

THE STATE OF LOGISTICS IN SOUTH AFRICA: INFRASTRUCTURE AND THE ENVIRONMENT – DECLINE WITHIN DECLINE

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ABSTRACT

The purpose of this research is to measure the cost of logistics in South Africa; determine the major cost drivers of logistics; and help the state to manage those drivers and logisticians to manage logistics in this context. Logistics as a whole are considered, including transportation costs, storage and ports costs, management and admin costs and inventory-carrying costs. The measurement is on an industry and national level and can, therefore, relate logistics input with GDP as well as with industry-level turnover. The research uses a quantitative approach, based on a gravity-orientated freight flow model, a road transport cost model (road transport costs are not available in South Africa), actual transport costs for other modes, a warehousing cost survey and inventory delay calculation (to inform warehousing cost calculations and inventory financing costs) for the economy. Research pitfalls are highlighted and guidelines given for the application of the research approach in other economies.

It is proved that logistics costs for South Africa can be measured in an extensive model; and cost drivers are identified. The model has been backdated for six years to enable the analysis of trends. Understanding the drivers and trends enables the development of specific areas that can be considered by industry and managed by government on a macro-economic level.

The results highlight the unfeasible structure of South Africa's freight transport industry in which the greatest proportion of long-distance transport is by road. Some of the key challenges that arise from the current transport situation are the unsustainably high freight transport costs; ineffective transport infrastructure investment and planning; and the

marginalisation of the developing portion of the South African economy. The model also points to one of the key missing links in the country's logistics services – the provision of intermodal solutions, which will not only draw from the strengths of the current role players, but also facilitate the establishment of a competitive freight transport industry to support economic growth and international competitiveness.

The model also enables the analysis of specific drivers in more detail:

- Recently, the sensitivity of logistics costs to fuel and interest rates is disconcerting because both of these are 'administered' costs on an industry level – and even on a national level – for economies that rely on imported fuel to transport freight over long distances.
- Logisticians relentlessly strive to minimise the time that inventory is held, but the 'Tragedy of the Commons' effect (Hardin, 1968) is overlooked, and trade-offs on a national, and even industry level, are often not managed effectively. Industry collaboration not only contributes to micro-improvements, but may also counter negative trends on a macro level.
- Eventually the trade-offs between specialisation, growth and sustainability come into play. The relationship between energy optimisation and environmental consciousness is illustrated and solutions suggested.

The cost of logistics to the South African economy is R339 billion, or 14,7% of South Africa's GDP. This figure is 50% higher than for most developed economies; the underlying weaknesses in the logistics system must be addressed urgently. This research points to specific solutions to achieve this objective.

Keywords: Logistics cost, transport cost, sustainable transport, externalities

INTRODUCTION

As South Africa experiences an era of uncertainty in times of unprecedented global upheaval, many questions are being asked about the country's economic stability and resilience. The country is relatively small in global terms, distant from its natural markets in Europe and Asia and possesses an open economy that is often negatively affected by global economic cycles. Furthermore, South Africa has a higher than normal domestic transport demand owing to long inland transport corridors and mining and production centres far from the coast (see Figure 1).

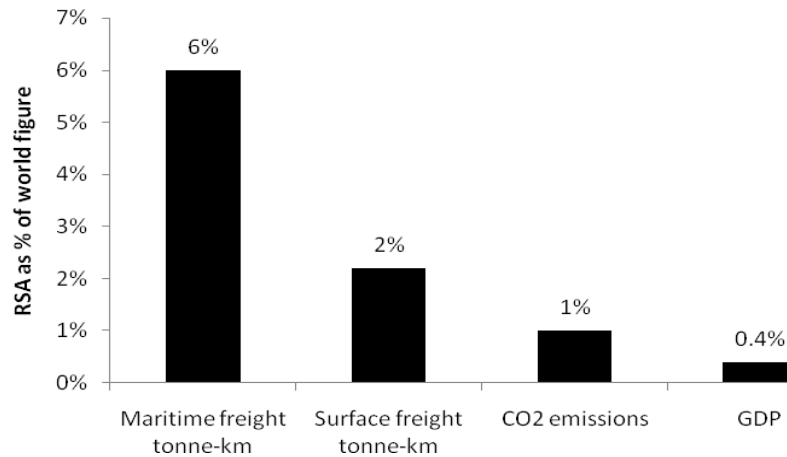


Figure 1 – Relative transport demand in South Africa

Given these challenges, questions are continually asked about South Africa's ability to manage transport as a strategic resource and to measure and track its role in the logistics system. The availability and correct use of management information determine the state of readiness of a system to respond to change. Change has two possible manifestations, namely gradual change or cataclysmic change. (In the natural world, this is the difference between evolution over a long period of time and a catastrophic change, such as that brought about by a meteor.) In both cases, information has a role to play. During evolutionary change information hones the performance of the system, whereas during cataclysmic change it enables survival. The absence of information will, therefore, either cause a system to run down gradually because it is not enabled to respond to a changing environment, or it may be destroyed as its inability to protect itself from upheaval is exposed.

In this physical science context, information is equated to the state of order in the system (the opposite of being run down), but it is not dissimilar to the business science context, in which order also equals information and growth. A case in point is whether South Africa would have invested more in its electricity generation infrastructure a decade ago had the recent energy crisis been anticipated and its impact understood. To address the similar absence of management information in South Africa's freight logistics discipline, the logistics cost model was developed.

