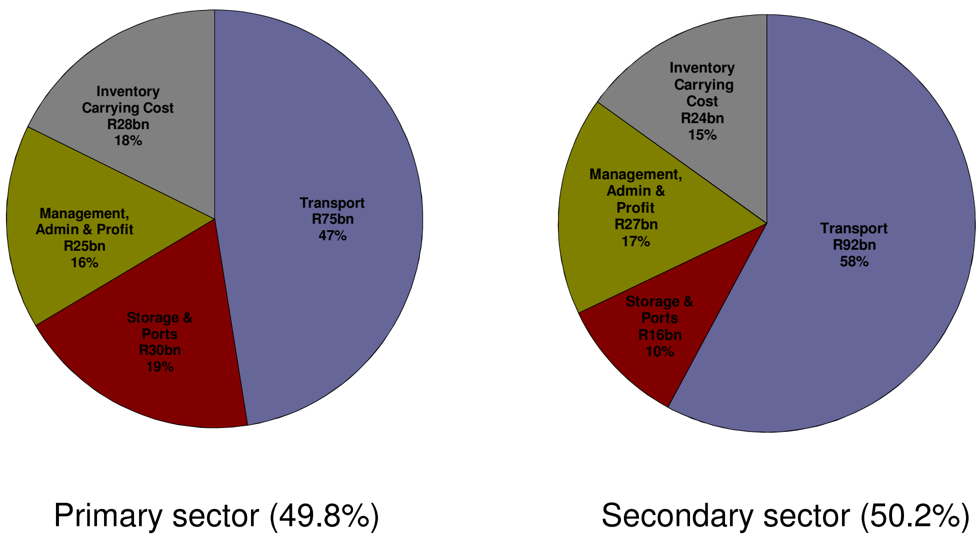

Figure 25: Primary and secondary sector logistics cost elements[103]

It must be explained that Figure 25 is not a resemblance of which sector carries most of the cost of logistics in South Africa. It purely reflects which sector accounts for the most logistics cost in the economy

The secondary sector of the economy accounts for most of the transport costs, while the primary sector accounts for most of the inventory carrying cost. The reason for the secondary sector having the higher transport costs is quite possibly that secondary manufactured goods are more expensive to transport due to their complexity (needs to be palletized, containerized etc.). This large percentage of transport costs in the secondary sector is a definite concern to the manufacturing sector, especially in today's economic environment, forcing the sector to try and cut costs to break even, leading to job cuts.

The primary sector experiences higher inventory carrying costs quite possibly due to the fact that the primary sector is much more exposed to seasonal supply, but continuous demand (agriculture). The sector therefore needs to keep a lot of stock to feed the continuous demand throughout the year, and all that stock needs to be financed.

As explained earlier in this dissertation, inventory carrying cost for the economy can be broken up into inventory carrying cost while in storage, and inventory carrying cost while being transported (Figure 26).

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[103] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p.19

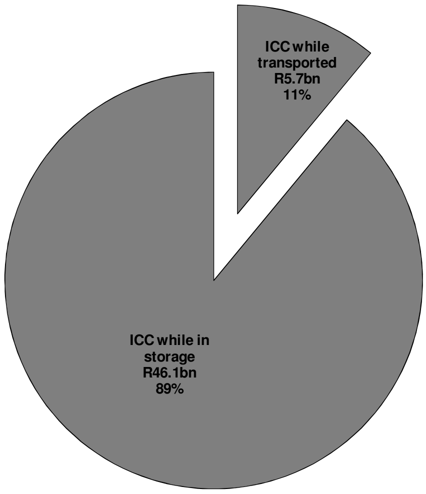

Figure 26: Transport's contribution to inventory delay financing[104]

It is clear that more than 10% of inventory carrying costs are due to long travel distances in South Africa. Better transport scheduling is a possible solution to this problem, but a better, more manageable solution to the problem lies in the other 89% of the inventory delay. Better sales forecasting together with the inbound transport scheduling could alleviate this cost dilemma.

Another logistics cost element that experienced an increase from 2006 to 2007 is storage and ports cost (rising from R39 billion to R46 billion). The causes of this increase are depicted in Table 4.

Table 4: The causes of increase in storage cost in 2007[105]

Change incurred due to:	R billion
1. Inflation	2.8
2. Increase in storage volume	0.4
3. Storage costs increases	1.7
4. Delay in inventory	2.2

Inflation and delay in inventory clearly are the main contributors to the storage cost increase in the economy, accounting for 70% of the increase. Direct

[104] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p.17
[105] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p. 17

inflation caused a R2.8 billion increase in the storage cost experienced in the economy. Storage volume increase is the actual increase in the volumes stored in the economy and was not a major contribution to the increase. Storage costs increases above inflation are the actual increases in the cost of storage per stock keeping unit (SKU). This had a rather large impact on the total increase of storage costs. Delay in inventory is the actual time that a SKU will spend in storage. A large increase in the delay indicates that, on average, stock was kept longer in inventory in the country (also contributing to the higher inventory carrying cost).

Now that all the different areas of the country's logistics costs are understood, another important facet needs to be addressed, and that is the modal cost contribution to the economy. The two largest contributors to the cost of transport in the country are road and rail (these two modes contribute over 90% of the logistics cost of the economy, as indicated in Figure 27).

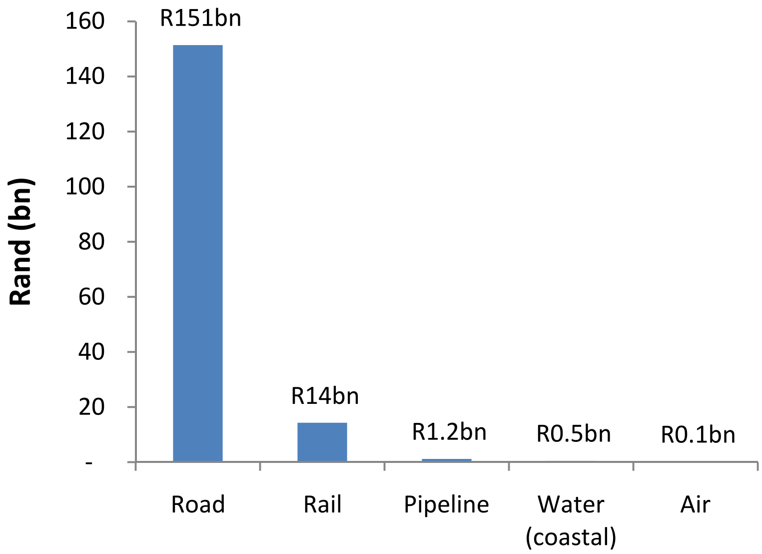

Figure 27: Freight Transport bill for various modes in South Africa[106]

It is clear that road is a very large contributor to the logistics costs of the economy. The fact that it is by far the largest freight volume carrier in the country is the primary cause. Future growth in freight volumes could cause serious problems for South Africa with road transport having such a high freight

[106] Havenga (2008) "Unpublished Transnet report", p.6

market share. As road corridors are already very congested, it is quite possible that road transport costs for the economy will increase dramatically in future because of high increases in infrastructural investment, high cost of road transportation, the cost of congestion etc. A look at the history of transport cost growth (Figure 28) provides some level of concern.

