THE DEVELOPMENT AND APPLICATION OF A FREIGHT TRANSPORT FLOW MODEL FOR SOUTH AFRICA

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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

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Chapter 1 – Dissertation Summary

South Africa currently experiences the double jeopardy problem of catching up to global economic competitiveness whilst at the same time feeling the pressures of sustainability management spearheaded by a global agenda. Global sustainability is defined as growth that is shared without depleting natural resources or damaging the environment. Academic disciplines are challenged to make a contribution and economics as such should contribute by providing the lead and lag indicators for the planning and measurement of scarce resources usuage. This integrative view includes economic sub-disciplines, such as logistics.

This integrative view is an acknowledged part of the economics discipline, except that the macro-economic context of some sub-disciplines, such as logistics, often receives less attention during the course of academic activities. The distribution of resources and outputs in the economy is a logistics controlled cross-cutting factor, but suffers from a lack of macro-economic perspective, and lead and lag orientated measurement. This state of the affairs is a historic backlog of logistics and its specific position within economics.

During the primary economic era the world began to configure networks and markets, which became more pronounced and settled with the dawn and settling of the industrial era. Logistics then was a "given" and did not receive much thought even as industrial, market economies developed. Transport was regarded as an administered cost, i.e. inefficiencies in logistics systems were evenly distributed between competitors, not giving any specific entity an advantage. With the advent of global competition and the diminishing returns on other cost saving measures, companies began to collaborate and integrate logistics functions within value chains, but the administered part of transport costs failed to receive the attention it required. In this way, global competitors did begin to experience disadvantages on a national level as whole economies suffered from inefficiencies in logistics and specifically transport systems.

Only a few theorists are beginning to emphasise the macro-logistics perspective, but not in depth, especially as it relates to infrastructure planning, relative sophistication between nations and differences in “vision” between nations. Precious little is, however, offered in terms of performance and planning measurement systems. Well-respected national measurement systems have been developed in a few cases, but they are usually very broad, not integrative, do not provide analysis of specific macro-issues and are based on very old methodologies.

In South Africa specifically, the problem of measurement absence was exacerbated over the past two decades when state assets were commercialised, the transport market deregulated and information on the performance of these sectors in the economy became even scarcer. South Africa’s rail system is old, has a narrow gauge and is uncompetitive in general freight, which places a massive burden on expensive road freight. The specific structure of South Africa’s transport market is important, because of high concentrations of people, resources and manufacturing plants far from the coast. Requests for research have been raised, specifically on modal market share, freight flows, including commodity freight flows and forecasting, but the few research efforts in this regard over the past 50 years failed to provide any meaningful answers.

South Africa’s transport development history followed five phases that can be described as foundations, industrial revolution, network, market connection and overcropping. During the foundation phase between 1830 and 1870 spatial planning was more difficult and as population densities were low research based approaches were not always neccesary to the degree required in the industrial era. During the industrial revolution phase between 1870 and 1910, the current narrow gauge was installed, more because of short-term profitability perspectives during road versus rail price wars rather than long-term based macro-research. During 1910 to 1950 in the network era the final rail network was established, transport was regulated and network design errors made as the new constituents insisted on a rail network for commercial farming, which hampered investment in major densifying corridors. The network was funded by cross-subsidisation from high-value traffic on the corridors, where investment did not keep track with concomitant high tariff based returns. This caused initial surreptitious, but later open, often illegal road competition in the market connection era, between 1950 and 1990, that was fraught with lawsuits and policing and general apprehension for the road mode from the railways. Rather than developing intermodal systems, as access roads improved and corridors densified even further, the modes remained separate. All South Africa's modal studies were done in this era, always through questionnaire-based approaches, but the results of the five known surveys (the fifth one was repeated a few times using the same methodology) were erratic and unreliable. No macro-economic perspectives were given and the stated intent to model total flows, commodity flows and to forecast never achieved. Only modal market share was reported on and only three of the studies (1958, 1971 and 1985) achieved some degree of acceptance as valid. The absence of research was a major cause of mistakes made during the first half of the overcropping era, 1990 to 2005 as transport was deregulated, the railways run down and transport densities (a major driver of efficiency) declined. Improved research was often requested, but to date precious little has been done. Information from Statistics South Africa is proven to be unreliable and even with the advent of a National Freight Logistics Strategy in 2005, little analysis is based on actual, repeatable research.

To address the lack of research three models are proposed to provide a valid, sustained and repeatable measure of freight flows, i.e. the national freight flow model, the commodity flow model and the logistics cost model.

The national freight flow model utilises vehicle counting technology at various permanent (398 stations) and secondary (430 stations) counting stations to model road data. Actual rail data are used and the model was then run for 1993, 1997, 2003 and 2004.

The research confirmed that in the absence of intermodal traffic South Africa's rail system (which is bigger than the next four in Africa combined) is in serious decline for the general freight mode. Total tonnage expanded by 50%, with about 60% growth on road over the last 11 years. The only rail growth was on ring-fenced export freight that grew by about a third. This means that South Africa's economic growth will have to be carried by its road network and the country cannot afford it, because the dense corridors are becoming expensive (because it is not leveraged with intermodal technology). This, in turn makes it difficult to enable the second economy to gain access to markets. The model was further applied to quantify transport in ton-kilometers (for exact scalability) to understand the distribution between various proposed typologies. The primary typology describes world-class one-directional bulk transport with few origin to destination points of low value mining commodities. The main challenge is systemic competitiveness with other deposits around the world that are mostly closer to the coast. The metropolitan typology describes many origin to destination points in cities with the main challenge to alleviate congestion. The rural typology describes many origin to destination points in rural areas with the main challenges to provide development as well as access to corridors and metropolitan markets. The corridor typology describes long haul, often high-value commodities, which originate at many points in cities, then converge, travel to a divergence point within other cities and are then distributed to consumption points. The challenge here is to alleviate South Africa's spatial challenge by providing effective solutions, probably intermodal, to solve this sizeable portion of the country's freight transport problems.

South Africa's population (under 1% of the world population) produces less than half a percent of the world GDP, but requires 2% of the world's ton-kilometers. This situation arises from the country's economic development history that placed mining production and population development far from coastal areas, in a relatively open mineral export, and beneficiated product and energy import economy, thereby creating long export and import corridor requirements.

The measurement of performance for each mode over each typology was also necessary to understand whether objectives are being met. All growth over densified corridors occurred in the road mode which expanded by more than 60% over eleven years. This growth would be understandable if the corridors in question are short or the density per corridor low. In these instances the economy would have to absorb this growth in the road mode. Cheaper options are, however, available in intermodality if the density per corridor can be calculated as sufficiently high. In South Africa's case the spatial efficiency objective of the corridor typology is not achieved. If this density is sufficient to sustain an intermodal solution, future investment should be channelled to such solutions. This could release funds for the development of the second economy in rural areas, which is a major economic objective of South Africa at present. Rural road traffic grew slower than corridor traffic (less than 60%), which correlates with the hypothesis that South Africa is not succeeding in the desired stimulation of rural economies. A major cause of this failure is deteriorating road infrastructure, which can now for the first time be measured. The development objective of this typology is therefore not achieved. Metropolitan growth is also slower than corridor growth.

Performance measures could also be developed and it showed that South Africa's GDP per ton generated fell from R1 000 about two decades ago to close to R900 in 1993 and lower than R800 in 2004. The transport system is therefor evaluated as not performing as it should, mostly because planning was not based on measurement and understanding of the realities of the situation.

The commodity flow model's objective was to translate total flows into commodity flows and develop a 20-year forecast. It was believed that forecasting on a commodity level will provide better insight into transport infrastructure demand planning. The model utilises the input-output model of the economy, disaggregated to 354 magisterial districts and translated from value to tons. Gravity modelling principles were applied to determine flows for 26 commodity groups. Forecasting was done on a commodity level, referenced independently and the top 20 commodities' distribution, flow and forecasts were independently researched and verified. The model clearly illustrated that the dense corridors will grow by more than 100% over the next 20 years, that the growth will occur faster in automotive, wood and chemical products and very fast in most commodities that can be containerised. It highlighted the specific nature of intermodal solutions and the size of container terminals that could be developed and where.

As a final step the results of the models were compared to the **cost of South Africa's logistics** in total and what the effect of these observations could be on logistics costs. The transport sector contributed more than 63% of logistics costs in South Africa (R141 billion of R223 billion) and grew faster as a cost factor than total logistics costs over the past two years. This compares poorly with the figure for the rest of the world which is below 40%.

South Africa need real information to understand the logistics performance of the economy and this study was able to provide it and also indicate the direction for future planning in order to alleviate problem areas. Through this study a better understanding of an important part of South Africa's economic system, that will inform and improve the management there-of was achieved. The study made it possible to measure on an annual and repeatable basis the volume, direction and modal market share of freight in South Africa, the commodities involved, its relation with logistics costs and forecasts for the future. For the first time the macro relationship between these major components are understood and the country can plan for future challenges.

Chapter 2 - Problem statement and overall approach

2.1 Introduction and background

The first decade of the twenty-first century in South Africa will go down in history as the decade of debate regarding infrastructure, infrastructure planning and infrastructure requirements for the next half century. The context for these questions and the rationale behind them are South Africa's national priorities of job creation, economic growth, poverty eradication, social cohesion and national identity[1]. Sustainable development is the core enabler of these priorities.

Alfsen and Thorvald arrive at a definition of sustainable development by stating that:

> the point of departure should be economic development … to respect future environmental and social conditions that are acceptable to our grandchildren… (with) widespread agreement that a main threat to global sustainable development can be found in the uneven distribution between rich and poor.[2]

Sustainable development is therefore defined as growth that is shared and that can be maintained within the context of the replenishability of the production factors consumed by the growth. This means that sustainable development requires the economy (i.e. wealth) to increase, requires society to ensure that everyone benefits from this increase in wealth, and requires the management of this process to ensure that the environment can continue to sustain the growth (Figure 1).

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[1] Jordan, 2007, p. 1.
[2] Alfsen and Thorvald, 2005, p. 5.

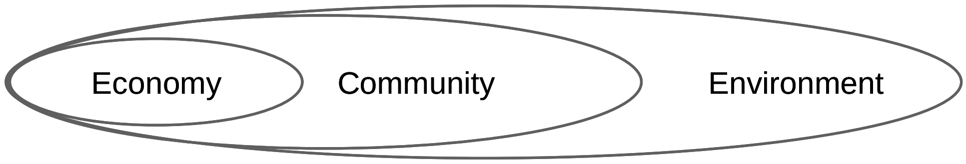

Figure 1: The three pillars of sustainable development[3]

In the ensuing debate around how these objectives will be met and what the infrastructure requirements are, another set of clear guidelines is emerging. The process requires planning, public/private partnerships and the practical application of theory to achieve these objectives. In this regard, the various disciplines in the academic sciences are actively commandeered to apply scientific thought and practical contributions to South Africa's infrastructure challenges.

The one academic discipline that could be a major contributor in this area is economic sciences, for reasons both intrinsically described in the science itself and extrinsically described in the role of economics in human culture and scientific thought. Intrinsically the discipline describes itself in well-known and accepted terms as an empirical social science[4] studying those activities that involve the production and exchange of goods. It also analyses the movements in the total economy, commerce amongst economies and the choices involved in these processes.[5]

Extrinsically economics could be described as one of the fundamental modalities of society[6] that defines the human ability to save resources and distribute them over time.[7]

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[3] Morris, 2005, p. 87.
[4] Mohr and Fourie, 1996, p. 17-18.
[5] Samuelson and Nordhaus, 1989, p. 4-5.
[6] Strauss, 1978, p. 10.
[7] Strauss, 1978, p. 20-21.

This means that economics could be regarded as a pure science with its own unique *a priori* reason for existence. It is defined by Samuelson and Nordhaus as:

> the study of how societies use scarce resources to produce valuable commodities and distribute them among different groups.[8]

Within the context of this definition, economics has always acknowledged both a macro-economic and micro-economic field, where total economic functioning (macro) is distinguished from component behaviour (micro).[9]

Its purpose in the macro field is not to make the direct technical contribution attributable to engineering, natural sciences and medicine. However, economic sciences are positioned squarely in the ambit of the management of economic growth and therefore, by definition, planning. The planning of economic growth has always been driven by a solid set of researched parameters. The targets and performance on these parameters, as lead and lag indicators, have to be known in order to be managed. This is done in great detail for overarching economic performance as well as for many of the inputs into this performance, such as for banking, productivity, mineral resources and some other macro-economic factors. These inputs, often called production factors, are well known, but are by no means exhaustively described. In fact logistics, though often not specifically identified as a production factor, is a clear and unambiguous part of the Samuelson and Nordhaus definition quoted previously. Logistics is in fact the factor that enables regional specialisation (and thereby economic growth) through efficient and effective exchange systems.[10] These relationships are depicted in Figure 2.

[8] Samuelson and Nordhaus, 1989, p. 5.
[9] Samuelson and Nordhaus, 1989, p. 5.
[10] Pienaar, 2005, p. 2.

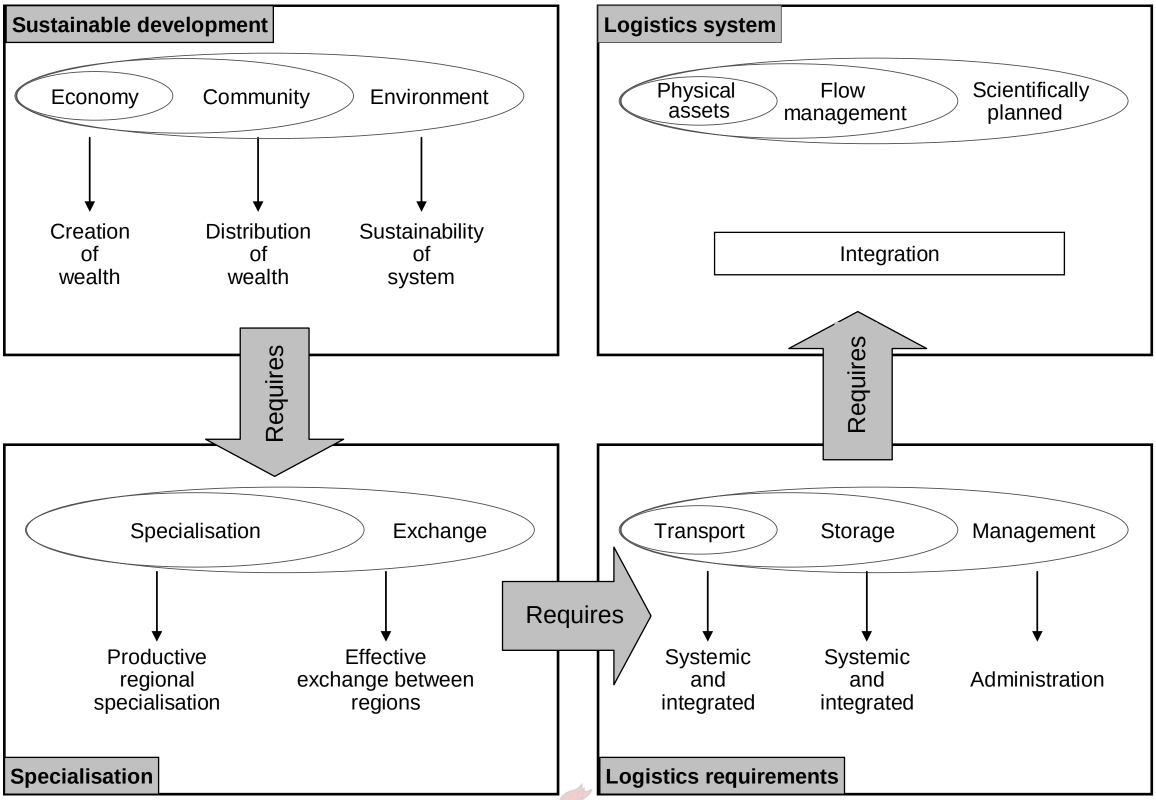

Figure 2: From sustainable development to logistics requirements

In the field of logistics a chronic and ever-widening gap emerged as far as the macro-economic context is concerned. Research is scant and over the past five decades very little in the development of a macro-economic context for logistics has been achieved, and definitely nothing comparable to the well researched field of pure macro-economics. As far as the macro-economic freight transport network of this country is concerned, research over the last fifty years has produced only five studies. When they are analysed, it is found that none of the core objectives of these studies were achieved. The modal market share, flow of commodities, future demand for flow and costs are simply not known.