RESEARCH STRATEGY

As far as the performance of logistics as a cost to the economy is concerned, the Delaney survey is the best-known macro-measurement of logistics costs globally (the 19th edition was issued in June 2008). The survey makes use of a variety of methodologies, outlined by Robert Delaney in a 1987 policy position paper (three years before the publication of his first annual state of logistics report). Alford-Bangs' approach is used to calculate inventory-carrying charges and their work of 1955 is cited. This approach is confirmed by Cooke (2004) when he states that the methodology 'preserves' the original Alford-Bangs approach.

The original work by Alford and Bangs had however already been published in 1944, but no copy of this work could be located. In the 1946 edition the formula to calculate inventory-carrying charges is described (Alford and Bangs, 1946: 396–397) and the authors initially estimate an inventory-carrying charge of between 10% and 20%. Alford and Bangs continued to refine this 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 obtainable is the third edition, published in 1941 (Alford, 1941). This previous work of Alford on the inventory charge was based on the work of Parrish, which obviously predated Alford's 1941 work (no further information on Parrish could be found). It is, therefore, safe to assume that the Alford-Bangs formula is at least seven decades old (if not more) and it is still applied to some extent in its original form today.

It should, however, be possible for the South African economy, with a transportable GDP hypothesised to be less than 1 billion tonnes, to develop a more refined model for the calculation of logistics cost, which both assists the country to manage those drivers and logisticians to manage logistics in this context.

The development of the South African logistics cost model: Overarching model methodology

The logistics cost model employs a 'bottom-up' approach for the computation of logistics costs by aggregating detailed commodity-specific data. The aggregation of logistics costs is based on primary input elements (the supply of a specific commodity per magisterial district) and the costs of performing logistical tasks with respect to that commodity (Havenga et al., 2007: 14). These costs are specific per commodity and per magisterial district; the logistical tasks that are measured are transport, storage and ports, management and administration, and inventory-carrying cost.

Transport cost data in South Africa can be described as official, quasi-official and unknown. Transport costs are measured by calculating the cost of transport by road (both distribution and line haul), rail, air, coastal shipping and pipelines.

Road transport costs

Actual road transport costs are not measured officially in South Africa and are, therefore, unavailable on a national level. In order to determine road transport costs, freight flows on a commodity level needed to be developed. The Freight Demand Model (Havenga, 2007) modelled the flow of 62 commodity groupings (representing total supply and demand) between 356 magisterial districts on all modes of transport, as well as researched coastal, air and conveyor belt flows, which are subtracted from the total modelled flows. (Coastal shipping and air transport account for less than 1% of all flows and are easily determined, and conveyor belt flows – though large – are only used by two entities – Eskom and Sasol – and are, therefore, easily researched.)

The remaining flows are road flows of commodities between specific origin-destination pairs (up to delivery at the final warehouse) and can be translated into costs of depreciation, capital costs, licence fees, toll fees, insurance, vehicle driver costs, fuel, tyre costs and overhead costs per vehicle combination. The vehicle combinations are in terms of vehicle size, axle numbers, payload and trips per year, assigned for each commodity, typology and region combination.

This provides the different cost elements of road transport within a typology (whether the flow is over a long-distance corridor, in rural areas or metropolitan areas) on a specific route. (Overhead costs are left out of the equation because they are calculated as a separate cost element in the model.)

The different cost elements of road transport in the model are determined by the vehicle type; and the vehicle type, in turn, is determined by the commodity type, typology and route of travel. The commodity's 'preferred' vehicle type will change with each of these variables. Once the vehicle type and volume are known, the cost elements can be assigned on the basis of payload, annual number of trips and region in order to determine an average cost rate per tonne-km.

The core drivers of transport costs, i.e. weight in tons and distance travelled together with average transport distance (ATD) per commodity, are then multiplied by the tonnage of the commodity produced in the economy to determine the line haul ton-kilometres for that commodity. It was possible to deconstruct each commodity's flows into 39 distinct typology sub-groups based on *where* the commodity flows and the *distance* of that flow. Each flow could also be attributed to one of 34 possible vehicle combinations. Using 34 vehicle combinations over 39 typology sub-groups provides 34 x 39 (1 326) possible cost measurements.

Rail transport

Actual rail transport costs are received from the national rail carrier per commodity per origin-destination station. Therefore, rail transport costs do not have to be modelled. However, the rail origin-destination pairs had to be allocated manually to the same corridor, metropolitan and rural typologies as the road flows in order to subtract them from total flows in the demand model, and also to enable granular market-share comparisons. From the manual allocation a conversion table was developed to enable use of the historical rail freight database. A conversion table was also developed to classify the 321 rail commodities into the 62 commodity groups. The national rail carrier has subsequently added the 62-commodity-group classification system to its core database.

Air transport

Air freight volume accounts for a very small portion of total freight transport in South Africa. Nevertheless, it is still included for the calculation of the total cost of logistics and to enable analysis of trends in this transport mode.

Air freight volume data are not available with a commodity split or origin/destinations, and, therefore, the calculation is less complex. Efforts are currently underway to improve the quality and granularity of air transport data for the improvement of this aspect of the model.

Coastal shipping

Coastal shipping consists of two components: the shipping of petroleum in oil tankers and the shipping of containers on container ships. Petroleum accounts for the largest volume by far, contributing approximately 90% of the total.