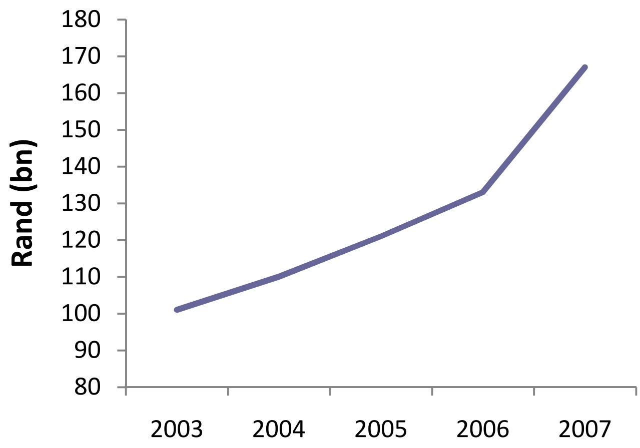

Figure 28: Transport cost in South Africa[107]

It must be remembered that road transport costs are by far the biggest contributor to this cost growth.

Another way of looking at the transport cost growth problem is to look at the transport sector's contribution to total logistics cost, as indicated in Figure 29.

Figure 29: Transport's contribution to logistics costs in South Africa[108]

[107] Havenga (2008) "Unpublished Transnet report", p.4

It seems that there was a slight decreasing trend in the past, but this is not the case anymore.

If focus should be put on road transportation it is clear that the largest road transport cost driver, fuel and lubrication, is out of the South African transportation industry's control (Figure 30).

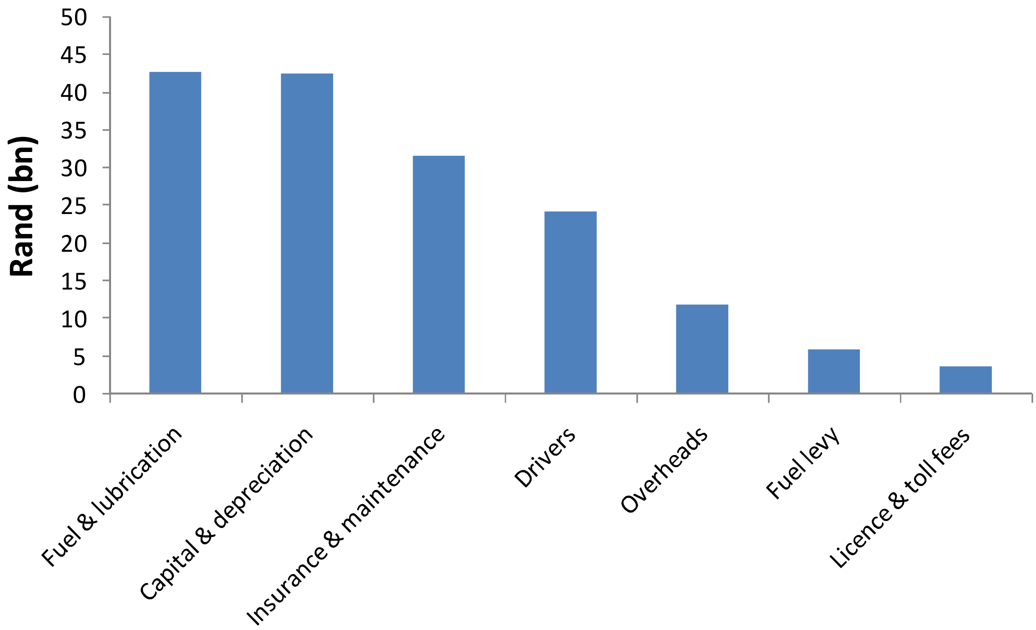

Figure 30: Road cost drivers[109]

The largest contributor mentioned is the cost of fuel. The cost of fuel could quite possibly increase dramatically in future, evident by the large increase historically (Figure 31).

[108] Havenga (2008) "Unpublished Transnet report", p.4
[109] Havenga (2008) "Unpublished Transnet report", p.8

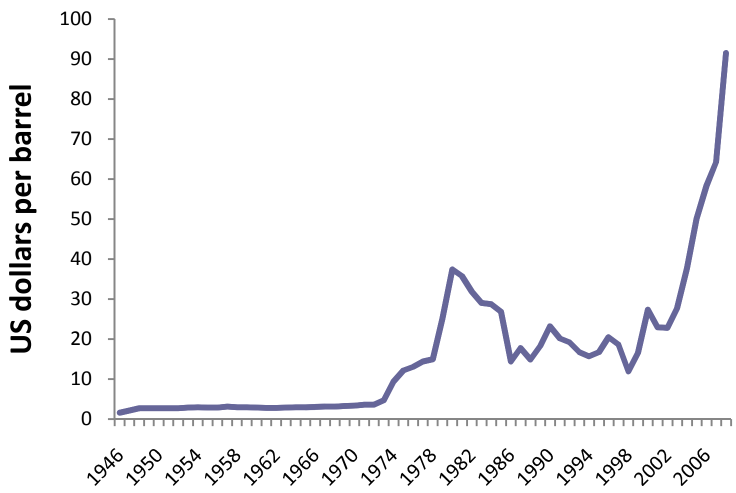

Figure 31: The historic trend in the cost of oil[110]

Road transportation is heavily dependent on fuel and would feel the impact directly in future should the oil price continue to rise as it has done up until now.

Breaking down the road cost drivers (mentioned in Figure 30) into the different typologies of the country paints the picture depicted in Figure 32.