The objective of the research presented in this dissertation is to introduce the fundamental model that can continuously provide these answers and to illuminate the process whereby these parameters can achieve the same macro-economic and national priority status as all other macro-economic parameters. The overarching design of this approach requires a few specific building blocks. In Chapter 2 the macro-economic point of departure is clarified; the history of logistics within this context described and a typology developed which can be used as a structuring tool for a literature survey of what was achieved in this field in South Africa in the past two centuries. Once this foundation is in place, the problem in more specific terms around the necessity for logistics measurement and the meaning of the concept of measurement are discussed within this context. This paves the way for a better understanding of the theoretical framework on which a macro concept is based and how its measurement support system should perform, informed by a comprehensive literature study (Chapter 3). Chapter 4 provides a detailed overview from the available research literature of the measurement performance actually achieved. From this overview of actual performance, a specific set of guidelines emerges that informs the performance criteria for a macro-logistics measurement system. These guidelines enable the proposed overarching design of such a measurement system, as set forth in Chapter 5.

The proposed measurement system is designed around three core models that describe the macro freight transport performance of an economy. The first of these models describes total flows according to network types, leading to an understanding of freight supply in a modal and network sense (a modal network measurement of the South African economy has never been achieved before). The model design is described in Chapter 6 and applied in Chapter 7. The second model describes flows on a commodity demand side basis and, because it is demand driven, it enables forecasting of freight demand per commodity in South Africa. The model design is described in Chapter 8 and applied in Chapter 9.[11] The third model calculates logistics costs for the macro-economy[12] and is described and applied in Chapter 10. Chapter 11 illustrates the validity of the overarching results of this work and how it can be used in future to become a standard annualised system of lead and lag indicators for the managing of macro-logistics performance.

[11] The national freight flow model and commodity flow model have been researched and developed over the last 11 years in collaboration with Ilse Hobbs

[12] This model was scoped together with this research and during the time period of this research (and in tandem with it) further developed by Wessel Pienaar, Francois Botes and Neil Jacobs.

2.2 Definitions of logistics and measurement

This dissertation specifically proposes a fundamental measurement model for macro-logistics measurement in South Africa. Definitions of the concepts of measurement and logistics are therefore required.

2.2.1 Definition of measurement

Measurement as a concept needs to be seen against the canonical steps of a decision-making framework, since measurement does not add value unless it informs decision making. Many decision-making models exist, but at its core the inputs are information gathering, information analysis or categorisation, and intelligence development as the final step in the decision-making process. This intelligence should adhere to certain principles, or at least endeavour to achieve certain performance goals.

Hofstadter[13] proposes certain general principles for intelligence which are valid in all contexts. He challenges the measurer to allow flexibility in data interpretation depending on the interpretive requirement, find new, novel and integrative areas to apply the data, deal with both paradoxes and similarities and highlight important areas for consideration. These principles call for significantly more than the reactive management information that is often available to decision makers and encourage the measurer to integrate the measurement with the measurement subject itself. This approach is integrative and intrinsically macro-oriented in nature as the connectivity of each research subject to higher orders of being is taken into account. If the speed of inventory turnover for a business, for example, is being researched, Hofstadter's definition would mean that the paradoxical result of higher speed making the administered cost of transport more expensive should also be considered. (This is because lower inventory levels and smaller faster-moving parcel sizes lead to reduced traffic densities, followed by modal shift). In this example the researcher might take the transport costs of any specific situation in a firm as a given administered cost, but the cumulative effect of all

[13] Hofstadter, 2000, p. 26.

the decisions will impact on the administered cost and thereby make the system as a whole either more or less competitive, in turn impacting on the cost of each shipment. Through this definition it is therefore shown that all measurement could, in fact, have a macro character.

Measurement as a management activity is both a lead and lag indicator of efficient and effective management practices. As a lead indicator it supports the targeted deployment of operational and capital resources, and as a lag indicator it indicates performance and prepares the way for corrective action. The tool is usually deployed in micro-economics on a firm level to determine capital and operational investment requirements and measure logistics performance efficiency. On a micro scale in the logistics field, Kaydos describes measurement as assigning "a numerical scale to the size, value or other characteristic of a tangible or intangible object."[14] This requires scalability of the various performance measurements, an objective that is not often achieved with macro-logistics measurement.

On a macro-economic scale measurement is common as a lead indicator to determine national policy, especially monetary and fiscal policy, and as a lag indicator to determine various elements of the performance of the national economy. It is less common as a tool in logistics infrastructure investment decisions and performance measurement, but sorely needed. As South Africa grapples with investment requirements for economic infrastructure development, guidance on where to spend limited resources is of critical importance. Over the next few years R400 billion[15] (equivalent to one third of the country's annual gross domestic product) must be spent by government on logistics infrastructure and it is self-evident that even relatively minor mistakes in this spending programme could have significant negative impacts. Specifically for rail, highways, ports and intermodal hubs, policy makers are experiencing an ever-increasing shortage of useful measurement tools to guide decision making and measure performance. This dissertation intends to fill this void specifically.

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[14] Kaydos, 1999, p. 15.
[15] "Billion" in this dissertation means one thousand million

Lakshmanan and Anderson emphasise the need for performance-based research to demonstrate the link between logistics infrastructure investment and economic growth. This will enable an understanding of the "effects of logistical transformation, productivity enhancing location shifts, and value adding effects" and "*ex post* assessment of major infrastructure projects and programs".[16] Their request is clearly for both the input (lead) and output (lag) performance measurements of macro-logistics systems.

2.2.2 A definition of logistics

Logistics can be defined as an extended time and place utility for intermediate and finished goods. The fact that intermediate and final production usually does not occur at the time and place of consumption requires the intermediate storage and transportation of these goods up to the point of consumption. In micro-economics the costs of this displacement are usually carried by the freight owner, who can either be the seller of the goods (in which case it is sold delivered) or the buyer (in which case it is bought ex-works). The cost of overcoming the time and place disparity, however, remains in the value chain, irrespective of who is responsible for its payment. The value of integrated logistics management is that it can reduce this cost. The phenomenon becomes even more striking where logistics is measured on a national basis and the specific logistics costs are carried by the national economy as the freight owner by proxy. This dissertation will address the issue on a national basis and make specific recommendations in this regard.

Logistics costs can be broken down into three direct elements, namely transportation, warehousing and administration, and one indirect element, namely inventory carrying costs (the time-based working capital financing cost of inventory in the logistics chain). This dissertation will report on all four elements. Transportation costs will be highlighted in far more detail, as this cost is hypothesised to be not only the largest element of logistics costs, but

[16] Lakshmanan and Anderson, 2002, p. 17.

also to be growing faster than the other elements of logistics costs in most economies.

2.3 Global trends

2.3.1 Industrial development context

The industrial revolution was enabled by automised production systems that had little to do, initially, with market balancing (i.e. the balancing of supply and demand) as initial demand outstripped supply. (Industrialisation meant many new products and also much more accessible products – due to cost rationalisation). The revolution was further fuelled by the two world wars and the production economy probably peaked (in terms of an ability to disregard demand-side issues) following Europe's rebuilding after the end of the Second World War. In 1946 Alford and Bangs described production control as:

> organization, planning, checking on materials, methods, tooling, and operation times, handling of routing, scheduling and dispatching, and coordination with inspection, so that the supply and movement of materials, operations of labour, utilization of machines, and related activities of factory departments – however subdivided – bring about the desired manufacturing results in terms of quantity, quality, time and place.[17]

Demand-side economics is clearly not significant in Alford and Bangs's description, which has a direct impact on how logistics systems were viewed (or not viewed) at the time when they described the theoretical principles of industrial management. At the same time logistics on a macro level is not taken into account, but rather treated as an administered cost, i.e. not providing a differentiation for companies, competing against each other, nor for countries competing globally. This points to the possible conclusion that the state of logistics and the acceptance, role and positioning of the function on a micro level relates to the macro-level structuring of the economic

[17] Alford and Bangs, 1946, p. 67.

platform from which it is launched. To test this conclusion a broad description or typology of economic platforms with an industrial development perspective could therefore better inform the current positioning of logistics and the global trends relating to this positioning.

2.3.2 An underlying typology

A discussion on global logistics trends should commence with a view of the different phases of economic platform development and the underlying physical support infrastructure of each phase, as depicted in abridged form in Figure 3.[18]

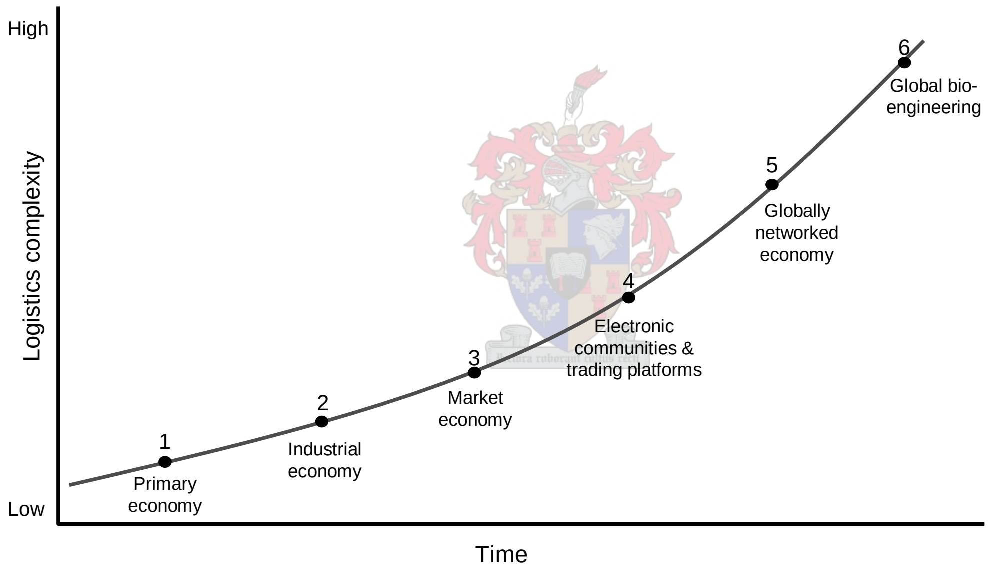

Figure 3: Abridged illustration of the growth in economic platforms

The six phases depicted here refer to the development of local, national, regional and global economies over time. Primary economic development (characterised by land grab) is followed by industrial economic development (characterised by development of technology and registering of patents), which in turn develops into a more market-orientated economy (demand driven and service orientated). With the development of electronic communities and electronic trading platforms, economies become more

[18] Havenga, 2005, p. 18.

globally networked and currently the world is entering a global bio-engineering phase on the back of these developments.

A few important dimensions of this construct should be considered:

- Movement along the axis differs for various parts of the world. In the last five decades the triad (USA, Germany, Japan) and their immediate geographical surrounds (North America, Europe and the Pacific Rim) developed faster along the curve, although catch-up by new entrants such as China and India is a specific feature of the last two decades.
- Movement along the axis is fundamentally one-directional. It is difficult to catapult an economy into advanced phases without solid groundwork in earlier phases.
- Entropy sets in, in earlier stages, as in all evolutionary systems. This requires continual revisiting of earlier building blocks.
- Economies compete from different national and regional platforms, creating development disparities. Attempts to address these disparities through world trade agreements, such as through GATT, are unfortunately often deficient.

The underlying physical support architectures of the various economic platforms are depicted in Figure 4.

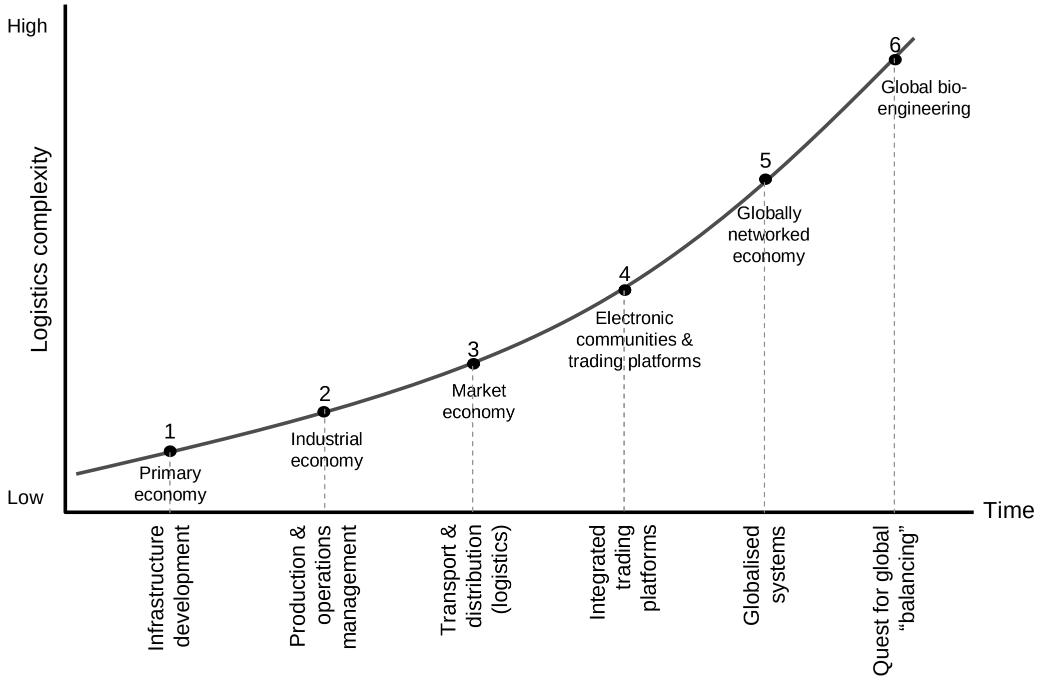

Figure 4: Physical support architectures of economic platforms

The physical support architectures describe the support for the underlying typology:

- In the primary economic development era communities required infrastructure to reach new regions, often to exploit the mineral and agricultural wealth to be found in these new regions. Within defined boundaries, such as South Africa, the era became known as "hinterland development". Infrastructure development to provide access to these areas, through roads, railways and harbours, played an important part in development and investment decisions. In some first world economies, such as Europe, this was preceded by maritime shipping technology and "hinterland development" was achieved much earlier than in South Africa.
- In the industrial revolution era communities required manufacturing support systems usually enabled by efficiency of production lines. The growth in the manufacturing economy made more products available, but a prevailing push mindset often put the onus on the consumer to find suitable products. Power was in the hands of the industrialists.

- In the market economy era power shifted from production to consumption and most systems began a transformation process from push to pull. Transport and distribution became functions of the production process as consumers demanded final products closer to the point and time of consumption.
- In the current electronic community and trading platform era, communities of consumers are more accessible through mega-portals (both virtual and bricks and mortar) and often enabled in both directions, i.e. virtual trading platforms required bricks and mortar logistics support infrastructure, but physical mega-portals required information systems enablement, through scheduling and demand forecasting. Suppliers in these areas realised the benefits of collaboration and even made use of third parties to engineer seamless delivery options.
- In the globally networked economy these support systems become global and as a specific feature certain new global blocks are catching up to the initial triad. Remaining global imbalances restrain systems through renewed security concerns and the rerouting of basic commodities for food aid and primary health care.
- In the global bio-engineering era the earth's resources will have to be balanced for all communities. The anti-globalisation forum will gain support and the fringe demand for overall balancing of resources should become a mainstream phenomenon.