The tariff used for shipping petroleum is a rate per tonne, which the industry can provide each year (distance is not a factor in determining the cost of coastal petroleum shipping). As far as containerised traffic is concerned, the rate for shipping one container could be determined relatively easily because very few shipping lines provide a domestic maritime service. The average container weighs 20 tonne; therefore, the rate for a container was divided by 20 in the equation.

Pipeline transport

Exact volumes and rates were obtainable from Transnet Pipelines, since the majority of pipelines are controlled by this state-owned enterprise. These figures could also be compared with total income for the state-owned enterprise for verification. Sasol also operates gas pipelines between the Panda fields in Mozambique and the province of Mpumalanga in South Africa. The costs associated with this will be included in the future.

Storage and ports costs

Storage and handling rates are used to calculate the storage and ports costs for the entire country. Storage periods per commodity within the economy are provided by estimating the average intra-seasonal storage time as the time-weighted difference between time of production and time of consumption. It is assumed that the quantities produced and consumed are equal in the long run.

Inventory-carrying cost

Inventory carrying cost is calculated by researching the rand value of inventory levels for different industries in the economy, and then multiplying that value by the weighted average overdraft rate for the year (which was 15% for 2008) and considering the calculated storage delay time.

Management, administration and profit

The methodology proposed by Botes et al. (2006) is used. 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.

COST OF LOGISTICS

Each year, the various vehicle combinations and other cost elements are reassessed and updated by research specialists in the field of logistics, and can be compared with the previous year to illustrate changes in the economy. These results indicates an improvement in the cost of logistics for South Africa, compared with the country's GDP (see Figure 2).

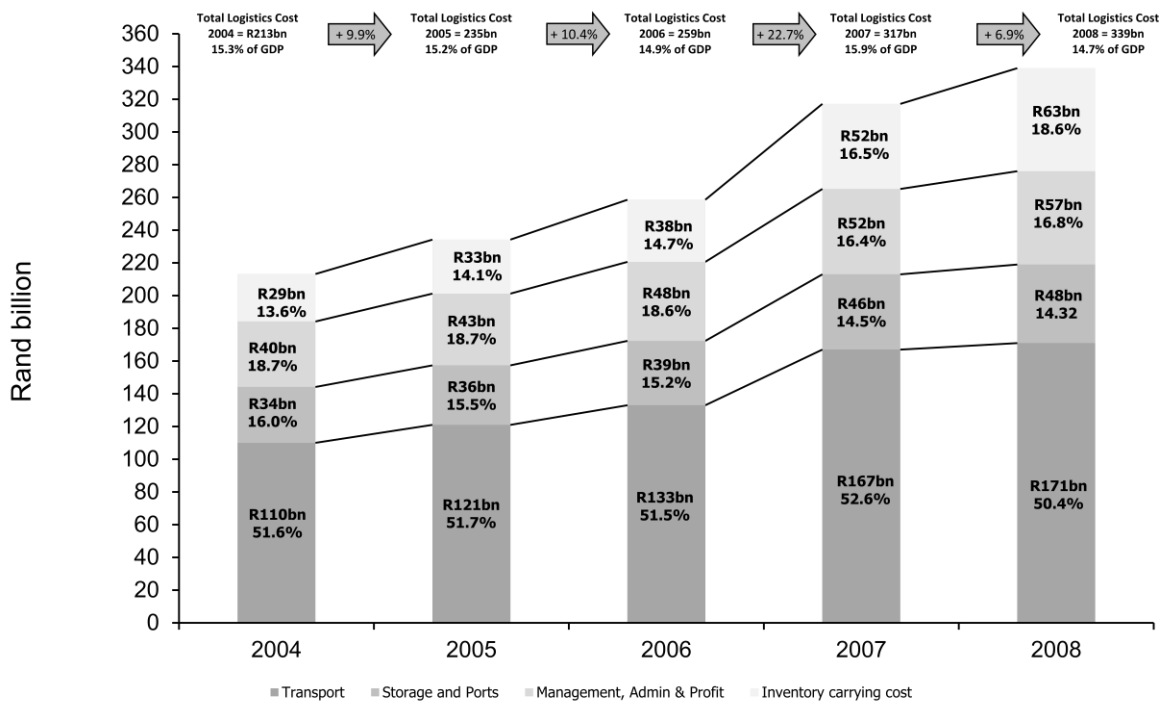


Figure 2 – South Africa's logistics costs

South Africa's logistics cost relative to GDP is at its lowest level since the inception of the survey, and transport cost increases are also lower than in any of the previous surveys. On the surface, one way of interpreting this is that desired results are being achieved. However, it is critical to understand whether there is an intrinsic improvement in transport efficiency or whether there are external factors at play (as alluded to in previous surveys). In order to answer this question, the significant impact of both the most important extrinsic factor (fuel prices) and intrinsic factor (improvement of load factors) are considered in the following sections.

FUEL PRICE SCENARIOS

As depicted in Figure 2, road transport is by far the largest contributor to transport costs in South Africa. Road transport cost drivers were analysed and the economy's serious exposure to the cost of fuel explained. South Africa's logistics industry narrowly avoided a serious challenge when the oil price, which had increased significantly in mid-2008, suddenly decreased markedly.

The very real risk, however, is still present and illustrated in Figure 3 by two fuel cost scenarios.