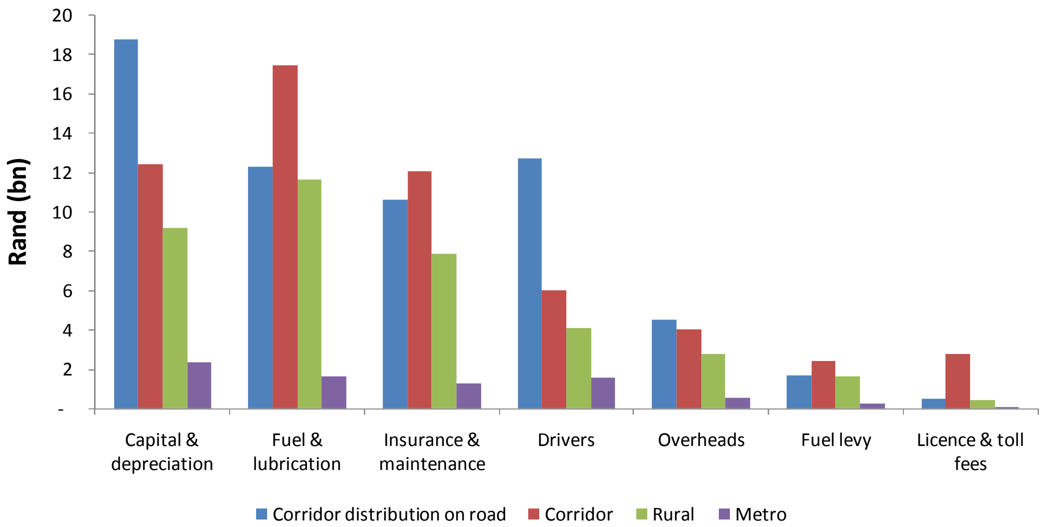

Figure 32: Cost drivers of road transport per typology[111]

It is clear that there is a lot of capital and depreciation on the distribution end of logistics. This is because smaller freight vehicles are generally used for distribution, causing more vehicles needed to distribute the large volumes

[110] http://inflationdata.com/inflation/inflation_Rate/Historical_Oil_Prices_Table.asp
[111] Havenga (2008) "Unpublished Transnet report" p.9

brought in by the larger line haul vehicles. On the corridors however fuel has the biggest share of the costs due to the longer distances travelled.

Dividing the road cost drivers into the different corridors of the country results in Figure 33.

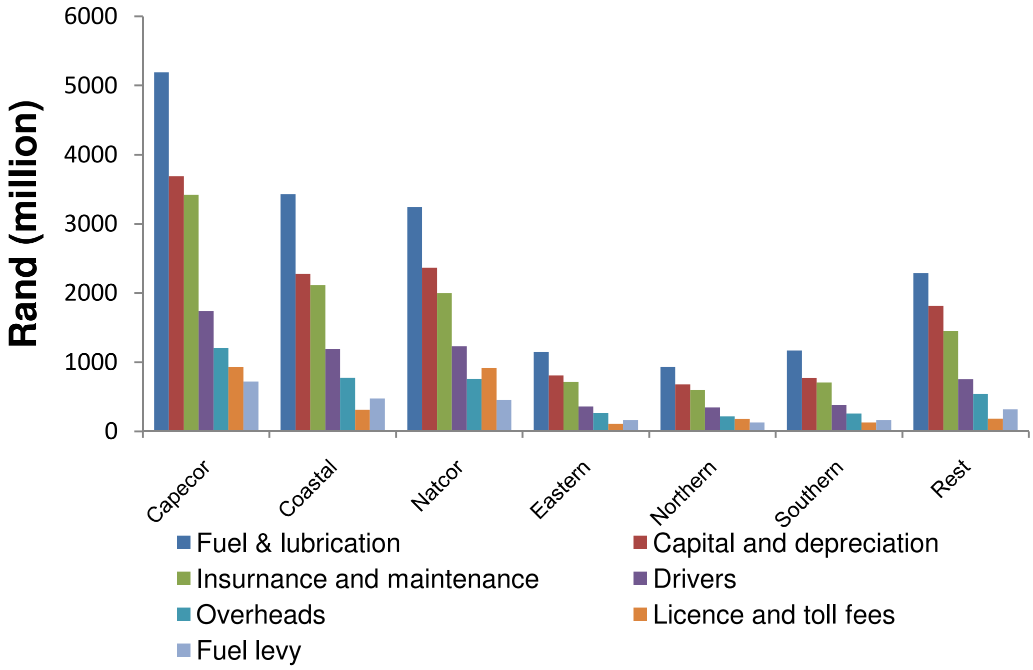

Figure 33: Road transport cost drivers per corridor[112]

It is clear that the Cape Town–Gauteng corridor (Capecor) has the largest costs of all the corridors in the county, even if it does not necessarily carry the most freight (the most freight is carried on the Natal–Gauteng corridor, Natcor). The reason behind the higher transport cost on the corridor is in distance: Capecor is more than twice as long as Natcor (1400km versus 600km). The result is that freight has to travel far longer distances to its destination, which causes very large logistics costs for the economy, especially in fuel (a cost of over R5 billion).

Now that the focus on road is understood, it is necessary to take a closer look at road and rail together (market share).

[112] Havenga (2008) "Unpublished Transnet report", p.9

Table 5 gives a market share comparison between road and rail. Road is further divided between road for reward (outsourced), and road as ancillary traffic (in-house).

Table 5: Market share for land freight[113]

<table>
<tr><th colspan="2"></th><th>Tons in millions</th><th>Ton-kilometres in billions</th><th>Cost or income in billion Rand</th></tr>
<tr><td rowspan="3">Mode</td><td>Rail</td><td>205</td><td>129</td><td>14</td></tr>
<tr><td>Road for reward (outsourced)</td><td>279</td><td>58</td><td>27</td></tr>
<tr><td>Road as ancillary traffic (in-house)</td><td>1 094</td><td>187</td><td>124</td></tr>
<tr><td rowspan="3">Percentage market share</td><td>Rail</td><td>13%</td><td>34%</td><td>8%</td></tr>
<tr><td>Road for reward (outsourced)</td><td>18%</td><td>16%</td><td>16%</td></tr>
<tr><td>Road as ancillary traffic (in-house)</td><td>69%</td><td>50%</td><td>75%</td></tr>
</table>

It is clear that most freight is transported in-house and by road. Rail's ton-kilometre output is 34% of the whole, yet only accounts for 13% of the tonnage transported. This indicates the long distances in rail transport. What is also indicated is the small income market share (only 8%) that rail enjoys in the economy.

That was the market share comparison done on the country as a whole. What also needs to be taken into consideration is that rail does not compete with road on all typologies within the country. As indicated in the previous paragraph, rail mainly operates over longer distances since it is the only way that it makes economic sense to use rail transport. Rail cannot be used as a distribution service due to its operating characteristics. Just how these characteristics inhibit rail's operating profitability over shorter distances is explained in detail later in this dissertation (section 10).

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[113] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p. 26

The result of this is that one area where rail should be competing with road is on the country's corridors (since there is high freight volumes and longer distances). The market share of corridors in South Africa is depicted in Table 6.

Table 6: Corridor market share analysis[114]

		Tons in millions	Ton-kilometres in billions	Cost or income in billion Rand
Volume	*Rail*	46	32	7
	Road	196	116	53
Percentage market share	*Rail*	19%	22%	11%
	Road	81%	78%	89%

It is clear that road makes 89% of the country's income on the corridors. This is a problem in many aspects as it causes serious future problems of congestion, high exposure to fuel prices and infrastructural damage. More focus should be placed on investing in more rail capital and moving rail-friendly traffic off the roads.