2.3.3 Global trends

A broad description or typology of economic platforms with an industrial development perspective has now been provided. This enables an understanding of the current positioning of logistics and the global trends relating to this positioning. Global trends have been, and will continue to be, one of the driving forces behind each of the economic platforms and is correlated to the underlying typology as is depicted in Figure 5.

In each of these eras the trends describe the basic mindset or point of departure of the logistics community. It also describes the key recurring theme that logistics professionals will or should revert to once entropy has set in.

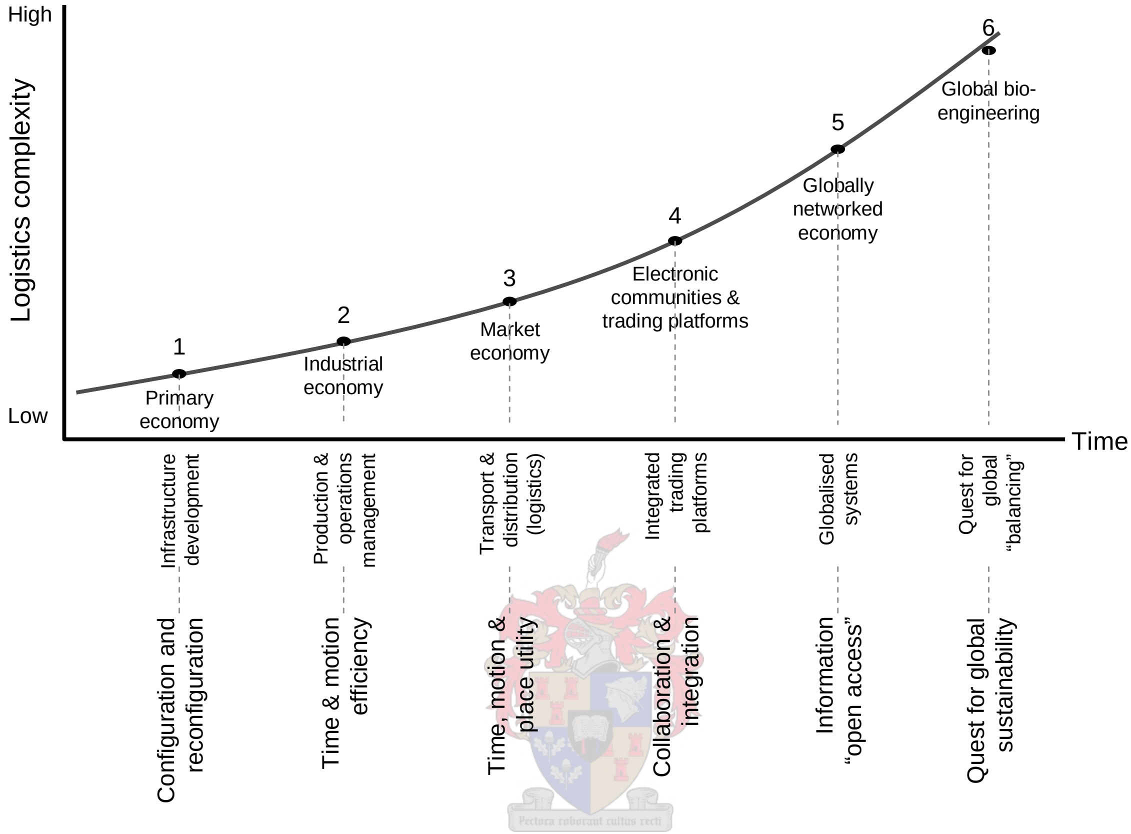

Figure 5: Global trends relating to the underlying typology

- **Configuration and reconfiguration**. The issue of configuration and reconfiguration relates to the basics of logistics. Yet, because of disparities in global development and entropy, this remains an issue and often requires new attention. The late Robert Delaney's closing remarks in his final speech, when he presented the fourteenth state of logistics report, are almost prophetic in this regard:

> Let's get our people right, our products right, and our production and distribution facilities network right and get our own house in order. Let's RECONFIGURE our businesses operationally as a first step before we consider the benefits and risk of collaboration. In our experience, you should collaborate from a position of strength, not

> weakness. We have to operate our way out of this challenge. We have to resist complaining about level playing fields. This is globalisation. There are no levelling playing fields. Recalling my favourite line from the award winning film Forrest Gump, 'That's all I'm going to say about that.'[19] (Capitals in original.)

When Delaney reverts to reconfiguration, he emphasises core structural problems that crept into systems within companies. This is, however, also true of national and regional economies, where the efficient development position that was evidently achieved is often lacking in some areas or has deteriorated over time. This could refer to people and processes on a micro level, but on a macro level it is often referred to as infrastructure development and investment and how to achieve a "perfect" balance for global competitiveness.

The key recurring theme for this typology is therefore that core structural problems are increasingly identified in national logistics systems. Cases for reconfiguration on a global scale will emerge over the next ten years.

- **Time and motion efficiency**. Time and motion efficiency was the initial stamping ground of experts such as Galbraith[20] (the famous American with twelve children who transposed household issues of surviving in a household of 14 members to the field of time and motion study). The initial idea of time and motion study led to production line improvements, but rapidly spread to materials management and inventory control improvements. These improvements received a further boost in the last three decades with "just-in–time (JIT)" management, and companies such as FedEx and DHL built entire business models and value propositions around the concepts:

> One of the most tangible impacts of FedEx on business is the lowering of inventories and their associated carrying costs. In the

[19] Delaney and Wilson, 2003, p. 20-21.
[20] Chase and Aquilano, 1981, pp. 16-19.

> United States it is widely established that the inventory-to-sales ratio has experienced a steady decline in the past two decades as a result of advances in information technology and better logistics management. The overall U.S. inventory-sales ratio has fallen by over 20 percent over the past 18 years.[21]

The double-edged sword of these improvements is the concomitant decrease in real interest rates, which accentuated improvements in materials handling, inventory management and the overall costs in the carrying of inventory. This, however, brought the rising cost of transport and transport inefficiencies in sharper focus.

Little attention was given to distribution and very few logistics measures were developed. As Keebler and Durtsche points out, “supply chain power rested with manufacturers”.[22]

The key recurring theme for this typology is therefore that “value chain efficiency” will in the next decade become a standard hygiene factor such as “production-line efficiency” has become over the past five decades.

- **Time and place utility**. Time and place utility refer to the era when transport and distribution systems became more sophisticated, although the field was not referred to as “logistics”. Gattorna and Walters refer to the start of this period “in the 1960s and early 1970s” when “physical distribution directors were very much an emerging breed.”[23] The early 1970s saw the emergence of cost trade-offs[24] and the beginnings of what would later be known as “total cost of ownership”. Power slowly began moving down the value chain towards retailers[25] and customer service became a competitive force.

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[21] SRI International, 2004, p. 33.
[22] Keebler and Durtsche, 1999, p. 47.
[23] Gattorna and Walters, 1996, p. 2.
[24] Gattorna and Walters, 1996, p. 3.
[25] Keebler and Durtsche, 1999, p. 48.

This era's sharp contrast in terms of distribution and customer focus is described in Wynne-Roberts's short but well constructed treatise on industrial management, the end-to-end business process and its management just before the 1960s. Towards the end of his careful analysis of production management he simply refers to the "disposal of the finished product" and states that this should happen as fast as possible.[26] The arrival of the customer focus era began to change this as evidenced by Baily's work in the 1960s where he talks about:

> The main task of any supply department is to supply the organization it serves with the goods and services required from outside the organization, in the right quality, at the right time, in the right quantity and at the right price. (Sometimes the right place must be added to the list…)[27]

Baily initiated the contemplation of the place dimension and what its ramifications would be. As the understanding of the place dimension grew, manufacturers and producers began to understand the importance of distribution management. Customer demands became more sophisticated and undifferentiated long-distance solutions (often rail bound) were no longer adequate. Lower utilisation of rail due to more tailored customer solutions led to a certain gradual demise in fixed, long-haul, heavy infrastructure, such as rail corridors, but at a cost that is still not understood in its widest context.

> …freight transport is likely to consume an increasing amount of energy and land, and it contributes to a wide range of problems such as air and noise emissions, congestion, traffic fatalities, etc. Social costs associated with road and air freight transport are reportedly much higher than those of rail and waterway freight modes.[28]

Although more efficient in individual cases, the transport or place utility therefore tends to become more inefficient on a macro scale as

[26] Wynne-Roberts, 1956, p. 47.
[27] Baily, 1969, p. 39.
[28] Hesse and Rodrigue, 2003, p. 12.

collaboration and integration efforts are hampered by piecemeal optimisation. The intrinsic costs could then be high, and rising, and in most cases extrinsic costs have not even been measured yet. This is a clear case of where macro and micro approaches diverge and both should actually be considered. These challenges are usually addressed in a reactionary way, as reported by the Environment Directorate of the OECD[29] Environment Policy Committee:[30]

- Large-scale investments in highway systems;
- Liberalisation of road freight over rail freight;
- Vertical separation and open access on rail;
- Lower real fuel prices; and
- Increased purchasing power for private motor vehicles.

Most of the configuration developments in basic transport infrastructure are therefore driven by factors outside the normal national cost consideration issues to the detriment of all users of the network. Reflecting on these developments over the past two decades, it is clear that the overall costs of logistics is declining, but that this decline is driven by factors other than basic transport infrastructure and the cost of transport. It seems, in fact, as if the costs of freight transport as a percentage of GDP might be rising and a case for national reconfiguration might be necessary.

Some initial savings were realised in the US economy as deregulation improved the speed of inventory in transport, but most of the savings came from the reduction in inventory.[31] Transport's contribution to US GDP has declined over the past two decades (by 20%), but the decline in inventory carrying costs was triple that (60% decline).[32] Even as long ago as in the early 1960s Heskett, Ivie and Glaskowsky reported that, in the decade between 1950 and 1960, transportation's contribution declined by 6%, but

[29] Organisation for Economic Co-operation and Development.
[30] Caid, 2003, p. 4-5.
[31] Sutherland, 2003, p. 1.
[32] Cooke, 2004, p. 2.

inventory carrying cost declined by 14%.[33] In the last decade transport and storage's contribution to the Australian GDP has risen from 4.7% to 5.1% (a rise of almost 10%).[34]

The key recurring theme for this typology is therefore that both the intrinsic and the extrinsic costs of transport and distribution systems will become more transparent (as nations adjust to this problem) and will lead to new policy and regulatory constructs.

- **Collaboration and integration**. As the power in value chains moved steadily down the chains towards final consumers, upstream players experienced margin squeezes. This phenomenon also holds true for supply chain practices. Dong et. al. report that buyers often transfer inventory costs to sellers and that relationships need to be formed to support both buyers and sellers:

> In order to build a long term supply relationship, it is likely that all members of the supply chain need to profit. Our exploratory research shows that JIT purchasing produces direct positive logistics results only for buyers, suggesting that long term JIT purchasing relationships may not necessarily be stable. In order to implement a successful JIT purchasing program from a supply chain perspective, managers in both the supplier and buyer organizations must act to produce the conditions conducive to JIT adoption and success for both buyers and sellers.[35]

Collaboration and integration were pervasive themes during the past decade, as the industry progressed from logistics to supply-chain perspectives. **Collaboration** refers to the propensity to share common objectives, plan jointly and measure from the same platform. **Integration** refers to the propensity to integrate assets, processes and systems seamlessly. There is, however, a marked difference between what was

[33] Heskett et al. 1964, p. 15.
[34] Australian Government, Transport Statistics, 2004, p. 1-2.
[35] Dong et al., 2001, p. 479.

intended and what was achieved, i.e. the focus is often short term, and secrecy and cut-throat competition continue to play a role. As sustainable development as a core approach grows, this should change.

Gattorna and Walters refer to the past decade as the time when information became a means to achieve competitive advantage, as opposed to the previous era (the 1960s to the 1980s), when information was purely a necessity.[36] This role of information was both driven by and drove the rise of electronic information capacity and the emergence of electronic data interchange systems.

The key recurring theme for this typology is therefore that collaboration and integration will move from JIT purchasing strategies to shared information and infrastructure, between buyers, sellers and logistics support service providers.

- **Information "open access".** The information "open access" era is driven by the arrival of globalisation in supply chains. Cohen and Roussel describe the two decades preceding the turn of the twentieth century as a time when "each site planned and scheduled its own operation with a focus on optimizing local results."[37] They emphasise the contribution of the growing complexity of business and added efficiency required by a global focus towards the end of the nineties to the arrival of this era. Christopher maintains that the management of global logistics "is in reality the management of information flows."[38] This is achieved through a balance of a local and a global focus where, for instance, local customer service is balanced by global network structuring and local market intelligence with global information systems.[39]

  Gollwitzer and Karl initiate their discussion on logistics on the basis of the role of the comptroller and how this role was changed and enriched by

[36] Gattorna and Walters, 1996, p. 4.
[37] Cohen and Roussel, 2004, p. 3.
[38] Christopher, 1998, p. 144.
[39] Christopher, 1998, p. 145.

logistics. They demonstrate how logistics in the current era is changing into a management function with three basic cornerstones, i.e. co-ordination, information and innovation. This required a process view of logistics and a process view is not possible without information which, according to them, changed to something much more than simply monetary information.[40]

Ayers describes the trend of "open access" information as a cultural rather than a technical trend.[41] He believes that supply-chain information sharing will be progressive as global relationships develop. In a sidebar on "A meeting of networked minds" he claims:

> In a networked economy, the company that has a distinct competitive advantage is the one whose supply chain has the largest span or presence – all the way from suppliers to the end consumers.[42]

The competitive advantage is clearly not related to concealing information, but rather sharing from a platform of strength to achieve the greatest visibility through the chain. Handfield and Nichols describe how this visibility has become inter-organisational, powerful and strategic and "much more than a simple technology."[43]

The onset of the globally networked economy gives rise to new imperatives:

> While the fundamentals of logistics service are frequently addressed, understanding the application of logistics service strategies in a global context is still in the early stages of development. It is the role of future research to continue to investigate the influence of LSQ (Logistics Service Quality) in a global context.[44]

[40] Gollwitzer and Karl, 1998, p. 20-21.
[41] Ayers, 2004, p. 2.
[42] Ayers, 2004, p. 2.
[43] Handfield and Nichols, 2002, pp. 296-334.
[44] Mentzer, 2004, p. 10.

These imperatives will go beyond customer satisfaction to the understanding of value and costs relating to national and regional characteristics (Figure 6). Value and perceived value are always products of costs and service rating.[45] It is therefore inevitable that a specific trend for the next decade will be the measurement of national and regional logistics costs as a percentage of GDP. The OECD has already estimated global logistics costs between 11-16% of world GDP.[46] (This figure will probably become firmer over the next few years and country benchmarks against this figure should emerge.)