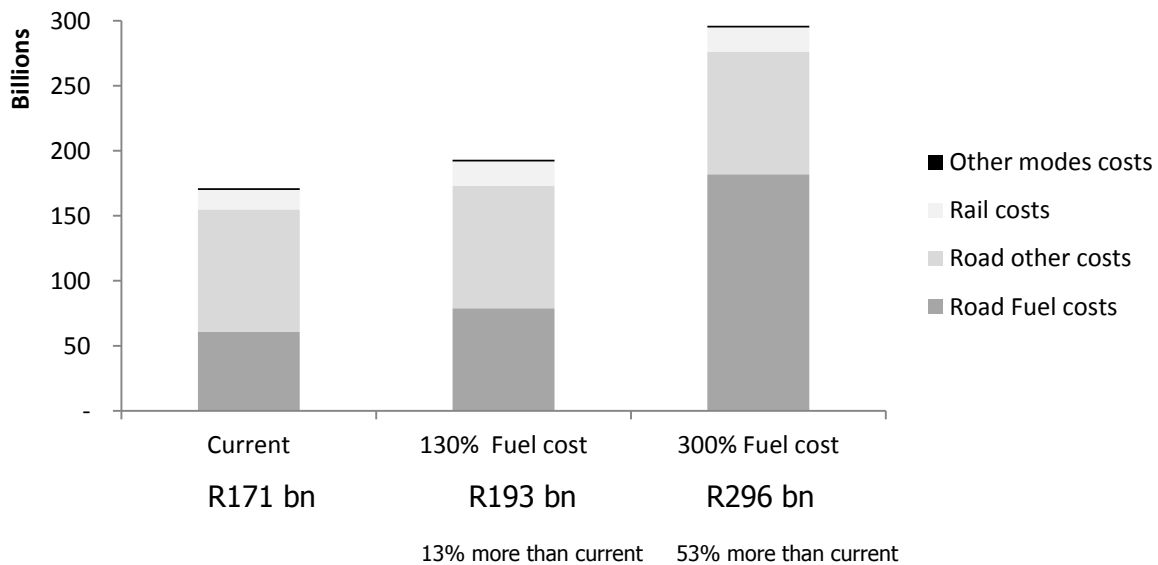


Figure 3 – Impact of higher fuel price scenarios on total transport costs (total transport costs depicted)

If the fuel price were to triple, logistics costs would rise by 53% in 2008 terms and under the conditions of 2008. This scenario is unfortunately quite realistic. The oil price is a highly unstable global phenomenon, evidenced again by the significant fluctuations over the past decade, with a low of \$17 per barrel in January 1999 and a peak of \$147 in July 2008.¹ The short-term fluctuations are just as disconcerting. The oil price broke through \$100 dollars per barrel on 2 January 2008, and reached \$147,27 on 11 July 2008. It steadily declined with the economic recession to \$33,87 a barrel on 21 December 2008. The average price for 2008 (\$91,48) was 42,5% higher than in 2007 (\$64,20).² Economists who dare forecast the oil price see it at least doubling towards the middle of this decade (McColl, 2009, p. 4).

Though all economies are affected by the oil price, South Africa's higher than normal transport demand and poor modal configuration (which includes lower than needed

¹ Price of petroleum, http://en.wikipedia.org/wiki/Price_of_petroleum

² http://www.inflationdata.com/inflation/Inflation_Rate/Historical_Oil_Prices_Table.asp

investment in rail infrastructure) means that the economy will be affected more than average by an increase in the oil price (a worsening of the relative position), as illustrated in Figure 4.