Putting the corridor cost market share into perspective with the other typologies paints a similar picture (Figure 34).

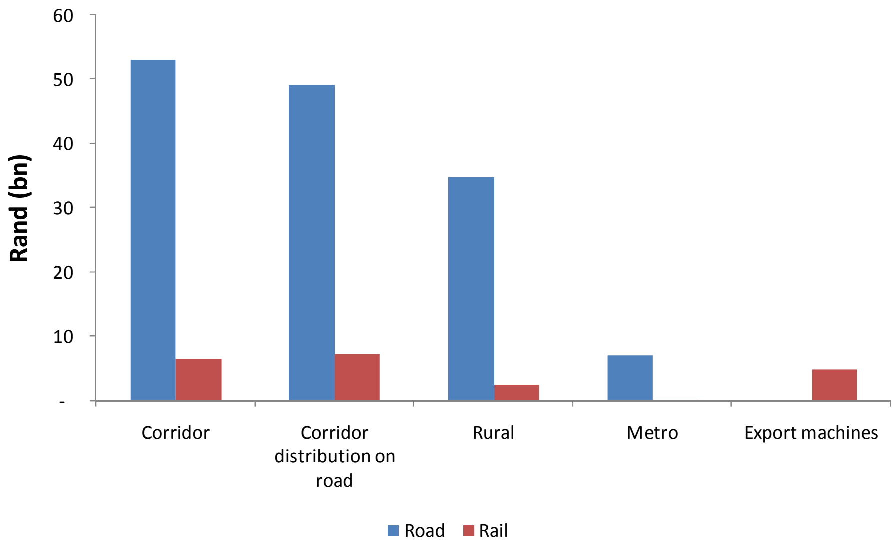

Figure 34: Cost distribution per mode and per typology[115]

[114] Havenga et al (2008) The fifth annual state of logistics survey for South Africa, p. 26

On the typologies other than corridor, road is more likely to dominate due to its characteristics. In rural areas only road infrastructure is mostly available, and in the metropolis only road transport makes economic sense, since a distribution function would mostly be needed. It is only on the corridors that there should be more rail traffic present, but there isn't.

One can compare the rail market share situation that South Africa finds itself in to Europe. But in order to do the comparison, a quick understanding of the recent history of rail transport developments in Europe is needed.

According to Ghijsen et al[116] in 1991 the European Commission (EC), the legislative body in the European Union, initiated the liberalisation process of the European railways[117]. Its aim was to promote and develop rail freight and intermodal services as an alternative for, and in addition to, road transport, to cope with growing environmental and congestion problems, according to Wiegmans and Donders[118]. In the years following, many European railways were split into track operating companies (e.g., NetRail in the UK, ProRail in the Netherlands, and DBNetz in Germany), and separate passenger and rail freight transport companies (RFTC), according to Haywood[119]. With liberalization, new rail-based transportation companies could enter the European rail freight market and start competing with incumbent RFTCs and other modes of transport, allowing in higher rail freight volumes and decreasing costs[120].

However, in spite of EC policies and directives, Ghijsen et al[121] further state that the share of rail freight in the total volume of goods transported seems to have deteriorated. In 2002, nearly 44 percent of the freight flows in Europe were transported over road, 41 percent over sea and 8 percent over rail, and 4 percent over inland water. Road carriers transported over 80 percent of the total volume of goods over land, while rail carried 13 percent, versus 18 percent in 1999. In 2003, the share of rail cargo had further diminished to 8 percent.

[115] Havenga (2008) "Unpublished Transnet report", p.6
[116] Ghijsen et al (2007) p.42
[117] European Commission (2001)
[118] Wiegmans and Donders (2007)
[119] Haywood (2003)
[120] European Commission (2001), Holvad et al (2003)
[121] Ghijsen et al (2007) p.42

Although the absolute rail freight volume is increasing slightly, the modal share is still declining[122]. The EC has since stressed the urgency to alleviate national impediments to ensure uninterrupted cross-border trade movements[123].

After reading the above information on the European rail market share situation, it is clear that South Africa is not the only country facing these current problems, and that even first-world countries in Europe experience the same difficulties. It is important however that South Africa should learn from Europe that having large freight volumes on the road is a problem, which should be addressed.

Now a much more detailed look at the South African corridor traffic and costs will be taken, but before this is done an explanation about the data is needed.

As was explained earlier in this dissertation, the National Freight Flow Model is generally used to indicate freight volumes in the country due to the fact that it indicates all freight flowing in the metropoles of the country. It is, however, not used for costing of logistics in South Africa. Therefore in the tables to follow, the Freight Demand Model volume figures will be used, as a more detailed comparison between volume and cost is needed,. This causes the slight difference in the total tonnages and tonkilometres in the following tables in comparison to the previous National Freight Flow Model volume graphs.

A cost comparison for the corridors is depicted in Table 7.

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[122] European Commision (2001), European Commission (2006)
[123] European Commission (2005)

Table 7: Cost comparison for corridors[124]

	Road			Rail		
Corridor	**Tons (millions)**	**Ton-km (millions)**	**Cost (Million Rand)**	**Tons (millions)**	**Ton-km (millions)**	**Cost (Million Rand)**
Capecor	36	30 071	16 005	3	3 531	757
Natcor	43	18 203	10 397	10	7 453	1 833
Gauteng–Richardsbay	6	2 672	1 100	10	7 118	1 542
Richardsbay–Swaziland	1	617	261	0.1	14	5
Cape Town–Namibia	0.2	90	47	-	-	-
Coastal:						
1. Cape Town–Durban	7	9 407	3 934	neg	44	11
2. Cape Town–Port Elizabeth	6	3 393	1 764	0.3	172	49
3. Durban–East London	9	4 338	2 147	neg	42	9
4. Durban–Richardsbay	7	2 130	999	1	305	97
5. East London–Port Elizabeth	6	2 541	1 174	0.1	26	8
Total coastal	**34**	**21 809**	**10 017**	**2**	**589**	**174**
Eastern Corridors:						
1. Gauteng–Ermelo	2	960	329	2	557	131
2. Gauteng–Nelspruit	3	1 656	777	1	231	64
3. Gauteng–Swaziland	5	2 380	1 064	neg	1	0
4. Gauteng–Witbank	12	1 991	1 212	4	1 246	322
Total Eastern Corridors	**22**	**6 987**	**3 383**	**6**	**2 034**	**518**
Eastern/Southern Cape to Gauteng:						
1. Gauteng–East London	3	2 787	1 143	0.3	202	59
2. Gauteng–Mosselbay	1	1 182	694	neg	63	15
3. Gauteng–Port Elizabeth	5	3 416	1 554	0.4	347	165
Total Eastern/Southern Cape to Gauteng	**9**	**7 385**	**3 391**	**0.6**	**611.1**	**238.3**
Northern Corridors:						
1. Gauteng–	5	2 448	1 384	1	675	146