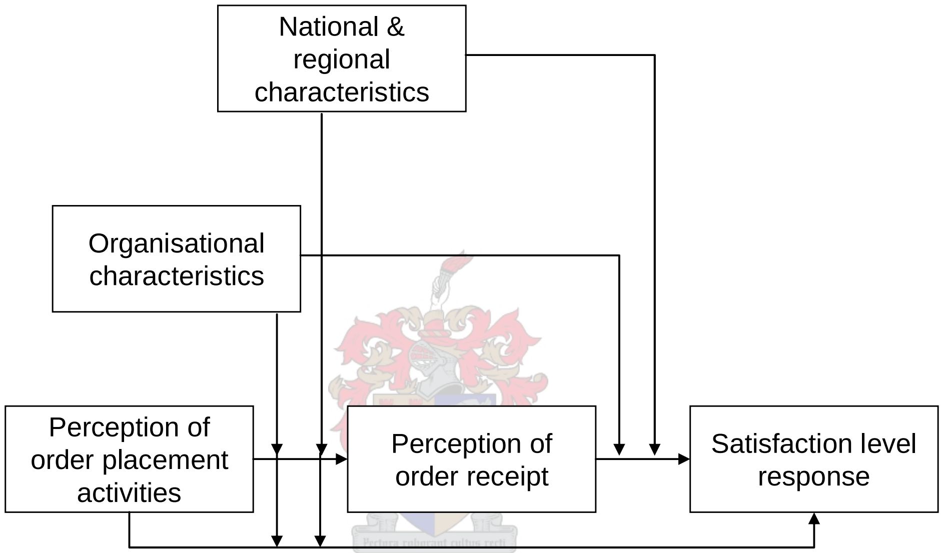

Figure 6: Factors influencing customers' preference for global logistics services[47]

The key recurring themes for this typology are therefore that:

- logistics information "through the chain" will become more transparent;
- the real winners will be supply-chain captains with more transparent and visible information systems from beginning to end; and
- national logistics costs will be measured in more economies and managed as a lead and lag indicator.

[45] Bradley Gale (1994) developed this useful concept. which he calls "a plot of the prices and overall performance scores of competing offerings". The map contains reference lines for assessing customer-perceived fair value and the *frontier prices* that represent the best *relative values* available to the buyers in the category.
[46] Australian Government, Transport Directions, 2004, p. 3.
[47] Mentzer, 2003, p. 18.

- **Quest for global sustainability**. Global sustainability relates to the way in which global communities interact, and to the distinctions between these communities and the emerging new world order. Not the least of the derived issues from this trend are security threats and natural disasters, and the impact of these phenomena on logistics.[48] Fawcett et al. highlight the various processes in which logistics are involved that have an effect on the environment, but single out three core concepts for consideration, i.e. ignorance of future damage by current actions, absence of direct "polluter" charges and the mindset of present gains for future costs.[49]

  A decrease in transport costs, globally, can also contribute to global upliftment. In a technical study to determine the quantitative role of transport in international business cycles, Ravin and Mazzenga found statistical proof for an interesting phenomenon:

  > The welfare effects of changes in costs of transportation are more intriguing. We find large welfare effects: a drop in the costs of transportation from 20 percent to 15 percent is equivalent to a permanent increase in consumption of just above 1.5 percent.[50]

The key recurring themes for this typology are therefore that global sustainability issues will drive logistics input cost decisions by the second decade of the 21st century, and that global security will play an important role in the logistics decisions over the next decade.

2.4 The state of global macro-logistics measurement

The case for understanding the cost and impact of global logistics is regarded as non-negotiable by benchmark researchers and authors of the discipline. It simply must be measured. Bowersox and Closs, in fact, refer to a difference

[48] Sutherland, 2003, p. 2.
[49] Fawcett et al., 1992, p. 286.
[50] Ravin and Mazzenga, 2004, p. 657.

between "*importance*" in the micro field compared to "*critical* for global manufacturing and marketing"[51] (Italics in original.)

In terms of global measurement three aspects are receiving growing attention, i.e. typological differences, infrastructure requirements and the performance of logistics in terms of cost to the economy.

2.4.1 Typological differences

It is true that broad-based typological differences between logistics costs of various economies can be hypothesised:

> In more highly developed countries, such as Japan, Canada, the United States, and most countries in Western Europe, the supply chain and logistics systems are highly sophisticated. A firm entering those countries will find economies with good transportation systems, high-technology warehousing, skilled workers, and a variety of logistics support systems.[52]

But is this broad-based understanding sufficient. Bowersox and Closs continue the argument by describing "vision" differences between North American, European and Pacific Rim perspectives. (The North American perspective is one of open geography with extensive land-based transportation needs, but relatively limited cross-border or international documentation requirements. Europe's geography is much more compact, with greater diversity and regulatory barriers. In the Pacific Rim the focus is much more on water logistics management).[53]

What is the overall typological perspective for South Africa? Conjectures in this regard are made, but are not based on any solid existing research results. The conjectures would revolve around the sprawling spatial nature of the country's economy, just like the economy of the United States, but with

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[51] Bowersox and Closs, 1996, p. 126.
[52] Stock and Lambert, 2001, p. 516.
[53] Bowersox and Closs, 1996, p. 127.

unfortunately a much lower gross domestic product in relation to these distances. A model solution would be to determine the flow volumes in general for the economy and relate these to GDP, in order to determine the size and depth of this typological difference.

The intent of this dissertation is to develop a national flow model that can inform the development of such typologies.

2.4.2 Infrastructure requirements

In terms of infrastructure investments Lakshmanan and Anderson address this issue as follows:

> An important dimension of these economic impacts relates to the impacts of transport investments on the performance of the rapidly evolving freight services sector, whose improved productivity in turn enhances the productivity of the overall economy.[54]

Productivity is therefore contextualised in the specific situation of the sprawling nature of the US economy (with long corridors) and the effects of this on infrastructure requirements and economic performance are understood.

Demis and Tavasszy discuss logistics infrastructure in Europe, Asia-Pacific countries and North America, elaborating on "companies, industries and governments" and their different objectives in this regard. They summarise four objectives of measurement performance indicators for the macro performance of logistics infrastructure:

- To establish a holistic view of the system;
- To give feedback in order to initiate a new and better way to conduct and handle the measurement system;
- To clarify the aim and goal for all participants in the system;

[54] Lakshmanan and Anderson, 2002, p. 3.

- To indicate overall important policy actions.[55]

As far as South Africa's logistics infrastructure is concerned, the best way to inform investment would be to determine the demand for the flow of all commodities now and in the future, so that infrastructure investments and the trade-offs between various investment options could be considered.

2.4.3 Performance of logistics as a cost to the economy

As far as the performance of logistics as a cost to the economy is concerned, the best known macro-measurement of logistics costs globally is the annual "State of Logistics Report" for the US economy, initiated by the late Robert Delaney and sponsored by Cass Information Systems and ProLogis. The report, according to Cooke,[56] uses the Alford-Bangs formula to calculate the total value of logistics as the sum of three components: inventory carrying costs, transportation costs and administrative costs. The report actually uses a variety of methodologies, outlined by Robert Delaney in a 1987 policy position paper (three years before the publication of the first annual state of logistics report).[57] Alford-Bangs's approach is used to calculate inventory carrying charges[58] and Frank A. Smith's approach to calculate transportation costs.

The 2003 report also quotes Heskett, Ivie and Glaskowsky as a methodology source, but the Alford-Bangs "standard" rate for inventory carrying charges is quite evident in the results of the reports over time. These standard rates are reflected in Table 1.

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[55] Demkes and Tavasszy, 2000, p. 4-5.
[56] Cooke, 2004.
[57] Delaney, 1987.
[58] Alford and Bangs, 1946, p. 396-397.

Item	Percentage
Storage facilities	0.25
Insurance	0.25
Taxes	0.50
Transportation	0.50
Handling & distribution	2.50
Depreciation	5.00
Interest	6.00
Obsolescence	10.00
Total	**25.00**

Table 1: Alford-Bangs's standard inventory carrying charges table[59]

What is mostly adjusted is the interest rate, according to Delaney himself:

> …but when comparing annual inventory carrying costs over time, it is necessary to replace the assumed 6 percent interest rate with the prevailing commercial paper rate, if it is higher. In 1981, for example when the average interest rate on commercial paper rose to 15.3 percent, most companies' carrying costs climbed to 34.3 percent of the market value of the inventories held in stockpiles and warehouses.[60]

It is then also quite obvious that, when Delaney reports on the inventory carrying rate in 1981 for the US economy, he uses 34.7%. This figure is the original Alford-Bangs formula of 25% minus 6% plus 15.7%, which was close to the average interest rate for 1981. It therefore seems as if the other components of the Alford Bangs model are still used as it was developed 61 years ago.

The performance of logistics as a cost to the economy has by now been calculated for a number of countries and is depicted in Table 2. It is becoming standard practice in many of these economies to do the calculation annually and report on the findings.

[59] Alford and Bangs, 1946, p. 397.
[60] Delaney, 1987, p. 3.

Region	Country	Logistics as % of GDP
Asian region	Australia	11.2
	China	14.5
	Hong Kong	15.9
	Indonesia	12.8
	Japan	10.1
	Korea	12.4
	Philippines	13.3
	Singapore	20.0
	Taiwan	13.5
	Asian total	**11.0**
European region	Austria	12.2
	Belgium	13.0
	Denmark	12.8
	Finland	11.5
	France	11.7
	Germany	11.8
	Greece	14.0
	Iceland	16.7
	Ireland	14.3
	Italy	12.6
	Netherlands	12.2
	Norway	13.2
	Portugal	13.6
	Spain	12.1
	Sweden	12.7
	Switzerland	13.2
	United Kingdom	12.2
	European total	**12.2**
North American region	Canada	11.8
	Mexico	14.4
	United States	11.6
	North American total	**11.7**
Industrial total		**11.7**

Table 2: Logistics cost comparisons for various economies[61]

[61] Bowersox and Closs, 1996, p. 128.

It would be possible for the South African economy, with a transportable GDP hypothesised to be less than one billion tons, to develop a much more robust model with fewer generalisations around inventory carrying cost (including interest charges and warehousing), administrative costs and transportation.

A discussion on the global state of macro-logistics measurement leads to a more specific question of the position in South Africa.

2.5 The South African situation

Various events over the past two decades have highlighted core structural issues, problems and competitive disadvantages in South Africa's logistics system. These include:

- The results of the commercialisation, corporatisation and legal succession of the South African Transport Services in 1990 (which led to critical underinvestment in important areas causing an illogical fragmentation of assets, processes and systems);
- The increasing scarcity of information;
- The RDP policy statement in 1994, which indicated the social shortcomings of logistics assets; and
- The Moving South Africa Study of 1998 (the most fundamental research project so far), which highlighted the possible future shortcomings of the system.

2.5.1 Transnet events

In 2004 the then CEO of Spoornet, Ms Mokgatle, referred to the situation as "severe", adding that "Spoornet's[62] performance has deteriorated following years of neglect" and that "Spoornet's long-term sustainability is in question".[63] Ms Ramos, the current CE of Transnet, talks about a business

[62] A division of Transnet. "Spoornet" refers to the business division of Transnet that is now known as "Transnet Freight Rail", but was known as Spoornet when most of the research in the dissertation was conducted.
[63] Spoornet Media Statement, 2004, p. 1.

that "has a long way to go in cleaning up its own house to become more efficient and accountable".[64] She also refers to the group's assets as some of "SA's most strategic assets"[65] and the drive to restructure these. Singh[66] says in the same article that Ms Ramos is in an unenviable position. She is dealing with a rail network, suffering from years of underinvestment, poor management systems and a skills shortage: "if Transnet does not get its house in order, it will not only have a continued negative impact on local business, but will also affect the New Partnership for Africa's Development."

More recently, South Africa's transport minister, Mr Radebe, referred to South Africa's transport system's performance as "poor" and a matter of great "concern". He emphasised that "it was necessary to restructure the transport system generally to make sure that logistics, or the lack of it, did not act as a restraint on economic growth, employment and sustainable development".[67]

Yet none of these statements are based on real macro-economic research. No framework exists to measure the logistics performance of the country's economy compared to internationally acceptable parameters.

2.5.2 The increasing scarcity of information

Another perspective on transportation cost performance and export competitiveness is provided by the World Trade Organisation, which determined that "the effective rate of protection provided by transport costs is in many cases higher than that provided by tariffs."[68] This statement is both ironic and painful in the South African situation, where tariffs and tariff protection are major topics of discussion and research, in spite of the fact that unnecessarily high transportation costs are probably a much more costly problem to the economy. Many databases, such as those of the South African Revenue Services and the National Ports Authority, have been established to

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[64] *Financial Mail*, 2 July 2004, p. 30.
[65] *Financial Mail*, 2 July 2004, p. 30.
[66] *Financial Mail*, 2 July 2004, p. 30.
[67] *Star Business Report*, 13 July 2004, p. 5.
[68] World Trade Organisation, 2004, p. 114.

enable tariff research or adhere to some international conventions,[69] often to the detriment of transportation research. The mere fact that tariffs are transparent leads to the self-fulfilling prophecy that this aspect is managed in detail, in spite of the fact that other issues might be more onerous.

Information in general in South Africa is scarce and the railways and road hauliers do not disclose any useful information easily. It is true that the modes are locked in competition, but the actual competition is for an ever-decreasing competitive landscape as the railways sheds customers and concentrates on long-haul bulk "rail-locked" clients to the detriment of the national economy. Sharing of information could support the development of complementary systems, which is unfortunately not the case.

South African society and business live in an economy where macro-indicators such as the inflation rate, the balance of payments, the exchange rate and the interest rate are tracked closely, and in some cases even reported daily. Macro and micro decisions are made based on these indicators, but the country fails to make a concerted effort to understand logistics cost, which, by all indications, could account for more than 10% (and according to some broader assumptions more than 15%) of the country's GDP.

2.5.3 Social factors

South Africa's President refers to "a government of the left" that "includes a reduction in inequality, the provision of public services, the principle that workers should be treated as assets, rather than commodities, regulation of enterprise...".[70] Such ideals should, however, be measured and tracked, and the performance of various aspects of the economy, including the logistics system, monitored to see if these ideals are being achieved.

[69] Many of these databases are used by SARS and the Department of Trade and Industry to collect information on imports and exports to enable trade statistics that specifically enable tariff policy and reporting on National Accounts. It is not clear what other objectives are served by SAPO information, other than collecting Ad Valorem tax.

[70] *Cape Times*, 1 July 2004, p. 6.

Moving South Africa, which embarked on a comprehensive data-driven approach,[71] found during their study that this objective is often hampered by a chronic lack of information. The situation is, however, at its worst for rural communities (second economy),[72] where the problem is described as "crippling."[73] Finally, the study notes with urgency that:

> The MSA strategy offers two responses to this situation. One is to develop more data, and the second is to apply the general strategic principles developed in other parts of the strategy to the rural situation once the data are developed.[74]

The development goals for South Africa around social upliftment are clear and unambiguous. However, strategies, the lead data to inform the development of these strategies and the lag data to track its performance, are mostly absent.

A recent statement of the Presidency of South Africa proposes:

> Monitoring and evaluation is the life-blood of sound and efficient planning and implementation. For it to add value to government work and to the broader process of social transformation, it should be based on objective measurements that reflect the ideals in our Constitution: to improve the quality of life of all South Africans and ensure that South Africa contributes to the creation of a better Africa and a better world. Cabinet has approved a set of key development indicators to provide evidence-based pointers to the evolution of our society. Based in part on Ten Year Review's human development indicators, they are markers that help define the milestones in the journey of social change.[75]

Out of 72 indicators that the presidency lists, a very noble undertaking, not one refers to anything vaguely related to transport and logistics.

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[71] Moving South Africa, 1998, p. 3, 5.
[72] Moving South Africa, 1998, p. 11.
[73] Moving South Africa, 1998, p. 178.
[74] Moving South Africa, 1998, p. 179.
[75] The Presidency of South Africa, 2007.

2.5.4 The quest for measurement

The events described in paragraphs 2.5.1 to 2.5.3 above necessitate an understanding of what has been achieved in terms of logistics research and measurement in South Africa.