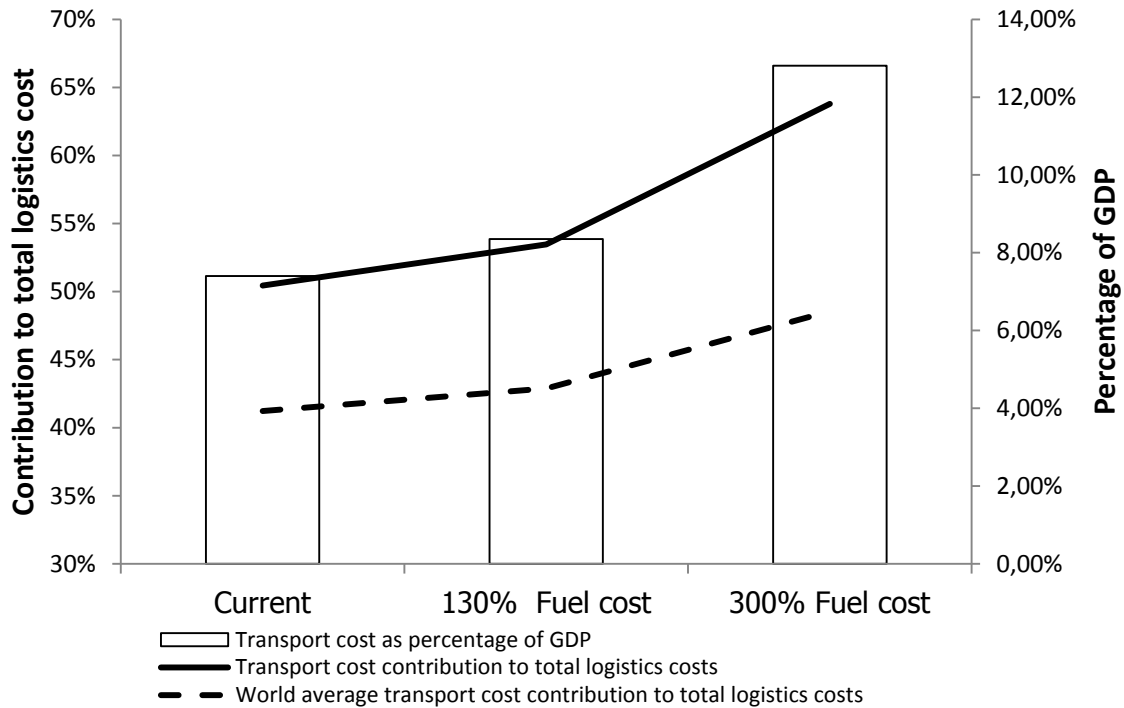


Figure 4 – Relative effect of fuel price scenarios

A fuel cost increase of three times translates into a rise in transport cost as a percentage of total logistics costs from half to two-thirds (a rise in 14% compared with the world average rise of 8%). Transport costs (on their own) as a percentage of GDP will rise from 7,4% to 12,8%.

Ironically, the pronounced oil price fluctuations of 2008 led to a serious drive by many freight transport service providers and freight owners to improve efficiency through load factor improvements. Eliminating journey legs with empty loads has been an important objective for many years, but these events made improvements even more critical. In logistics terms, an important trade-off was also highlighted. Smaller consignments with lower levels of consolidation (to reduce inventory) are a primary cause of empty legs. At some point, however, managing the increasing transport costs will become more important than managing inventory-carrying costs; especially for an economy with a significant road transport market share such as South Africa.

This approach also has a limitation, i.e. complete elimination of empty legs, and for corridor transport (which constitutes two-thirds of total transport costs) this objective is very close to being reached. Thereafter, the threat of significant and detrimental oil price rises could only be mitigated by modal shift.

STORAGE AND INVENTORY-CARRYING COSTS

Costs associated with storing inventory are largely influenced by inventory volume and how long it is stored (managed by logisticians) on the one hand and the cost of storage and the interest rates (largely 'administered costs', especially for interest rates, over which the logistician has no or little control) on the other. Table 1 reflects an analysis of the changes in storage costs.

Table 1 – Changes in storage costs

Factor incurring change	R billion
Inflation	+3,7
Increase in storage volume	-1,8
Storage cost increase above (decrease below) inflation	-4,3
Delay in inventory	+3,6
Total increase in storage costs	+1,2

The R1,2 billion net increase in storage costs specifically is a result of storing slightly less inventory for a longer period of time at slightly less real storage rates (cost per volume) – a mixed result for efficiency and a positive result as far as price increases (price negotiation ability) are concerned.

Unfortunately, the positive effect of lower storage rates is negated by higher inventory-carrying costs. The trend in inventory-carrying costs, which, once again, were much higher in 2008 (21,2% higher than in 2007), is illustrated in Figure 5. The reasons for the increase in inventory-carrying costs are twofold: firstly, the average weighted interest rate increased from 13% to 15% between 2007 and 2008, and, secondly, the levels of inventory increased. The change in interest rates contributed 40% to the increase in inventory-carrying costs, while the increase in inventory levels contributed the remaining 60% of the increase.