[124] Havenga, (2008) "Unpublished Transnet report" p.10

	Road			Rail		
Corridor	**Tons (millions)**	**Ton-km (millions)**	**Cost (Million Rand)**	**Tons (millions)**	**Ton-km (millions)**	**Cost (Million Rand)**
Beitbridge						
2. Gauteng–Polokwane	13	3 518	1 535	1	207	72
Total Northern Corridors	**18**	**5 966**	**2 919**	**1**	**882**	**217**
Western Corridors:						
1. Cape Town–Upington	4	3 484	1 899	0.2	258	46
2. Gauteng–Lobatse	7	2 204	1 379	4	1 154	343
3. Gauteng–Upington	6	3 893	2 268	6	4 350	907
Total Western Corridors	**17**	**9 581**	**5 547**	**10**	**5 762**	**1 296**
Grand Total	**188**	**103 382**	**53 068**	**43**	**27 993**	**6 581**

What is clear from Table 7 is that Capecor and Natcor alone account for half of all corridor cost and volume. The rest is dispersed mostly over the coastal and eastern corridors, followed by the northern and western corridors. The least corridor traffic is flowing from the Eastern/Southern Cape to Gauteng. What is also indicated, after some division, is that on average it costs R282 per ton (and 51c per tonkilometre) to transport goods on the corridors by road, whereas it costs R155 per ton (and 24c per tonkilometre) to do it by rail. One question that should be asked is would the cost saved on rail for the economy be enough to justify increased capacity investment in it? How long would it take to cover the cost of investing in more rail capacity? These are questions that need to be answered.

The operating cost per ton and tonkilometre of road and rail on the two busiest corridors of the country is depicted in Table 8.

Table 8: Cost summary for Natcor and Capecor[125]

	Rand per ton shipped		Rand per ton-km shipped	
	Road	**Rail**	**Road**	**Rail**
Capecor	442	289	0.53	0.21
Natcor	243	185	0.57	0.25

It is clearly visible how the distance of Capecor has an effect on the cost per ton shipped. The cost of shipping by rail on the two busiest corridors is half of the cost of shipping by road.

If a commodity-characteristic comparison were done on the two busiest corridors, Table 9 would be the outcome. Comparing commodity-characteristic classifications is important because each of these classifications requires different packaging types and transport requirements:

- Automotive is cars and either needs containers on rail or car carriers on road.
- Break-bulk is bulk broken down into units that are either palletized or loose in boxes, cartons, bags etc. and can be transported in containers on rail or on flat bed trucks by road.
- Dry bulk is transported in bulk, and only requires a rail wagon or open skip on road.
- Perishables need refrigerated container transport (reefers) on road or rail.

[125] Havenga, (2008) "Unpublished Transnet report" p.10

Table 9: Commodity characteristic summary for Natcor and Capecor[126]

		Road			Rail		
	Commodity characteristic	**Tons (millions)**	**Ton-km (millions)**	**Cost (millions Rands)**	**Tons (millions)**	**Ton-km (millions)**	**Cost (million Rands)**
Natcor	Automotive	0.5	262	133	0.2	132	100
	Break-Bulk	20	9 452	4 618	2	1 292	338
	Dry Bulk	8	2 960	1 510	6	5 057	1 107
	Liquid Bulk	11	4 550	3 414	1	930	277
	Perishables	2	1 005	721	neg	42	12
Capecor	Automotive	0.1	50	13	-	-	-
	Break-Bulk	19	16 004	8 368	0.4	539	135
	Dry Bulk	9	7 394	3 690	2	2 722	549
	Liquid Bulk	4	4 471	2 378	0.2	269	72
	Perishables	3	2 217	1 557	-	-	-

In terms of volume, break-bulk is the largest of the commodity classifications shipped via road, whereas dry bulk is the largest commodity characteristic shipped on rail. Most freight travelling by road would either be break-bulk on a flatbed, or containerized freight. On rail, most freight would be export bulk iron ore or coal in rail wagons.

Another important point that should be realised here is the amount of rail-friendly commodity-characteristic classifications flowing on road (on the two main corridors of the country). On both corridors there is more dry bulk (the most rail-friendly commodity characteristic of all) tonnage on road than on rail. Break-bulk, of which a large portion can easily be containerized and shipped by rail, is completely dominated by road on the corridors. This is one of the main reasons why South Africa will continue to suffer from high domestic logistics costs, which will never change unless inter-modality comes into play.

The cost of moving the different commodity-characteristic classifications on road and rail is depicted in Table 10.

[126] Havenga (2008) "Unpublished Transnet Report", p.11

Table 10: Natcor and Capecor costs per commodity-characteristic classification[127]

		Rand per ton shipped		Rand per ton-kilometre shipped	
		Road	Rail	Road	Rail
Natcor	Automotive	268	577	0.51	0.76
	Break-Bulk	227	158	0.49	0.26
	Dry Bulk	189	171	0.51	0.22
	Liquid Bulk	320	255	0.75	0.30
	Perishables	308	0	0.72	0.29
Capecor	Automotive	230	0	0.25	0
	Break-Bulk	449	342	0.52	0.25
	Dry Bulk	394	278	0.50	0.20
	Liquid Bulk	536	290	0.53	0.27
	Perishables	475	0	0.70	0

Looking at the difference in cost per ton shipped between road and rail for the different classifications, there doesn't seem to be such a large cost saving incentive. This is because rail service usually takes place over longer distances than road, even on the corridors, and this is evident by looking at the cost per ton-kilometre comparisons, where rail rates are largely half that of road.

Another important comparison needed to be made is the volumes of the different commodity groupings transported in the economy, as well as the cost of moving those volumes (Table 11).

[127] Havenga (2008) "Unpublished Transnet Report", p.11

Table 11: Road and rail cost disaggregated on a commodity level[128]