The Transport White Paper (TWP) of 1997 and the fourteen-month Moving South Africa (MSA) research project that followed[76] were designed to articulate strategies for the long-term development of South Africa's transport and logistics infrastructure. The vision, in terms of the TWP, was for "efficient and fully integrated transport operations and infrastructure". MSA "was designed to produce a data-driven programme for strategic action" to enable this vision.[77] The following specific challenges were highlighted during these studies:

- Old priorities were still reflected in operational planning;
- The overall system received systematic under-investment;
- Broad prioritisation avoided focussing resources on specific customers;
- Highly concentrated corridors have to carry freight from and to dense industrial locations, which requires intermodal systems that are absent to date; and
- High prices, poor service levels and low reliability indicated a lack of support for export competitiveness and system sustainability on these corridors.

MSA indicated that solutions to many of these problems could be facilitated by research-based regulatory involvement around infrastructure development. The study itself provides some measurement results and asks for it to be repeated at regular intervals. This never happened.

Some policy guidelines were developed by the Department of Transport to address these issues, but now, almost a decade later, very few actual results have been realised. In the historical literature survey in Chapter 4 this element

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[76] Moving South Africa, 1998.
[77] Moving South Africa, 1998.

of the research will be developed further, but for now suffice it to say that the current situation was predicted, outlined and well formulated as a possible outcome about a decade ago. Furthermore, MSA was quite clear that the absence of research will seriously hamper future strategic management of the country's transport and logistics system.

Many government departments, such as the Department of Transport and the Department of Trade and Industry, are to some extent investigating strategies, policies and action plans to address this problem. Progress is slow, however, and erratic in nature. Transnet is also busy with a drive to inform national strategies and priorities, and to align Transnet's transport and logistics strategy, market positioning, resource deployment and investment with these strategies. The dilemma is that very little discussion and alignment take place between the various stakeholders in this industry, e.g. government, parastatal organisations (such as Transnet and its rail, port and pipeline divisions), the national roads agency and road operators to align this research around a common platform.

A contributing factor to this dilemma is that there is very little data and interpretation, and few frameworks, to provide a backdrop to these strategies, resulting in intermittent and disjointed research informing the discussions. In fact, there is reason to believe that current initiatives will once again be hampered, delayed and even restricted, as so often in the past, because of the shortage of a strategic information system for logistics in South Africa. The country could consequently be in an even worse position a decade from now. The strategic research should therefore not only provide a framework for strategy and policy formulation, but also for shared and aligned points of departure for the disparate parties that have to contribute to this discussion.

The conclusion is that, although the development of micro-logistics costs measurements is more pervasive in standard reference material, only a few references and measurements for macro-logistics costs are found in the literature[78] and some work in this regard is performed globally. In South Africa, however, no real attempt is being made to measure the cost, efficiency and effectiveness of South Africa's logistics system. The capital investment in the county's logistics infrastructure is also not guided by any measurement, research construct or model that could be monitored. Schneidewind maintains that:

> the established cost management system has direct effects on management decisions in supply chains.[79]

Macro-management decisions will as a result be hampered by this state of affairs. The absence of any cost management system on a macro level will also seriously impede national policy in this regard. This is confirmed by Fredenhall and Hill:

> As the logistics functions become more integrated, they are able to achieve many efficiencies. But, a barrier to fully implementing an integrated logistics function is the lack of accurate information about costs.[80]

2.6 Proposed approach

2.6.1 Methodology

The overarching approach of this dissertation is quantitative and is based on economic modelling. Economic data are available in many forms and in many areas of the South African economy. The literature study of historical approaches will illustrate the failure of the survey methodology to solve the measurement problem. A modelling approach that works and could be tested over time for intrinsic and extrinsic congruity could provide a lasting solution to this problem.

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[78] Voortman, 2004, p. 13.
[79] Schneidewind, 2003, p. 92.
[80] Fredendall and Hill, 2001, p. 213.

The array of data available to do this modelling is extensive, but success can only be achieved through the design process that will transform the applicable data sets, identify the underlying and often hidden relationships and integrate the data to answer the fundamental questions of size, flow, modal market share and future demand.

The dissertation will describe the modelling of national surface freight transport flows, measuring the demand for freight infrastructure on a commodity or industry sub-sector level, and developing an understanding of logistics costs in South Africa. In order to achieve this, three models and the interpretation thereof will be proposed. Each of these models achieves a break-through in own right, but an integration case study of all three models will also be developed to illustrate the powerful strategic application of this work. Strategic themes will be developed and recommendations made based on the results of the work as well. The models' final test would be the repeatability of the construct on an annual basis, which will ensure application as both a lead and lag indicator of national logistics decision making and performance.

2.6.2 The transport flow model

The transport flow model is needed to answer the core question of modal market share in South Africa (an issue that has been irregularly and unsatisfactorily researched in the past), modal corridor flows (an issue that has been addressed in a few research works, but never resolved) and the core configuration of South Africa's transport system.

The transport flow model will utilise the South African Traffic Count Yearbook to develop a current and historical view of all freight traffic flows in South Africa. The model will account for the differences between corridor, rural and metropolitan freight, and the various net and average carrying capacities of the types of trucks that are used, and develop measurements for 1993, 1997, 2003 and 2004.

This information will then be collated and compared to actual Spoornet data for the same time periods to develop an insight into market shares, corridor densities and overall investment strategies for South Africa.

2.6.3 The commodity flow model

Different commodities have different logistics requirements. It is therefore necessary to model the flow of all commodities in the economy – now and in the future – to enable planning for future requirements.

The model will use a gravity modelling approach based on magisterial district supply and demand figures for South Africa that will be researched and developed from input-output models of the economy. Data will be developed for 2004.

2.6.4 The logistics cost model

The logistics cost model will be scoped and the measurement developed together with a research team from the Department of Logistics at the University of Stellenbosch. The model will be used to identify transport, storage, inventory carrying, and management and administration costs for the South African economy from 2003 to 2005, and will be compared to the GDP. The measurement will use a "bottom-up" approach and will allow for detailed differences between industries for various cost drivers.

2.7 Economic and historical base for continuance

The problem statement refers to logistics' macro-economic role and the lack of research in this regard in the history of the economy in South Africa. These statements require validation and explanation in this dissertation. It is therefore important to research the concept of logistics in a macro-economic context further. This issue is addressed in Chapter 3.

Chapter 3 - Macro-economic literature study

3.1 Introduction and background

Logistics is distinctive amongst oranisational functions as an integrator. It is process orientated internally, but also externally, in that it endeavours to integrate all organisational processes in a value chain view – even beyond the boundaries of a single organisational entity. As such, it should be well suited to play a role in the integration of macro-economic production factors. In order to fulfil this role, however, the discipline needs to come to grips with this macro-economic context. It also needs to develop, through introspection, an understanding for the reasons why the macro-economic context is so often neglected.

3.2 The quest for a macro context

3.2.1 The macro context of science

One of the fundamental points of departure of this research is the distinction between micro and macro perspectives. This distinction is more than merely approaching a problem from two angles, in layman's terms often referred to as "bottom-up" vs. "top-down" or in scientific terms "reductionism" in process, discovery or experimentation vs. integrative, synthesised and holistic thinking. It is in fact this incongruity that cuts through all scientific thought, since the overwhelming energy in scientific discovery tends to gravitate towards the micro or reductionist view. Jack Cohen and Ian Stewart plead for the macro or integrated view:

> Despite the success of conventional science, we think there should be more to the scientific endeavour than just the study of ever more refined internal bits and pieces.[81]

[81] Cohen and Stewart, 2000, p. 5.

This plea, from a well-known reproductive biologist (Jack Cohen) and one of the most active research mathematicians (Ian Stewart) of the current era, is made because they observe the increase and growth of reductionist thinking in all sciences. This could in fact point towards a Zeitgeist of the sciences.

Dodig-Cmkovic describes how the scientific process of antiquity has at its heart thought experimentation and holism rather than the practical experimentation of contemporary science and its reductionist nature. [82]

At the initiation of the experimental phase of science this holistic integration was well retained. John Brockman argues the point from the perspective of an "official culture", which he terms the "humanities", that abandoned science and technology after the fifteenth century.[83] He refers to the thinkers of the fifteenth century, when the word "humanism" was tied in with the idea of one intellectual whole:[84]

> These men were intellectually holistic giants. To them, the idea of embracing humanism while remaining ignorant of the latest scientific and technological achievements would have been incomprehensible. The time has come to re-establish that holistic definition.[85]

Brockman's wish for holism is, however, still a problem and this is why Murray Gell-Mann relates the problem to management science and asks for a move away from "narrow discipline" to "integrative" thinking."[86]

Also *within* sciences this disconnect between the holistic and reductionist view becomes apparent. In physics a stand-off emerged between the practical experimentalists and theoretical modellers, with insufficient integration between the two. In economics the place of both macro-economics and micro economics is firmly established. But is this true of the sub-disciplines of economics?

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[82] Dodig-Cmkovic, 2001, p. 11-13
[83] Brockman, 2003, p. 3.
[84] Brockman, 2003, p. 2.
[85] Brockman, 2003, p. 2.
[86] Gell-Mann, 1994, p. 346

Many of the operational applications of fields within economics seem to be by definition micro disciplines, i.e. relating to micro economics as such. Management science, for instance, might be seen as a study of an integrated or co-ordinated set of activities within economics. Within management science the more traditional fields of production, finance and marketing arose, more or less in that order. In this group business logistics is relatively new.[87] The question arises, however, as to what extent business logistics should reach back into economics to establish the macro-economic parameters of the discipline, and whether this is the role of the business logistics researcher or economics researcher – the question specifically addressed by this dissertation.

In terms of management process and development, logistics professionals are contributing to ever higher levels of decision making, as large corporations appoint senior executives to head the logistics function, which is often created by:

> pulling the sundry logistics functions out of marketing, operations, and elsewhere and placing them under a director or vice president of logistics.[88]

The question that should be asked is "Who is responsible for this development and growth of the logistics function and all its applications (both micro and macro)"? In many respects the discipline, through research and development as well as informal and formal activities (such as the work of the Supply Chain Council), took charge of its own development and positioning. The assumption that the logistics discipline should at least be partially responsible for its own positioning in macro-economic thought could therefore hold true and should be considered. In this line of reasoning a more specific treatment of macro-economics and the role of logistics becomes necessary.

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[87] Ballou, 2004, p. 3.
[88] Russel, 1994, p. 2.

3.2.2 Macro-economics

Macro-economics accounts for the economy of a country as a whole and informs the overall strategic management of the country's economy in terms of the contribution of holistic components as well as the interaction between these components. This is achieved through measuring, modelling, reporting and strategising around these components as well as the whole, normally aggregated as holistic benchmarks such as gross national product (GNP) and gross domestic product (GDP). In short:

> [it] is the study of the *behaviour* of the economy as a whole.[89]

Mohr and Fourie[90] continue by setting specific goals for the macro-economy, i.e. growth, full employment, price stability, external (balance of payments) stability and fair income distribution. In order to achieve these objectives the components or "production factors" of the economy need to achieve optimal interaction and output, very much in the same way as in which the production factors of a firm (on the micro level) is expected to achieve optimal interaction and output.

In the South African economy "cluster studies" were initiated by the Department of Trade and Industry to evaluate and consider the contribution, effectiveness and prospects of various economic clusters in South Africa. During the course of these studies, and in some sense almost by chance, the researchers realised that certain cross-cutting issues emerged, of which logistics emerged as an important factor. These cross-cutting issues do in fact relate to the production factors that economists define in macro-economy, but in a different way as the defined standard, and it seems that macro-economic theory neglected to follow these emerging issues as in micro-economy, where the understanding of production management has expanded greatly over the last few decades. The macro-economy is therefore not necessarily equipped to use micro-economic principles in economic management and it is therefore no surprise that in spite of the pervasive logistics problems identified, no effort

[89] Samuelson and Nordhaus, 1989, p. 76.
[90] Mohr and Fourie, 1996, p. 95.

was made to develop a macro-economic view of logistics or at least the role of logistics in the macro-economy.

The fact is that the distribution of resources in the economy, and therefore macro logistics, is a macro-economic production factor and requires measurement together with issues such as employment, crime, the production price index (PPI) and investment. The lack of macro-economic thought in logistics leads to a concomitant gap in macro-measurement thinking.

3.2.3 Macro-measurement

Textbooks on transportation, distribution, logistics management and supply chain management are usually completely or partially silent on macro-logistics cost issues. Cursory references to transport policy, deregulation and the effects of modal shifts do occur, but these topics are seldom analysed in depth and the macro-economic results of these structural changes are hardly ever discussed. Schary and Skjott-Larsen[91] provide a reasonable analysis for Europe and discuss the conflicts between national interests and EU policy, infrastructure investment decisions in this context and the significance of supply and demand against this background. The fact that a similar conflict of interest could arise between firm, industry and national interests, is not addressed. These relationships are depicted in Figure 7.

[91] Schary and Skjott-Larsen, 2001, pp. 220-223.

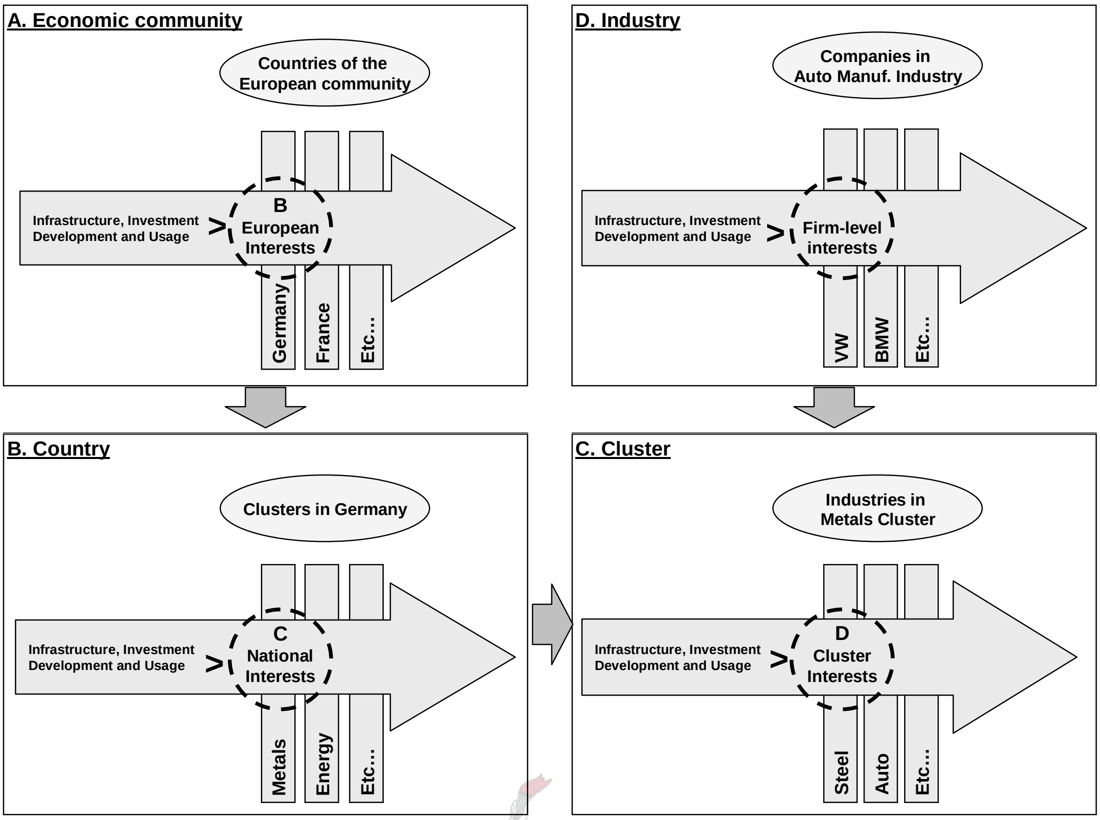

Figure 7: From firm-level interests to macro trans-national interests

The areas marked A and D are commonly discussed, but B and C are often not considered. It is important to note that it is always the *same* infrastructure that is at stake and that the field of logistics seeks integration in a *systemic* context. This integration could therefore not be limited only to areas A and D.