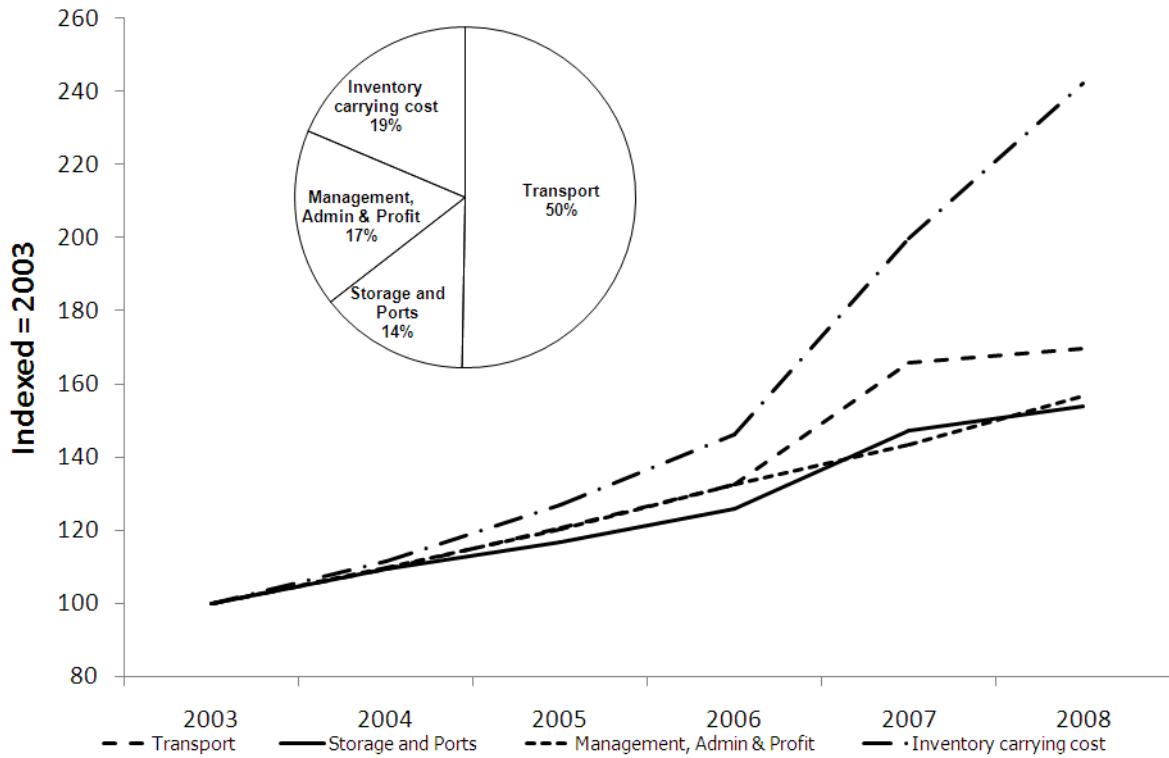


Figure 5 – Logistics cost growth at current prices and 2008 cost contribution

CURRENT FREIGHT FLOW POSITION

Freight transport activity increased by 4% in 2008 in terms of tonne-kilometres shipped and by 2% in terms of tonne shipped (see Figure 6).

The state of logistics in South Africa
Havenga, Jan; Van Eeden, Joubert and Simpson, Zane

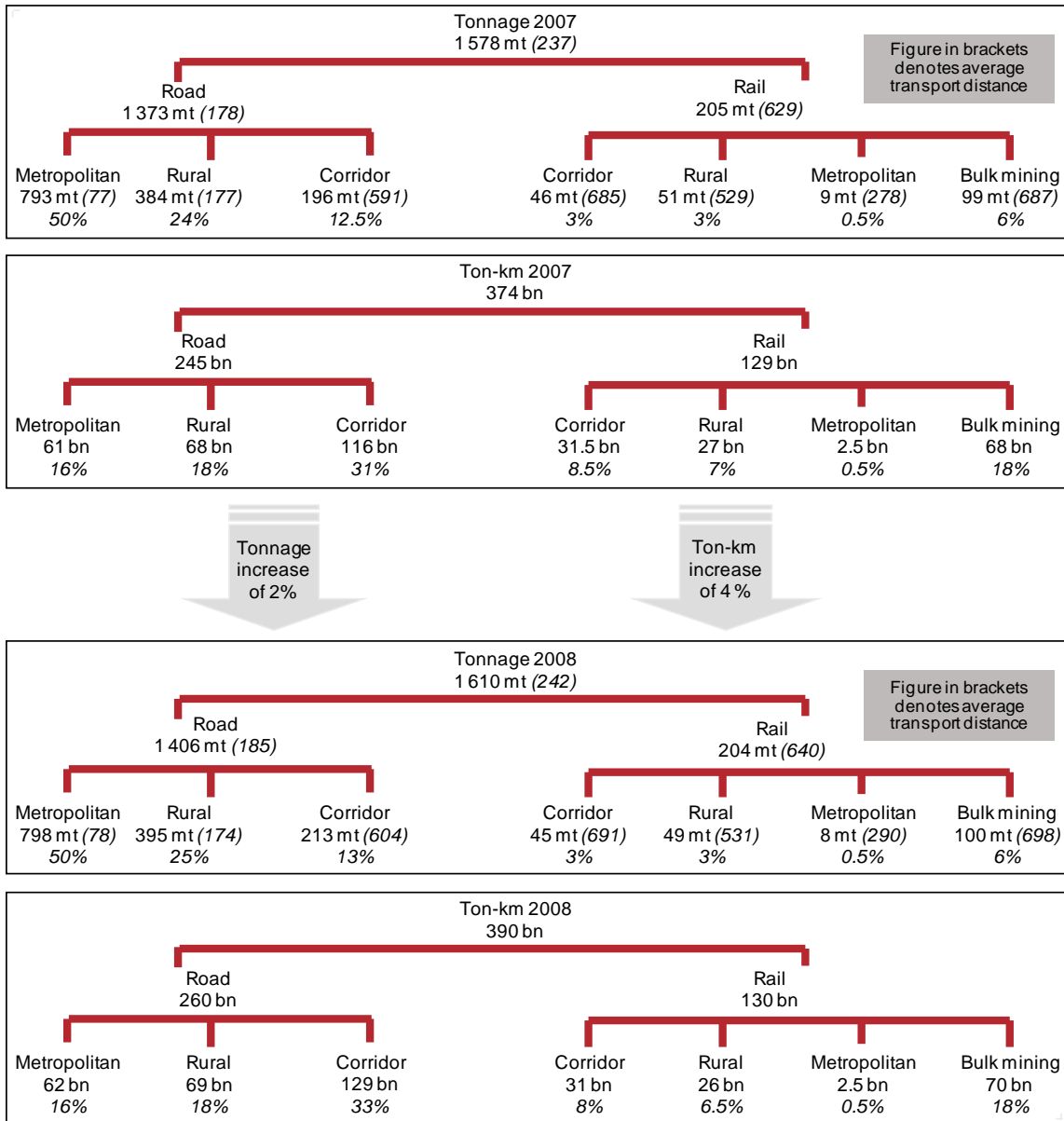


Figure 6 – Modal distribution of road and rail freight in South Africa

The trend of flattening rail traffic volumes and the absorption of growth in road traffic volumes continues, as evidenced by the growth in road corridor traffic (see Figure 7).