	Road			Rail		
Commodities	**Tons (millions)**	**Ton-km (millions)**	**Cost (million Rands)**	**Tons (millions)**	**Ton-km (millions)**	**Cost (million Rands)**
Food and food processing	59	28 374	45 357	1	272	86
Coal mining	183	15 638	13 521	85	46 603	5 485
Petroleum products	39	11 687	13 347	3	1 461	596
Limestone	29	8 959	7 910	3	724	215
Other stone	75	7 141	7 156	1	448	112
Other mining	39	9 649	6 484	2	53	30
Beverages	19	9 588	5 821	1	399	107
Vegetables	7	2 838	4 518	-	-	-
Other agriculture	13	7 011	3 674	neg	17	5
Other chemicals	17	7 829	3 374	0.2	144	42
Industrial chemicals	5	2 870	2 617	1	830	265
Cement	13	4 502	2 516	5	1 705	450
Bricks	22	4 481	2 166	-	-	-
Paper and paper products	9	3 952	1 689	0.2	169	45
Non-metallic mineral products	9	4 398	1 492	2	1 039	340
Wood and wood products	11	3 734	1 338	4	1 331	323
Sugar cane	18	2 360	1 185	0.4	19	10
Water supply	23	2 278	1 139	neg	0.1	0.1
Subtropical fruit	13	650	1 049	-	-	-
Chrome	7	662	1 037	2	1 382	290
Iron and steel	9	2 258	819	2	1 151	317
Wheat	4	1 046	707	2	796	216
Maize	8	1 512	629	3	996	305
Chemical and fertilizer mineral mining	8	1 057	233	3	2 267	375
Non-ferrous metal basic industries	5	705	221	0.1	58	13
Sunflower seed	9	103	68	neg	0.3	neg
Crude petroleum and natural gas	-	-	-	-	-	-
Iron ore (hematite)	-	-	-	39	32 843	2 157
Manganese	-	-	-	6	5 921	1 034
Other	57	22 750	21 299	11	5 035	1 401
TOTAL	**712**	**168 031**	**151 365**	**175**	**105 664**	**14 218**

[128] Havenga (2008) "Unpublished Transnet Report", p.12

What should be noted here is the volume of rail-friendly traffic that is on the roads. Coal mining is the primary example that comes to mind. There is a complete excess on the roads. The same goes for the mining sector commodities like stone and other mining. One might argue that the reason behind the large road volumes are that those specific commodity grouping don't travel long distances, and therefore it doesn't make sense to use rail transport for those specific cases.

Table 12 depicts the difference in average travelled distance (ATD) and cost of the two modes between two distinct commodity groupings with two complete different transporting requirements. Both these commodities also play a large role in the country in terms of volume shipped. It is clear that rail has a rather low cost market share.

Table 12: Food and coal cost, ATD and market share comparisons[129]

	ATD		Cost (million Rand)		Cost per ton shipped (Rand)		Cost per ton-km shipped (Rand)		
	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Rail cost market share
Food and food processing	485	334	45 357	86	775	106	1.6	0.3	0.2%
Coal mining	85	550	13 521	5 485	74	65	0.9	0.1	29%

Food gets mainly transported over long distances by both modes. Coal mining on the other hand travels short distances mainly on road, where long distances are travelled on rail. That might explain the reason why such high coal volumes are travelling by road, since the distances are mainly short and so it would not make sense to use rail in that regard.

[129] Havenga (2008) "Unpublished Transnet Report", p.13

There should be a focus on rail-friendly traffic flowing long distances on road, and moving this traffic to rail. It is therefore essential to take a look at all the commodities with high average travel distances in one table, and do a modal comparison of these commodities to look for irregularities (Table 13).

Table 13: Commodities with high ATD and costs[130]

	ATD		Costs (million Rands)		Cost per ton shipped in Rand		Cost per ton-kilometre				
	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Total costs (million Rands)	Rail costs market share	Total ATD
Manganese	0	1051	-	1 034	0	183	0.00	0.17	1 034	100%	1 051
Iron ore (hematite)	0	841	-	2 157	0	55	0.00	0.07	2 157	100%	841
Industrial chemicals	534	595	2 617	265	487	190	0.91	0.32	2 882	9.2%	547
Other agriculture	524	0	3 674	5	275	0	0.52	0.27	3 679	0.1%	524
Beverages	492	750	5 821	107	299	201	0.61	0.27	5 928	1.8%	499
Food and food processing	485	334	45 357	86	775	106	1.60	0.32	45 443	0.2%	483
Non-metallic mineral products	471	435	1 492	340	160	142	0.34	0.33	1 833	18.6%	464
Other chemicals	452	602	3 374	42	195	176	0.43	0.29	3 416	1.2%	454
Paper and paper products	443	750	1 689	45	190	198	0.43	0.26	1 734	2.6%	451
Other	396	468	21 299	1 401	371	130	0.94	0.28	22 699	6.2%	407
Vegetables	396	0	4 518	-	631	0	1.59	0.00	4 518	0.0%	396
Cement	337	332	2 516	450	188	87	0.56	0.26	2 966	15.2%	335
Wood and wood products	331	319	1 338	323	118	77	0.36	0.24	1 660	19.4%	328
Petroleum products	302	505	13 347	596	345	206	1.14	0.41	13 943	4.3%	316
Coal mining	85	550	13 521	5 485	74	65	0.86	0.12	19 007	28.9%	232

The different commodities have been sorted from those with the highest total ATD to the ones with the lowest. It is clear that rail has a small market share of most of the commodities, even if the ATD is long. It is felt that more industrial chemicals, agricultural products, non-metallic mineral products and other

[130] Havenga (2008) "Unpublished Transnet Report", p.13

chemical products should at least be on rail, and that is not even mentioning cement and wood. More petroleum could also be travelling on rail, or even be pumped through additionally invested pipelines. There should not be such high volumes of petroleum on road costing the economy R13 billion annually.

9.3 Chapter summary

Logistics costs have been steadily increasing since 2003 to a total of R317 billion in 2007 for the country. The largest contributor to total logistics costs is transport cost, totalling R167 billion (52.6%). The largest contributor of transport costs is road transport, totalling R151 billion (90.4%). The fact that the South African logistics system is so dependent on road transport exposes the country to petrol price fluctuations, being the highest cost contributor to road transport cost (over R40billion in total for the country).

There are high volumes of rail friendly freight on the roads of South Africa, and there should be initiatives put in place to move it to rail. This will reduce the overall logistics costs for the country, and decrease the congestion on roads in the long run.

10 The way forward

It is understood that a lot of emphasis is put on the low rail market share in the country. It is possible to argue that modal choice should be left to the market forces to decide, and should not be interfered with. The market unfortunately does not always take the whole economy into consideration when making business decisions or take into account the long-term negative effects on the road infrastructure (which will lead to increased logistics costs for road haulers in future, according to Steyn et al[131], as is depicted in Table 14).

Table 14: Potential increase in vehicle damage costs under deteriorating road conditions[132]

Road condition	% Total vehicle damages	% Total cost of vehicle damages	% Increase in costs
Good	5.2%	3.9%	
Average	17.4%	30.8%	684%
Bad	77.4%	65.2%	1560%

A sample of 577 trucks driving on different road conditions was taken. Steyn et al[133] mentioned that the findings are by no means absolute. However, it is felt that even if the sample gives a slight misinterpretation of the total population, it is still evident that within this sample bad roads result in a large increase in vehicle operating costs. It is therefore clear that steps should be taken to preserve the national roads.