Baudin, in his work on how to make logistics "leaner",[92] addresses logistics performance at the firm level, but unfortunately not the performance of all systems within industries nor industries in a national or societal framework. He does, however, provide examples of "dysfunctional outcomes of free interactions", which is essentially the problem associated with allowing the optimisation of inter-firm-level systems (as opposed to intra-firm-level systems), rather than regional cross-cutting systems. Logisticians understand collaboration, and the collaborative aspect of inter-firm-level strategies, design and flow management is a well developed field. Collaboration is, however,

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[92] Baudin, 2004, p. 14.

always seen as groups of firms utilising and optimising pieces of infrastructure and processes.

The hidden and often invisible effects of many firms (often unrelated to each other) using the same infrastructure, often overcropping it to the detriment of the whole, are never discussed. This is in contrast to other factor conditions such as banking, labour and resources that are discussed, developed and measured. (If bankers extend too much credit too easily, inflation rises and monetary policy responds with interest rates. Yet if modal shifts because of firm-level interest in speed or any other reason reduces the overall efficiency of a country's transport system, who responds or should respond?)

Logistics textbooks, such as Grant et al., make a distinction between the role of logistics in the economy[93] (described as important because of its cost to the economy and its role in the facilitation of transactions) and the role of logistics in the organisation[94] (described as important because of its link to the marketing concept and because it provides one of the last remaining areas of major improvements in profitability and competitive performance). Pienaar makes a similar distinction between the macro-economic perspective[95] (where he discusses the actual costs for the South African economy) and the emergence of logistics in the business context[96] (where he describes the function's organisational context in history, its tools and position in the firm).

Murphy and Wood specifically define a "macro perspective" for logistics and also refer to the economic and growth impetus that logistics and especially transport provide to an economy. They highlight the Irish case study, where the country decided to upgrade transport systems to sustain recent growth in the economy.[97]

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[93] Grant et al., 2006, p. 7.
[94] Grant et al., 2006, p. 8.
[95] Pienaar, 2005, p. 3.
[96] Pienaar, 2005, p. 4.
[97] Murphy and Wood, 2004, p. 3-4.

Healey and Ilbery describe the logistics function in terms of linkages, and distinguish material and information flow as the core linkage requirement with associated monetary and sometimes personnel flow.[98] They continue to argue that:

> strong material and information linkages are often associated with agglomerations of economic activity, but to what extent linkages encourage agglomeration…is a more debatable question. To begin to unravel the relationship between linkages and agglomeration it is first necessary to discuss the nature of *agglomeration economics.* Agglomeration effects which arise from the clustering of activities and which are external to the firm are called *external economies of scale.*[99]

They go on to describe how all firms that share these external economies of scale can benefit from resultant cost savings[100] – an important and very much overlooked point in the economic development of South Africa, especially in how it pertains to the management of long-haul corridors where purely micro-economic considerations drive modal split, with no policy to drive long-term economic agglomeration advantages.

The element of macro-economics that does receive attention relates to investment in logistics infrastructure. In this case, infrastructure is viewed as a "direct injection to the economy"[101] and an additional production factor. Lakshmanam and Anderson describe this better-known field of study in terms of the accepted positive correlation and the regulatory impacts that are therefore required, but they are careful to note the deficiencies in the body of knowledge around the networks created by different modes and the effect of this on production factors.[102] In this way they indicate the way towards a more robust understanding of the effect of different modes on network design to benefit an economy as a whole.

[98] Healey and Ilbery, 1990, p. 84.
[99] Healey and Ilbery, 1990, p. 88.
[100] Healey and Ilbery, 1990, p. 88.
[101] Lakshmanam and Anderson, 2002, p. 5.
[102] Lakshmanam and Anderson, 2002, p. 6.

Similarly, in South Africa, the infrastructure component is understood in general, but without an understanding of the concomitant network and modal view. Logistics News reports on the Barloworld Supply Chain Foresight Study and the fact that "many SA businesses have cited the imbalances in the country's Supply Chain and logistics infrastructure as the cause of their increasing lack of competitiveness."[103] In a follow-up study the same target research audience (chief executives and senior supply chain managers) reports concern for "pressures placed on SA's supply chains by increasing demand locally, and by the increases in supply chain complexity brought about by rapid globalisation and a new diversity in the customer base of many companies."[104]

These concerns are often raised and also topical right now in South Africa for large parts of the country's infrastructure, but a move forward would be to:

1. Describe the calculation, cost drivers and supporting processes of the macro logistics costs as an important field of study (i.e. open up the process of the macro-economic study of logistics); and
2. Describe the *inter-relationships* between the two areas (macro and micro) and to contemplate whether these areas offer a complete description of logistics (a question often best answered by taking a more in-depth approach to the problem).

The answer to the first question is an outcome of this study, but it is the second question that requires an answer now.

3.3 The systemic relationship between the various roles of logistics

The systemic relationship between logistics roles is often discussed on the level context, such as the strategic and operational level issues within the firm, giving rise to discussions on centralisation versus decentralisation, the positioning of logistics management within the firm, and the appointment of

[103] Logistics News, March 2006, p. 13.
[104] Logistics News, April 2007, p. 2.

the logistic management function on the executive and board. The hierarchical relationships between firms, organised industry, clusters and national economies are not so frequently analysed. South Africa's cluster study group of the mid-1990s came across the issue of logistics as a cross-cutting issue literally by chance, when the analysis of various economic clusters gave rise to what was called "cross-cutting" issues and the state of logistics came under serious scrutiny for the first time.

The cluster studies originally set out to understand various important industries in South Africa (such as the steel, automotive and petrochemical industries) in order to facilitate the global competitiveness of these industries. The Logistics "society" was silent during this process, but the researchers soon found that certain issues impact on all industries, and logistics problems in South Africa seemed to top the list.

The studies soon arrived at Porter's competitive forces constructs and the related topics of how the production factors of nations should be organised.[105] Yet, incredibly, the logistics community once again missed the opportunity and remained largely silent on the type of contributions that the discipline could make to further advance integration on a national and regional level. Even in international texts these issues are largely ignored or at best receive cursory reference. Coyle et al. discuss the importance of a competitive environment in global logistics and do, in fact, make a connection between Porter's model elements and logistics. The model elements are summarised as factor and demand conditions, on the one hand, and company strategy and related and supporting industries (i.e. cluster conditions), on the other hand. They also maintain that the United States specifically is "slipping in international trade", because of poor performance in transportation and technology.[106]

Louw, in his work on advanced supply chain planning processes and decision support systems in the petrochemical industry, arrives at industry views for

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[105] Porter, 1990, pp. 74-76.
[106] Coyle et al., 2003, p. 152.

inter-supply chain focus.[107] He defines clusters as "groups of businesses that need to cooperate closely due to interdependencies and synergies that exist between their supply chains or segments thereof."[108] The work proceeds to identify some interesting distinctions between what is called "advancement dimensions", i.e. moving from firm level to value clusters through industry clusters. The final and highest dimension is called "logistics network integration" and is typified as a move from transactional relationships to a deeper trust level across industries.[109]

Critically though, and given that the identification of macro perspectives is not the focus of Louw's work, he suggests a company-driven approach to move through the dimensions. He describes each stage or dimension as "the building block required for the next level of advancement".[110] This is acceptable for the context of the work, but could also be compared to a situation where micro-economists argue that firms, industry and commerce should organise themselves along "deep trust" levels to achieve the macro-economic objectives of a national economic system. This description is entirely correct in the micro-economic context, as no company has a responsibility to act in the "common good" of a country (i.e. to act in such a way that its actions are detrimental to the company, purely to satisfy some national objectives). The situation from a national strategic and policy setting perspective is, however, clearly not tenable, as macro-economic objectives are usually set independently, measured according to defined parameters and then managed according to performance within these parameters. Is there any reason why this should be different for logistics than for economic systems in general? Louw's "advancement dimensions" are therefore exactly correct as companies move through the dimensions to achieve own objectives, but in the same way the macro-economic policy maker (usually the regulator) should initiate the move through the dimensions from a macro-economic starting point.

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[107] Louw, 2006, p. 384.
[108] Louw, 2006, p. 382.
[109] Louw, 2006, p. 382-383.
[110] Louw, 2006, p. 383.

In the next section, a basic definition of an economic system and the role of logistics in that system is provided.

3.4 Economic systems and the role of logistics

3.4.1 Macro-economics, clusters and cross-cutting factors

Terreblanche describes economic systems as the various methods that countries (or communities) can use to organise their economic life in the broadest sense.[111] What is important is the totality of economic life that is included in the definition and Terreblanche's contention that an economic system at least requires economic activities that are collated according to a certain principle or principles into a coherent structure and that this structuring activity can be enforced.[112] Hayes describes the alternatives inherent in this enforcement as two "sharply contrasting methods of bringing about cooperation in an economic society."[113] These are strict regimentation (socialism or collectivism) and spontaneous and voluntary individualism (capitalism). Notably Hayes describes the extreme forms of these systems as either communism or anarchism, and then argues that even the more individual nature of the United States system (compared to other nations) requires restrictions and that "these restrictions upon private property are so extensive today that our system is considerably removed from a state of Individualism".[114]

The process of economic organisation within a community is therefore total (it includes all aspects of economic life), structured (collated according to principles) and enforceable (not only spontaneous, but by a specified power). The resulting macro-organisation's existence is qualified by certain objectives (increased output, high employment, stable prices and proper foreign economic policy – i.e. the relationship between the macro-organisation and

[111] Terreblanche, 1994, p. 3.
[112] Terreblanche, 1994, pp. 5-14.
[113] Hayes, 1928, p. 21.
[114] Hayes, 1928, p. 22-23.

others),[115] and this qualification is achieved by certain instruments that involve trade-offs or choices.[116]

A further perspective on macro-economics is provided by McCarthy, who refers to the aggregation principle in economics.[117] Micro-economy aggregates common goods such as the demand and supply of oranges, whilst macro-economy aggregates uncommon goods, such as the total production in the economy. He provides the standard definition of the production factors of macro-economics, i.e. land, labour, natural resources and enterprise.[118] Is this list complete or could it at least be expanded horizontally? Are transport facilities, for instance, a micro-economic cluster or a macro-economic production factor or both? Unmined coal (resources in the earth) could be seen as a natural resource (macro-economic production factor to some extent), but becomes a micro-economic cluster when mined. As soon as it is mined, it can be used by other clusters (as energy in boilers, to manufacture steel or to generate electricity), but is, as per the definition of a cluster, not a cross-cutting factor. It can be replaced by other alternatives, it can be imported and certain sectors of the economy can do without it. This is not the case for functions such as banking or transport, which cannot be substituted nor imported, and the economy basically cannot exist without these factors. It seems as though cross-cutting factors in the economy, in addition to the standard production factors, also require aggregation and understanding at a macro-economic level.

The fact that businesses require, for instance, a transport or treasury function and that other businesses such as hauliers and investment banks provide these services on an outsourced basis leads to a misconception in that logistics is seen as a cluster (and therefore micro-economically orientated) function only. All the micro-economic principles necessary to run a transport company or bank would be present, as well as the micro-economic principles to run the transport function and treasury function in each non-transport or

[115] Samuelson and Nordhaus, 1989, p. 83.
[116] Samuelson and Nordhaus, 1989, p. 86.
[117] McCarthy, 1998, p. 104.
[118] McCarthy, 1989, p. 105.

non-banking business. These activities, however, also have a macro-economic dimension in that when they are added together, a cross-cutting factor arises where, for instance, if all orange production functions or coal mining functions in a country are added together, at most a cluster arises. Clusters are important, but not critical; clusters need all cross-cutting factors, but cross-cutting factors do not need all clusters. This principle is appreciated fairly well in non-logistics functions such as banking and labour, but not really appreciated as far as the logistics function is concerned. It is this macro-economic dimension of cross-cutting factors (that also has micro-economic counterparts such as employment agencies and human resources functions for labour and transport companies, and transport functions for logistics) that provides an interesting descriptive challenge to the macro-economy in that the macro-economic context are often ignored. This leads to the final deduction in this regard, i.e. that if logistics' objectives are the creation of maximum value for the least cost, then the macro-economic objective of this cross-cutting factor would be in the net value added to a country's Gross Domestic Product, and in order to achieve this it should be managed as such.

To proceed from this point forward requires an understanding of clusters compared to cross-cutting factors, a definition of cross-cutting factors and the general role of these factors in the economy.

3.4.2 Economic clusters

The cluster concept probably originated when Porter expanded his five-forces concept to national competitiveness and developed his "diamond of national advantage".[119] Porter calls the formation of clusters a "pervasive" characteristic of all "advanced national economies" and it relates to the fact that successful industries "help to create others in a mutually reinforcing process". The process can be either vertical (buyer/supplier) or horizontal (common customers, technology, channels, etc.).[120]

[119] Porter, 1991, p. 73.
[120] Porter, 1990, p.149.

South Africa has well-known examples of such clusters, for instance the vertical relationship between the country's extensive coal and iron ore mining industries, iron and steel manufacturing, automotive and steel distribution commerce. Other vertical examples include chemicals (from conversion of raw materials such as coal and other minerals to chemical manufacturing and downstream processes), food production (from agriculture to downstream food production and branding) and paper (from forestry to downstream printing, ink production and usage). These vertical chains are often described as value chains, but a cluster would form where these value chain activities are grouped together in close geographic, process, ownership or other group configurations.

Clusters are often seen as only a geographic concept, such as in the conclusion of Wisner et al. that "the concept of business clusters represents a new way of thinking about facility decisions". This could be construed as including various typologies, but they continue to refer to "geographic concentrations."[121]

Clusters are, however, a multidimensional concept, incorporating both arguments mentioned above. Two of the most important dimensions are geography and industry sectors (including the "agglomeration" of enterprises in these sectors).[122] One could argue that these are pre-determinants for cluster development, i.e. economic clusters cannot develop if both of these dimensions are not in place. If, however, these dimensions are in place, other "external economic factors"[123] such as market access, labour market pooling, intermediate input effects and technological spill-overs come into play as "unintended or incidental by-products".[124] In order to identify a fully developed cluster there should also be joint action[125] or what Zeng[126] describes as taking "deliberate efforts to cooperate and collaborate."

[121] Wisner et al., 2005, p. 355 .
[122] Schmitz, 1992, pp. 64-69.
[123] McCommick, 2004, p. 1.
[124] McCommick, 2004, p. 1.
[125] Nadvi, 1999, p. 1.
[126] Zeng, 2006, p. 3.

The concepts of cooperation and collaboration are not foreign to logistics, but what is interesting here is that the act of collaboration (in any economic context) is not possible without common platforms or points of departure. Movement through a value chain always implies that physical product (via beneficiation) and transactions flow downstream, with supported upstream and downstream flow of information – core to the logistics concept. This definition therefore implies, as illustrated in Figure 8, important flows in the economy, i.e. of goods, transactions and information – without these important linkages neither unintentional nor intentional co-operation and collaboration could be possible.