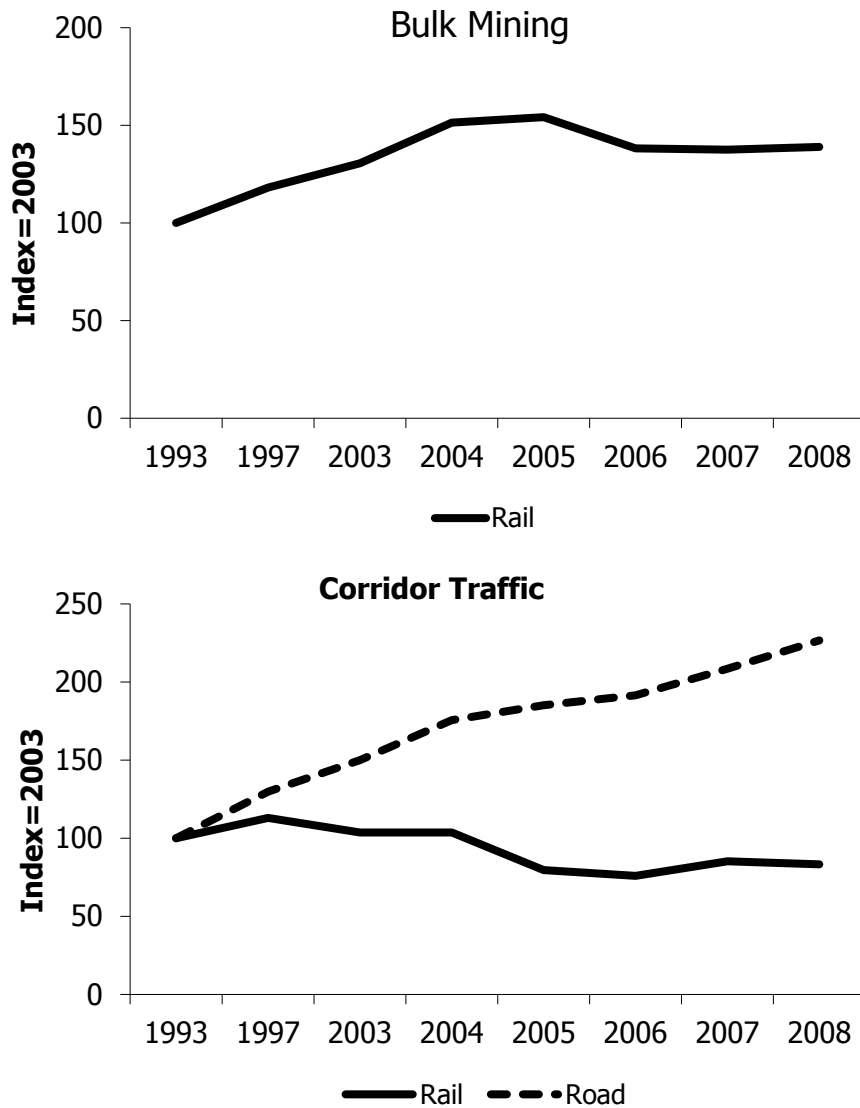


Figure 7 – Bulk mining and corridor transport in South Africa since 1993³

The national rail carrier recently announced a major capital investment plan. Initial analysis suggests that this will have a positive impact on this position, but is notably unsure of the extent or time effect of the plan. Much more funding may be needed over the long term to develop more capacity, especially if domestic intermodal solutions come into play.

SUSTAINABILITY OF LOGISTICS SERVICE PROVISION

Captains of industry recently interviewed through this study indicated that the sustainability and continuity of logistics service provision at a steady level are becoming increasingly prominent issues and require improved management from logistics service providers. Three key trends are emerging globally:

³ Note the irregular time period prior to 2003 due to unavailability of data.

- Consumers are giving preference to economies that adhere to sustainability principles.
- Measurement of critical elements are becoming more transparent and are being used as bargaining tools, giving rise to phenomena such as emissions trading.
- Freight and inventory users are beginning to favour less harmful solutions.

Measurement of sustainability in logistics service provision is difficult, but an attempt is made to measure the externalities for the South African logistics system for the first time.

Externality costs are estimated to add another R34 billion (or another 19%) to the South African transport bill (see Figure 8).⁴