Another issue worth mentioning is the environmental issue. According to Schoeman[134], both South Africa's greenhouse gas emissions per capita and per unit of GDP are nearly double that of the world average. Schoeman[135] further states that the transport sector is the fastest growing emitting sector. Since 80% of all freight transported in South Africa is by road, as the Freight Demand Model reveals, it makes complete sense to understand that heavy vehicles are

[131] Steyn et al (2008) The fifth annual state of logistics survey for South Africa, p. 51
[132] Steyn et al (2008) The fifth annual state of logistics survey for South Africa, p. 51
[133] Steyn et al (2008) The fifth annual state of logistics survey for South Africa, p. 51
[134] Schoeman C (2008) The fifth annual state of logistics survey for South Africa, p. 52
[135] Schoeman C (2008) The fifth annual state of logistics survey for South Africa, p. 54

the main culprit in the environmental damages caused on the country's roads. One train locomotive can move far greater freight volumes than one truck, and therefore less greenhouse gas emissions would result if large volumes of freight are moved on rail rather than road. Improved technology away from petrol and diesel will also improve situations[136].

It has been explained briefly earlier in this dissertation that rail is a better mode over longer distances carrying large volumes of certain rail-friendly commodities. Certain commodities are more rail friendly than others since rail is not as gentle to commodities during transportation as road (road has improved shock absorption), and rail will thus cause more breakages to more fragile commodities. Large volumes justify rail because:

- Rail can carry large volumes at once due to its characteristics
- Large volumes justify the large fixed capital investment in rail, since larger volumes delivered means a larger pay check to the rail operator.

Now there will be a closer look taken into why rail is more effective over longer distances. Figure 35 is an indication of the "as is" situation in South Africa regarding the modal volume split over distance.

[136] Schoeman C (2008) The fifth annual state of logistics survey for South Africa, p. 54

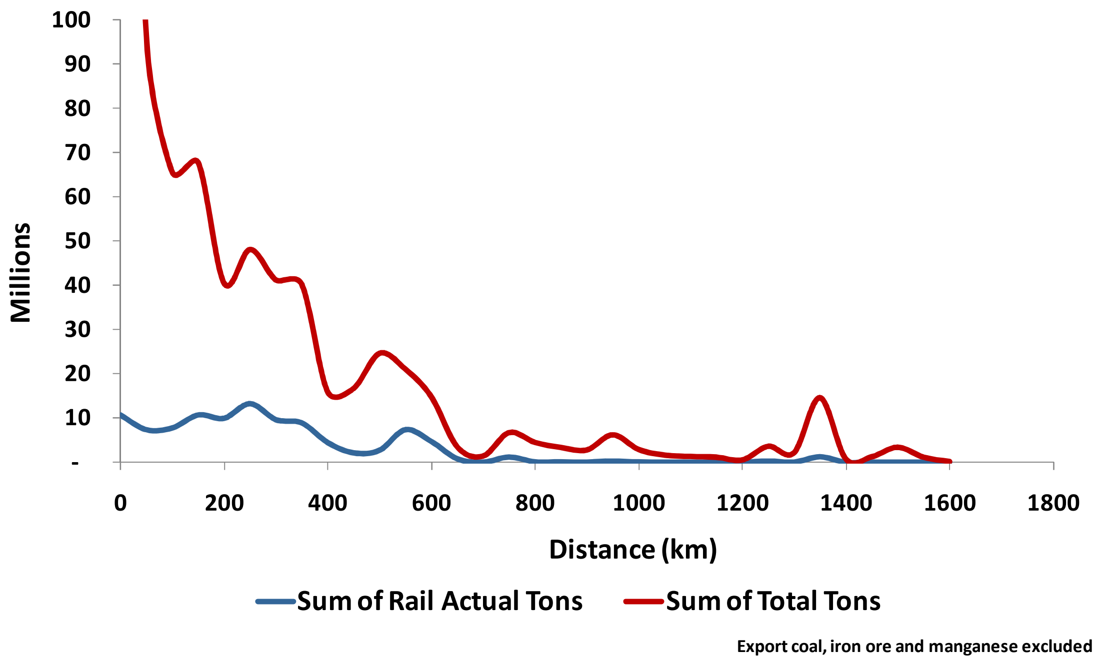

Figure 35: Volume of rail versus total freight carried over distance[137]

The red line represents total freight volume carried over different distances in the country, while the blue line indicates the rail freight volumes carried over different distances. When one looks at this picture it seems that rail should be targeting more short distance freight movement (and not the corridor traffic as advised earlier in this dissertation), but this would be a misinterpretation. The reason for this is purely that rail is inefficient as a means of freight transport over shorter distances. Rail is not a door-to-door service. It collects freight at a rail terminal then delivers it to another rail terminal. It still needs road transport to bring the freight to the starting terminal and to distribute it at the end terminal to the final consumer. Because of the extra freight handling required it does not make sense to apply rail to short distance deliveries.

Another reason why rail is ineffective over shorter distances is explained by Figure 36.

[137] Centre for Supply Chain Management, University of Stellenbosch (2009) "PowerPoint presentation, presented to Transnet"

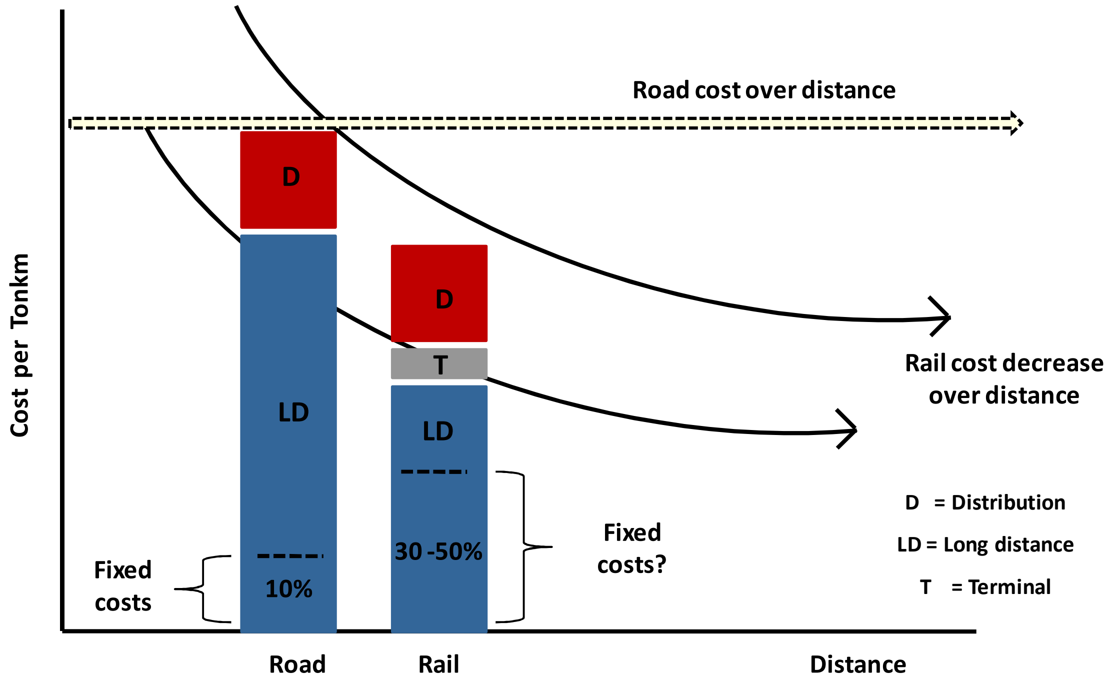

Figure 36: The advantages of rail over long distances[138]

Road costs per tonkm will remain constant over longer distances (since a small part of road transportation costs are fixed and a large portion variable with distance). Because of the high fixed costs in rail, its rolling stock cost per tonkm on the other hand will decrease as distance travelled increases, and this therefore gives rail the advantage over longer distances, but a disadvantage over shorter distances. Rail should therefore be targeting longer distance corridor traffic. All the rail-friendly commodities transported in the space between the blue and red line (Figure 35) on distances above 400km should be targeted first.