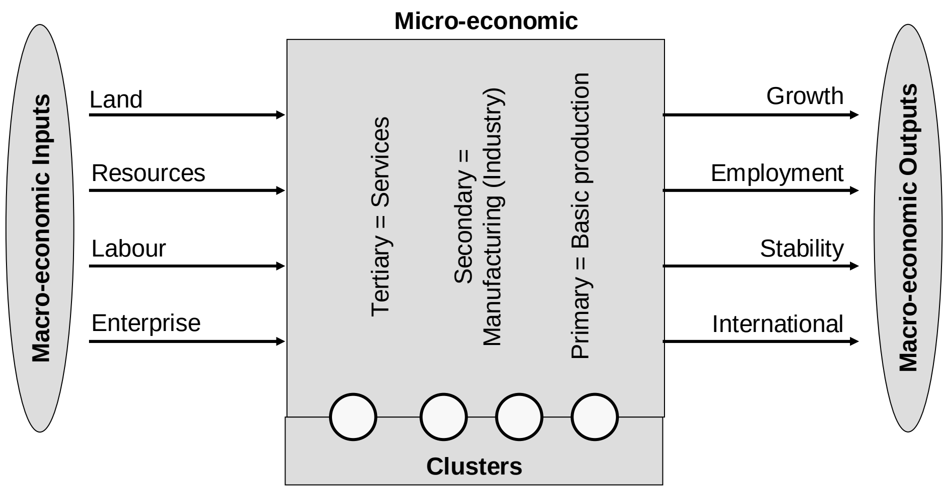

Figure 8: The development of clusters

A further requirement of this study would be to define the list of underlying economic sectors that can be used to construct cluster identities and provide a stable platform from which these could be studied. No clear framework exists in the economy to do this, which in turn gives rise to the unfortunate situation where research databases differ. This is usually acceptable for micro-level work, but hampers exactly the macro framework that the economy requires. Data produced by the South African Revenue Services, the National Ports Authority, Spoornet, Statistics South Africa and other sources all differ in frameworks. This is clearly an unfortunate state of affairs and should be addressed.

In terms of logistics two important drivers should be considered when developing a framework for economic data gathering. Globally the standard industrial classification system is used for economic data reporting, with various derivatives that differ between countries, but are almost always comparable through various concordances like the one that makes comparison between NAICS (the North America system) and NACE (the grouping of European systems)[127] possible. The harmonised system is often used for international trade and is unique in that services are excluded and only physical goods are classified, but once again comparisons within the larger groupings of standard industrial classification systems can be reached.[128] It should be apparent that any system of reporting on economic production should refer back to these related frameworks. Statistics South Africa uses this classification scheme and the overarching framework is depicted in Table 3.[129] (Statistics South Africa does unfortunately not always publish data at this level of detail.) Other comparative problems exist even within the organisation such as the fact that much of the data are aggregated, some publications have been discontinued, some are in rand value and some are in weight.

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[127] Communication and Resource Centre Administrator, European Commission, 2007, p. 5.
[128] Communication and Resource Centre Administrator, European Commission, 2007, p. 7-8.
[129] Central Statistical Services, 1993, p. 1.

First Digit SIC Code	Overarching Economic Sector	Economic Division
1	Primary	Agriculture, hunting, forestry and fishing
2	Primary	Mining and quarrying
3	Secondary	Manufacturing
4	Tertiary	Electricity, gas and water supply
5	Tertiary	Construction
6	Tertiary	Wholesale and retail trade; repair of motor vehicles, motor cycles, personal and household goods; hotels and restaurants
7	Tertiary	Transport, storage and communication
8	Tertiary	Financial intermediation, insurance, real estate and business services
9	Tertiary	Community, social and personal services
0	Consumption	Private households, exterritorial organisations, representatives of foreign governments and activities not adequately defined

Table 3: Overarching economic classification

From a demand side, the overarching system makes a clear distinction between the primary, secondary, tertiary and consumption sectors of the economy, or from a supply side view only of primary, secondary and tertiary sectors. According to a value chain perspective, one could refer to the extraction, beneficiation, services and consumption sectors of the economy (Figure 9).

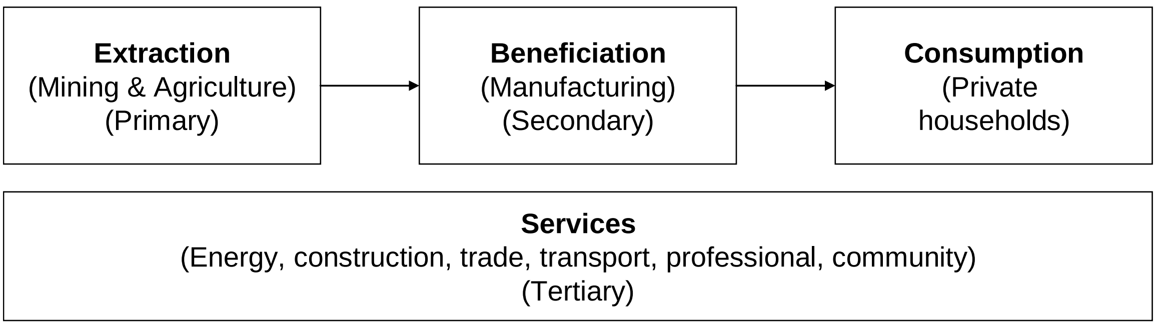

Figure 9: The economic value chain according to the standard industrial classification

The problem with this classification arises at the next level SIC code, i.e. the further sub-classification of the system. (For the purposes of this discussion the study concentrates on the extraction and beneficiation sectors, as the other sectors' weight is negligible compared to the first two). The global system subdivides agriculture into a further three subdivisions, mining in six and manufacturing in 10. On the third level, as depicted in Table 4, 10 agricultural, nine mining and 60 manufacturing subdivisions are included in the classification.

	2nd div.	3rd div.	4th div.	5th div.	% of total
Agriculture	3	10	14	14	6
Mining	6	9	18	21	9
Manufacturing	10	60	131	190	85

Table 4: Detailed sub-sectors of the extraction and beneficiation sectors of the economy

The problem that arises from this classification scheme is that it is hypothesised that the mining sector, which has access to only 21 5th divisional sub-sectors (6% of the total), comprises about half of our economic production by weight. On the other hand, the manufacturing sector, which has many more divisional sub-sectors, also has many more internal complexities irrespective of its lower weight. The fact is, however, that neither weight nor logistics complexity plays a role in the determination of these groupings, as logistics is not considered nor forms part of the decisions in this regard. This is a clear indication of how logistics considerations (which strive to provide systemic integration on a firm level) have failed to provide the same guidance on a macro-economic level. The outcome of this state of affairs is that various entities with various considerations use systems that serve their own objectives (e.g. Spoornet – which has more bulk commodity classifications than average; National Ports Authority – ad valorem considerations; SARS – tariffing) and therefore design distinct and incomparable systems to serve these objectives. This is understandable and acceptable, but the simple missing link, i.e. relating all these considerations back to the standard system, is not executed nor required by any entity in the process and especially not the regulatory authority that should be concerned with the recording of information for macro-economic guidance around logistics issues, i.e. the Department of Transport.

The process of further refining this system, as well as informing the weight versus complexity debate, is a natural further by-product of the study and will be considered in the outputs.

3.4.3 Cross-cutting factors defined

Cross-cutting factors identified in South Africa and often referred to in the literature include transport and logistics, the banking system, AIDS, sectoral business structuring and clustering, international trade and tariffs and tariff strategy, multi-factor productivity (both management and workers), import and export parity management and the development of downstream industries.

The process of identifying cross-cutting factors was driven by the foreign investment that followed the attainment of democratic freedom in South Africa in the early nineties and the wish to establish strategies that will accelerate growth. One of the first initiatives was studies funded by Japan, called the Japanese Grant Fund (JGF) studies. The JGF's initial focus was on the following cross-cutting studies:

- Pre-shipment export finance;
- Strengthening business services for South Africa's SMMEs;
- Promotion of foreign direct investment;
- Labour skills upgrading: financing of training; and
- Regional industrial development policy: an evaluation of the RIDP.[130]

As the process of specific cluster studies continued, this list grew rapidly to incorporate previously unidentified factors, such as transport which, though

[130] Nedlac, 1996.

initially overlooked, soon became the one issue that seemed the most difficult to deal with and resolve.

A clear and unequivocal distinction between economic clusters and cross-cutting issues arises from this list. These cross-cutting factors all relate back to macro-economic management and the achievement of the national objectives of growth, employment, stability and international trade growth, as well as the protection and advancement of the macro-economic production factors of land, resources, labour and enterprise.

3.5 From macro-economic imperative to measurement

Logistics and its management is clearly shown as a macro issue that requires management and then, by definition, measurement. The case for measurement is articulated in Chapter 3 of the study, but to what extent has the measurement ideal been achieved in South Africa? The historical context and past achievements in this regard are discussed in Chapter 4.

Distinct time periods can be identified that match closely with the phases of logistics development as identified in Chapter 2. These time periods are summarized in Table 5. The framework can now be used to consider the history of transport logistics measurement in South Africa.

Description of Economic Platform	Time	Logistics Support and Architecture	Global Trend
Primary economy	< 1870	Infrastructure development	Configuration & reconfiguration to achieve efficient access
Industrial economy	1870-1960	Production & Operations Management	Time & motion efficiency
Market economy	1960-1990	Transport & distribution (logistics)	Time, form & place utility
Electronic communities & trading platforms	1990-2000	Integrated trading platforms	Collaboration & integration
Globally networked economy	2000-2020	Globalised systems	Information "open access"
Global bio-engineering	2020 +	Quest for global balancing	Quest for global sustainability

Table 5: Phases of logistics development

Chapter 4 - Literature study and historical context of macro transport logistics measurement history in South Africa

4.1 Introduction

In the context of the importance of the macro-economic dimension of transport logistics and the resultant management and measurement imperatives, this chapter discusses the history of measurement, milestones and problems. This discussion uses the framework typology developed in Chapter 2 as background.

The performance of macro-economic measurement in South Africa specifically (against the backdrop of a local and historical context) was researched and the available literature studied to form a picture of what was achieved and where improvements were possible. Only five surveys (Figure 10) conducted over the past five decades (of which the last one was repeated a few times) could be found and the relative successes and shortcomings of these will be discussed in this chapter. In the absence of surveys, the role and position of measurement in general are also analysed.

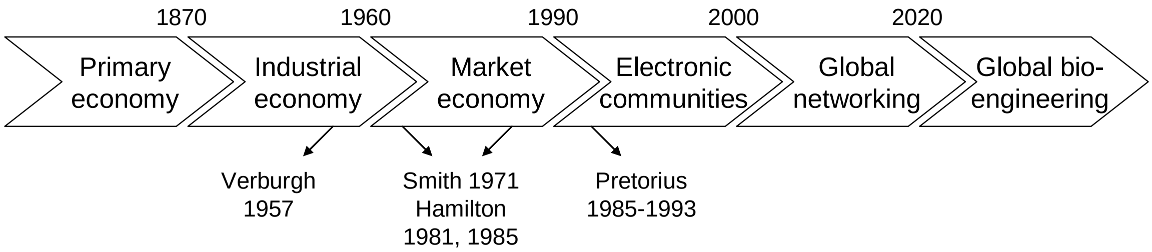

Figure 10: Logistics phases and surveys

4.2 Infrastructure development during the primary economy phase

In the years between the invention of steam transport and the second industrial revolution, first world rail transport began to blossom. Europe saw the development of a major rail network and the transcontinental rail link was completed in the United States of America in 1869.[131]

Transport in South Africa in the pre-industrial era was slow and painful, and people often did not move much from place to place during their lifetimes. Incidents like the sinking of the Birkenhead close to Gansbaai led to a situation where Afrikaans-speaking people with English surnames could trace their lineage back to English soldier survivors of the shipwreck that simply remained in Gansbaai after the incident, because it was so difficult to get back to Cape Town. The possibility of building a railway was therefore seen as "immensely beneficial"[132] and "enterprising local merchants and speculators were pleading for a link to the interior".[133]

What about planning and measurement? This has to be seen against the context of the cost of investment, the planning horizon and the long-term effect of planning decisions. In many respects this context places the planners of the mid-19th century in very similar position to the one South Africa faces now. A lack of foresight and a critical lack of planning around the required links between the coast and fast-developing hinterland were evident. In 1845[134] illustrious figures such as the Attorney General of the Cape Colony, William Porter and the Surveyor General of the first Railway company to be formed in South Africa, i.e. The Cape Town Railway and Dock Company,[135] refused to have their names associated with the first railway construction in South Africa. Conradie states that political agendas rather than economic considerations are "a fundamental principle on which transport development in South Africa was built" and that this state of affairs still persists today.[136]

The political hue that affected transport issues was also evident in the first road-rail debates in South Africa. A number of people had a vested interest in road transport on ox wagons. As long ago as the early years of railway

[131] Coyle et al. 1986, p. 6.
[132] South African Railways, 1960, p. 1.
[133] South African Railways, 1960, p. 3.
[134] South African Railways, 1960, p. 2.
[135] South African Railways, 1960, p. 3.
[136] Conradie, 2007.

development the short-term advantage was enjoyed by the road transporters, because of low capital and maintenance costs (i.e. not paying for road infrastructure).[137] The emotional debate, however, revolved around vested interests, and the measurement and demand for transport in the future were not considered. It was reported in 1885 that the rail system saved the Cape a million pounds per annum,[138] but the argument did not contribute to future investment scenarios. Burman draws an interesting parallel with the development of commercial farming when he talks about transport in the early 19th century. This should serve as a warning regarding South Africa's national objective for the second economy and the development push from subsistence to commercial farming:

> Why should a farmer in the Overberg risk his wagon, his precious oxen and even his life, to carry produce over the mountains to Table Bay? So the farmer grew just enough crops for subsistence, and produce at Table Bay remained scarce.[139]

One of the fundamental problems of the change from subsistence farming to commercial farming is access, which was a problem nearly 200 years ago and is still a problem today.

At the start of the second industrial revolution in Europe, South Africa had 104 km of railway (between Cape Town, Wynberg and Wellington; and in Durban between the Point and the city).[140]

4.3 Production and operations management during the industrial economy phase

4.3.1 Introduction

In Europe the industrial age truly burgeoned during the late 1800s. The 19th century was typecast as the century of the "transport revolution" and 1870 as

137 Heydenrich, 1965, p. 101.
138 Heydenrich, 1965, p. 109.
139 Burman, 1984, p. 11.
140 Van Rensburg, 1996, p. 2.

the year of the start of the “second industrial revolution”.[141] The establishment of industrial complexes had two immediate effects on logistics, i.e. the decision criteria for long haul and short haul, which mostly implied rail transport for long haul and local distribution by truck,[142] and the decision that plants should be located in the “locality where the aggregated transportation costs are the least”.[143]

These approaches are clearly devoid of a total logistics view and the more advanced cost and competitive advantage trade-offs that the logistics profession is capable of in the modern era. Most theory concentrates on production and operations management and sees the logistics function more as the work-in-process function on the factory floor. The inbound transportation of raw materials and the outbound delivery of finished goods receive little strategic attention. Cost measurement on a micro-scale is considered, but the long-haul imperative for rail is hardly questioned, nor measured as an economic activity. Wynne-Roberts discusses three causes for increased product cost, i.e. the cost of raw materials, sub-optimisation of assets used for production and labour unproductivity. He lists eight reasons for raw material cost increases, but fails to mention inbound transportation or logistics costs. Nowhere in the text does outbound distribution play any role.[144] Evidently in this era transportation was still seen as an *administered* cost, with a belief that management could not have an impact on this cost, nor use it to provide a competitive advantage for the firm. According to Keebler and Durtche, “transportation services such as rail and trucking were heavily regulated and comprised 70 percent of a manufacturers’ logistics expenses, compared with 57 percent today.”[145] The concept of an administered cost is, however, a macro-economic concept *per se*, and this therefore places logistics squarely in the macro-economic arena.