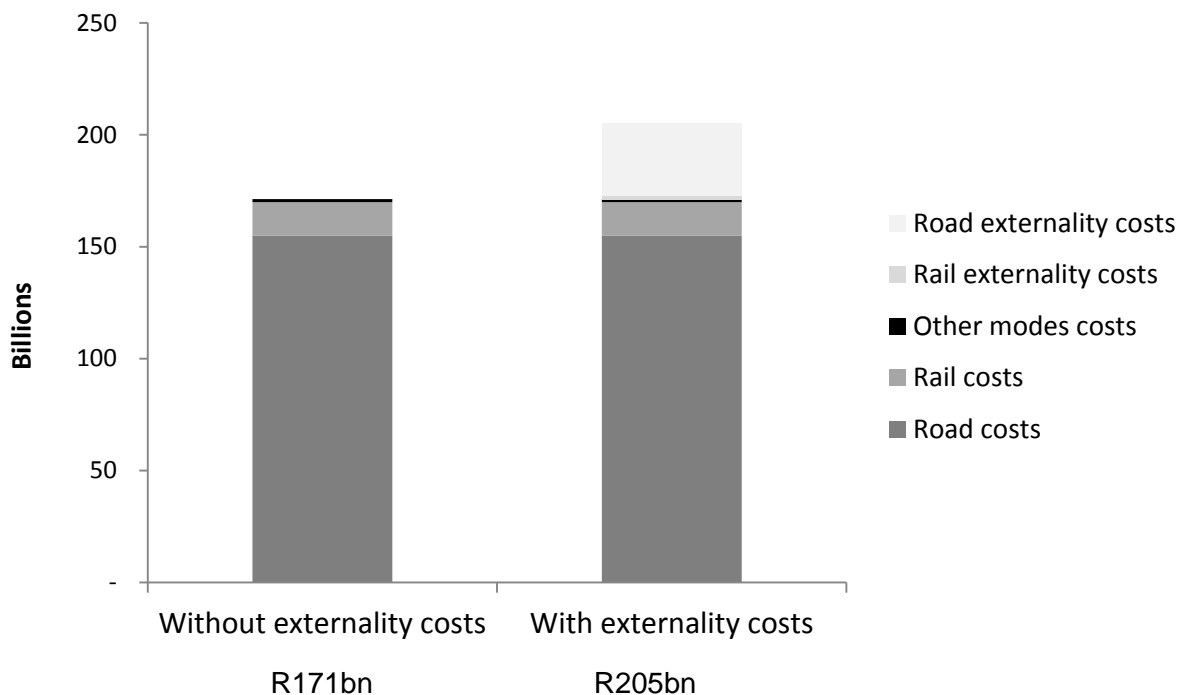


Figure 8 – The impact of externality costs on total transport costs

Adding this cost to the cost of transport increases the cost percentage of transport from 7,4% to 8,8% of GDP. The combined effect of a tripling of the fuel price (discussed earlier) and the transparent accounting of externality costs could mean that the cost of transport would be 14,2% of GDP.

The main factors contributing to externality costs are emissions and accidents, as illustrated by Figure 9.

⁴ The measurement of externality costs is still in its infancy and more detailed work is required. Some results were presented by Allen Jorgensen at the Africa Rail and SATC conferences in 2009, and the data in this section are based on his research. It is clear that the impact is significant.

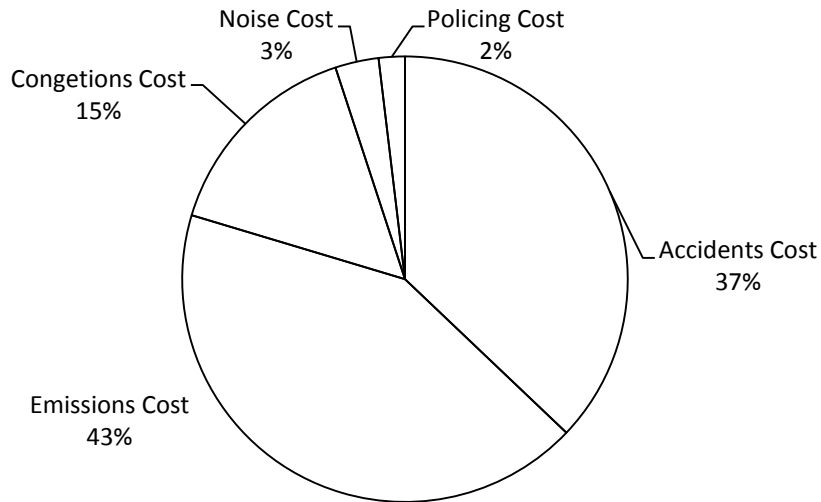


Figure 9 – The externality costs of transportation

Previous surveys highlighted the advantages of a modal shift. The sustainability advantages in this regard are obvious, with much lower externality costs associated with rail transport (see Figure 10).

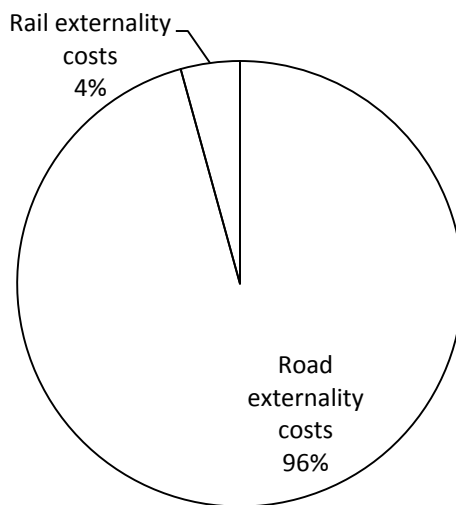


Figure 10 – The externality costs of road and rail transport

CONCLUSION

Given the significant contribution of fuel costs to total transport costs, and the exogenous volatility of this input commodity, the mitigation of this risk remains prominent on the strategic agendas of the road haulage industry and freight owners. In line with global trends, the drive towards a more sustainable logistics system is also gaining prominence. Consolidation and other efforts to increase efficiency have contributed to improvements, including the development of more fuel-efficient equipment with lower emissions. However, these improvements are approaching a natural limit. The real mitigation of risk and an increase in sustainability can only come from a structural change. Two-thirds of South Africa's transport costs are incurred on long transport corridors and mostly by road. With the introduction of intermodal freight solutions on these corridors the fuel risk can be decreased, sustainability improved and harm to the environment reduced.

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