Now that the argument behind modal shift is understood as a viable solution into the future, it is important to look at ways to make rail more attractive to use for private logistical service providers.

Ghijsen et al[139] compiled a questionnaire that was mailed to 138 principal executives (managing directors, commercial directors, or fleet managers) of an

[138] Havenga (2009) "PowerPoint presentation, presented to Transnet"
[139] Ghijsen et al (2007) p.44-53

estimated 250 major European RFTCs, according to the HIDC and NFIA[140]. This group consisted of traction providers, traction providers that also offered logistics services (rail-asset based LSPs), incumbents as well as new entrants. Table 15 contains a summary of the answers provided by the sample of respondents.

Table 15: Stakeholder Perspectives on Improving European Rail Freight Services[141]

Stakeholders	*How can rail freight elements contribute to improved rail services?*	*How can road carriers contribute to improved rail services?*	*How can government policies and practices contribute to improved rail services?*	*How can more customers benefit from improved rail services?*
Traction Providers 25 returned questionnaires and 5 interviews	Increased efficiency of the internal organization, expansion of capital investment, partnership establishment, and increased equipment productivity.	Focus on uninterrupted, international deliveries door-to-door and extension of the service portfolio.	Facilitate dedicated rail freight infrastructure. Inform local/ regional authorities and the general public.	Development of logistic concepts based on better understanding of supply chains and on better information to market.
Rail-asset-based LSPs 26 returned questionnaires and 5 interviews	Cost control, long term planning, divesting weak operations, and increased equipment productivity.	Focus on uninterrupted services on lucrative routes, cooperation with road and rail, and increased flexibility.	Improve the image of rail freight and increase efforts to inform local and regional authorities and the general public when achievements occur	Good understanding of supply chains, modal choice intelligence and in depth knowledge about customers' relationships, greater service portfolio.
Truck-asset-based LSPs 25 returned questionnaires and 8 interviews	Rail access from and to warehouses, and solve issues regarding long distance, cross border freight flows.	Both road and rail face the issue of not using the assets to full capacity. Cooperation instead of competition.	Initiate projects in which rail freight has a key position. Investments are required to facilitate intermodal interfacing.	View rail as a potential customer; combine forces with road transport and extend services to door-to-door delivery.
Non-asset-based LSPs 8 returned questionnaires and 2 interviews	Further development of routes and disposal of sufficient assets.	Comparing freight key performance indicators may increase the use of rail.	Help grow awareness for rail specific issues among shippers and LSPs.	By actively working together with road and rail to develop logistic concepts, based on customer knowledge.

[140] Holland Intemational Distribution Council (HIDC)/ Netherlands Foreign Investment Agency (NFlA) (2003)
[141] Ghijsen et al (2007) p. 52

Stakeholders	***How can rail freight elements contribute to improved rail services?***	***How can road carriers contribute to improved rail services?***	***How can government policies and practices contribute to improved rail services?***	***How can more customers benefit from improved rail services?***
Shippers / Customers 5 interviews	Improve availability of resources and capacity planning.	Improve terminal management and road-rail change over.	Allow more night trains to shorten transit times. Facilitate cross border traffic.	Better marketing and sales promotion. Full access to tracking and tracing information.
Government officials 3 interviews	Strong association with incumbents. Allow licensed multi-lingual drivers who operate trains across borders.	Forceful road lobbying is not balanced by rail lobbying. Increase awareness of rail options in combination with road.	Development of rail projects by small teams. Coordinate national, regional, and local initiatives.	General lack of awareness.

It is understood that South Africa does not necessarily have the same freight environment as Europe, but we do have the same challenges regarding modal distribution; in other words, a lack of intermodal initiatives (as was proven earlier in this dissertation). This work done by Ghijsen et al might provide some insight on how to start tackling the challenges we face and, in turn, make rail more attractive for industry to use as an alternative to road.

10.1 Chapter summary

Rail transport should target long distance corridor traffic on road. An increase in rail market share will decrease the countrywide deteriorating infrastructure, as well as air pollution. In order for rail to gain more business it would need to become more customer focussed as well as improve on service delivery.

11 Recommendations

It is hoped that this dissertation provided clarity on all past improvements made in the Logistics Cost Model methodology, as well as offering some clear propositions on improving it in future. The aim was also to create an understanding of how the current model functions as a whole with all its inputs and outputs.

It is also hoped that an understanding around the importance of studying the methodology of the model to the logistics system of South Africa is reached. Because the Logistics Cost Model is a tool that is used in macroeconomic decision making in South Africa, it is all the more important to carry on studying the methodology and developing it even further.

Regarding the current model outcome, there are two clear messages that the Logistics Cost Model outcome tries to get across:

- South Africa Inc. should realize that it is entering a domestic logistics cost crisis that will not be easy to get out of in the future.
- Once this realization is complete, South Africa Inc. should actively get involved in improving the situation in order to keep the country competitive on a global scale in the future.

The first point mentioned above is already in effect, thanks to the efforts of the University of Stellenbosch regarding the Logistics Cost Model, and the State of Logistics Survey together with the CSIR and Imperial Logistics over the past five years.

The second point mentioned above only recently started to get going slowly. As Abrie de Swardt, Marketing Director of Imperial Logistics in South Africa mentioned at the launch of the Fifth Annual State of Logistics Survey of South Africa (that took place in Johannesburg on the 3rd of April 2009), Imperial Logistics are now involved in efforts, together with Transnet Freight Rail, to move more freight onto rail through the use of improved intermodal initiatives.

More logistics companies in South Africa should get involved in intermodal initiatives and, until this is done, it is felt that South Africa will not be able to break away from the problem it is about to face down the line.

Because the Logistics Cost Model played such a dominant role in the realization of the domestic logistical challenges in South Africa, as well as providing ideas of possible solutions, it remains imperative that efforts are put in place to preserve and improve upon the methodology within the model.

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