[141] Terreblanche, 1988, p. 106.
[142] Spriegel and Lansburgh, 1947, p. 114
[143] Locklin, 1935, p. 114.
[144] Wynne-Roberts, 1956, p. 52-53.
[145] Keebler and Durtsche, 1999, p. 48.

In the Heckscher-Ohlin model that has been used since the 1930s as an orthodox approach to the ultimate causes of international trade, it is stated that commodities differ in their factor requirements and that countries differ in their factor endowments. Ten assumptions are used in the running of the model, of which the tenth is that transportation costs are zero.[146] The model concluded that factor endowments of one nation competing with another drove competitive advantage (just as Ricardo's model stated that labour productivity is the key)[147] and that transportation costs do not play a role in the determination or acquisition of competitive advantage. McDougall tested these models in 1951 and determined that there is a direct positive correlation between relative trade advantages and improved labour productivity, but that even in the case of vast factor and labour productivity advantages, markets are not captured by competing nations completely, as the models suggested. He lists the exclusion of transport costs from the model and the relative effect of negative transportation abilities in spite of positive factor endowments as one of the reasons for this phenomenon.[148]

On a firm level in this era operations management came of age as a quantitative discipline. Most contributions during the 1920s and 1930s were quantitatively driven with statistical quality controls as a benchmark,[149] but inbound and outbound logistics played little or no role.

In South Africa in this era the industrial revolution hadn't taken off yet to the same degree as in Europe, but the discovery of gold and diamonds in the latter half of the 19th century led to increased requirements to reach the hinterland effectively. Opposition to a railway still prevailed and especially in the East Free State rallies opposing this development were held.[150] Details on the "traditional" transport mode (on road and by ox wagon) were known,

[146] Chacholiades, 1990, pp.63-66.
[147] Chacholiades, 1990, p. 88.
[148] Chacholiades, 1990, p. 90.
[149] Cook and Russel, 1984, p. 4.
[150] Van Rensburg, 1996, p. 3.

i.e. it cost about 40 shillings per 100 lb. to move around 1 000 miles. The wagon and mules required 65 days to do the trip.[151]

Disagreements over the rail gauge, which led to the replacement of the first track of 54 inches with the current 42 inches, also broke out. The winning arguments were not based on proper research, but short-term interests and powerbases.[152] The decision of 1871 to revert to the narrow 3’6” gauge was based more on speed of construction than actual cost savings (which were in dispute) and not thought through on all dimensions.[153]

Railway development was, however, rapid and the two colonies and two republics that would later form the Union of South Africa independently established railways, connecting the gold and diamond fields of Johannesburg and Kimberley with Cape Town, Port Elizabeth, East London and Lourenço Marques (then Delagoa Bay, today Maputo).[154] These developments often entailed acrimonious deliberations;[155] they were one of the main causes of the first Anglo-Boer war in the early 1880s, and although the first railway companies were in private hands, as in the United States, governments became more and more involved as the territorial scramble continued.[156]

The establishment of the Union of South Africa in 1910 led to these lines being officially connected and the establishment of one national railway organisation. This organisation controlled more than 12,000 route kilometers (60% of today’s total), about double the 6,500 km at the turn of the twentieth century. This grew to approximately 22,000 kilometers by the late 1920s.[157] The peak of development was reached at this stage – compared to the United States, where track mileage peaked in 1916.[158]

[151] South African Railways, 1960, p. 15.
[152] Burman, 1984, p. 50.
[153] Heydenrich, 1965, p. 62.
[154] Van Rensburg, 1996, p. 4-5.
[155] Coetzee, 1940, p. 215.
[156] Coetzee, 1940, p. 218-219.
[157] South African Railways, 1960, p. 14.
[158] Coyle et al., p. 6.

Transport policy of the Union between 1910 and 1948 was straightforward. The basic objective was to develop and run a railway on business principles (i.e. it should pay for itself), but that agricultural and industrial development should be taken into account.[159] Somehow this consideration led to differential tariffing: low tariffs for mining and agriculture and high tariffs for industrial goods. This was the first form of cross-subsidisation and the first threat to rail density as higher-value goods immediately sought to move to road transport, because of the inordinately high tariffs that were required for rail transportation. This reduced rail density and applied cost pressures on lower-value commodities. The total cost concept for the economy was, however, not considered and possible solutions ignored this basic approach. The solution to “control” road freight (as proposed by the Le Roux commission in 1929 and confirmed by the Page commission in 1947) didn’t really address the problem structurally and in fact, even today, the problem has not been solved. Simple calculations of macro rail economics, current and future demand, and costs to the economy could have suggested better solutions, but these were, however, never addressed.

The drivers of regulation were much simpler, as indicated by the 1927 report of the General Manager of the South African Railways and Harbours. He specifically argued that road hauliers are not “common” carriers and can charge any tariff and ignore any traffic. They could in effect “reverse” railway’s strategy of charging more for higher-value traffic and the only reason for prohibiting this practice would be to protect the railway investment.[160] The options available in terms of protecting the self-interest of railways by considering density and other transport economic arguments were clearly ignored. This issue surfaces again in an interesting way when the same General Manager quotes Mr R.N. Harvey (Vice-Chairman of the Executive Committee of the Association of Chambers of Commerce) from an address delivered at the annual congress of Assocom held at East London during October, 1959:

[159] Van Rensburg, 1996, pp. 8-11.
[160] South African Railways and Harbours, 1927.

> I leave aside the aspect that some reduction in high-rated railway traffic would not necessarily have the dire effects upon Railway finances which the Railways apparently fear, because high-rated traffic is not always highly remunerative traffic, high costs are associated with a good deal of high-rated traffic, notably where the shorter hauls are involved and proportionately high terminal costs are experienced.[161]

The General Manager interestingly continues to complain that the Railways needs to "be administered on business principles" and should "balance its own annual budget".[162] The issues of density, the opportunity costs of lost traffic and fixed versus variable costs, are ignored. This problem persists even today and Spoornet continues to shed customers without considering opportunity costs and density.

4.3.2 Verburgh's 1958 contribution

Verburgh, in the years directly after the new government came into power in 1948, began detailed studies on transportation volumes and demand for transport. He did pioneering work and should be appreciated for many reasons, including the ground-breaking nature of the surveys. His first analysis defines the "safe" domains for rail and road in two categories. These are fragile, urgent and perishable for road, and bulk long-haul for rail.[163] Verburgh conducted his research long before the advent of intermodal solutions and containerisation and his transport classes therefore do not include other more sophisticated categories.

Verburgh begins his work by defining capacity in terms of equipment for road and rail. He includes in his datasets these capacities as well as rail tonnages. He also makes a graphic comparison of these data against net national income at factor prices (Figure 11).

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[161] South African Railways and Harbours, 1959.
[162] Ibid.
[163] Verburgh, 1958, p. 13

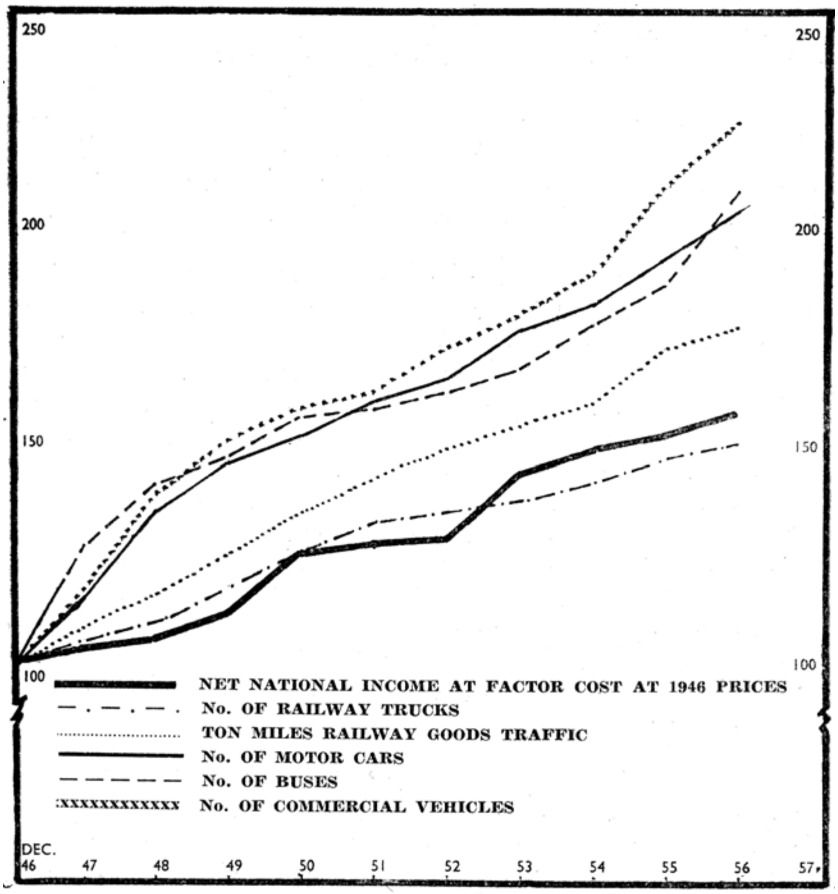

Figure 11: Verburgh's 1958 illustration (indexed 1946 = 100)

In his analysis Verburgh expresses satisfaction with rail's growth of 78% over the period, attributes this to the growth in inter-city transport in "splendid isolation" and does not express concern for what the data might show initially, i.e. that rail volumes are growing slower than the commercial road vehicle population.[164] It is possible to analyse Verburgh's data further, both in terms of what the data intrinsically express and in terms of what extrinsically could be added to the data.

4.3.2.1 Intrinsic problems highlighted with Verburgh's data

Verburgh's satisfaction with rail market share and the protection of intercity rail freight is disconcerting. He ignores, at first, the real relationship between the capacities of road and rail. He tabulates in a clear and unambiguous way

[164] Verburgh, 1958, p. 15-18

the growth in road operational capacity, compared to rail operational capacity, i.e. wagon and truck populations[165] (an important element of operational capacity). Even if no data were available, he could have hypothesised other elements of capacity, i.e. the growth in truck capacity (which improved markedly over this time period),[166] and more importantly the relationship between road and rail fixed infrastructure. Rail's fixed infrastructure reached its current levels in 1956 and was therefore able to carry 180 million tons easily (if not more) compared to the 64 million tons that Verburgh reported for 1958. This must mean, in an "administered" tariff environment, that additional freight on the rail infrastructure could be carried more cheaply (even if the ratio of fixed to variable costs is low – and some authors today postulate that as much as 70% of rail costs are fixed). This then also suggests that one of four options exists around the user-pay principle:

- Either trucks are paying the full costs of fixed road development, in which case the country as a whole is paying too much for transport; or
- Trucks are subsidised by motor vehicles in terms of fixed road development, in which case a distortion is occurring, and the economic cost will rise; or
- The economy is subsidising road development, in which case a distortion is occurring, and the economic cost will rise; or
- There is limited road transport next to railway lines, i.e. all transport is on feeder routes, in which case no specific problem exists.

The only sensible option would be option four, but Verburgh reports exemptions granted to road operators that allow long-haul operations, which contradict this statement[167] and therefore at least the possible effect of the other three options should have been considered. In reality, a combination of

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165 The capacity of a transport system can be explained in three classes, i.e. installed, maintained and operational. Installed capacity is the initial fixed investment and can only be improved in leaps; maintained capacity is a view on the annual level of maintenance of this infrastructure and can also only be improved in leaps *if the maintenance schedule deteriorated,* whilst operational capacity is the real capacity available on the fixed infrastructure, given current levels of employees, systems, motive power and carrying capacity. These definitions have become more poignant in today's world of infrastructure capacity issues and were developed further by the candidate for current policy makers.

166 Australian Bureau of Statistics, 2001, p. 3.

167 Verburgh, 1958, p. 36-37, p. 44.

the fourth and other options occurred in South Africa, which means that railway tariffs remained unnaturally high, making the system more vulnerable than it should have been when deregulation finally occurred. The high tariffs also created a false sense of security in the narrow gauge, which have created undue investment challenges today.[168]

4.3.2.2 Extrinsic problems highlighted with Verburgh's data

A comparison of Verburgh's rail data with national accounts information which was available in 1958 leads to more interesting extrinsic questions. The data can be correlated with production in agriculture, mining and manufacturing, often called the "transportable" portion of the economy. These statistics are available and point to structural problems in transport. The comparison is for obvious reasons not a precise measurement of market share, as structural changes in the locations of production and consumption are not included, but it remains a good approximation of indicative rail market share in the absence of other data. The correlation is depicted in Table 6.

[168] The carrying capacity of railway trucks – which remains the biggest driver of marginal costs and means that larger carrying capacities decrease costs – increases with wider gauge. In most cases this capacity can at least be doubled with a wider gauge. Compared to Europe, which has a wider gauge and half of South Africa's road truck carrying capacity limits, an important marginal cost component of South Africa's rail system today has an installed backlog by a factor of four – a result of the lack of this reasoning by many researchers of the day.

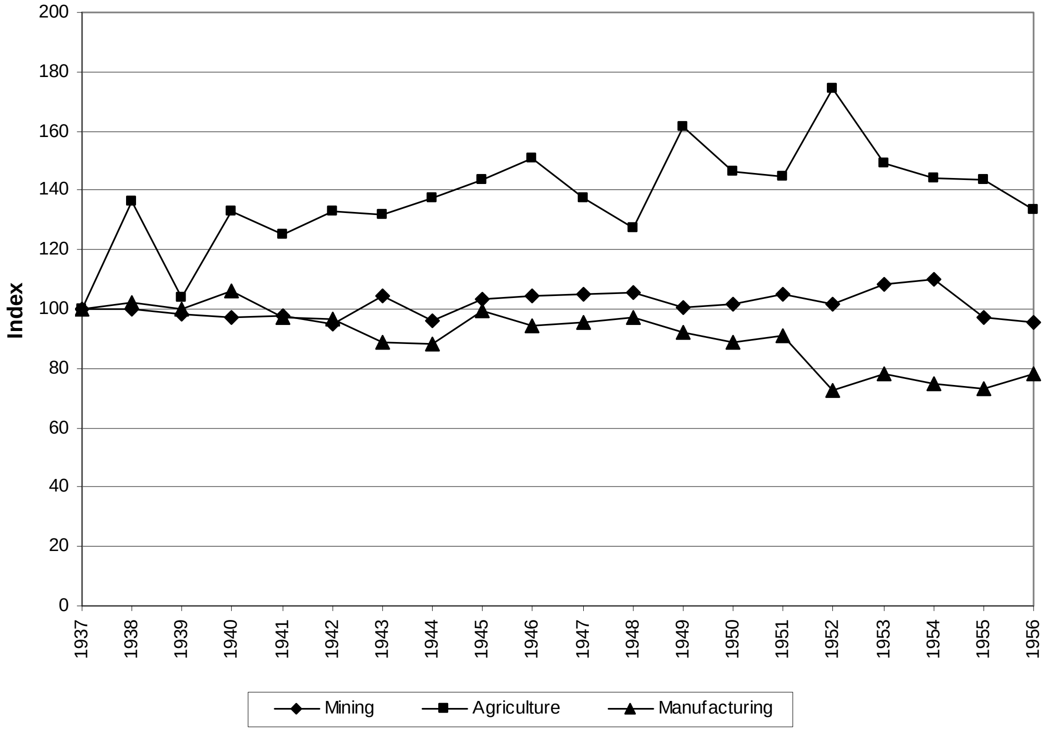

Figure 12: Rail transport as percentage of transportable GDP in tons (Indexed 1937=100)

The time series points to interesting developments:

- Rail's share of agriculture traffic is rising. This sector is the most heavily subsidised, difficult to transport (due to many collection points) and one of the most difficult to invest in as far as transport equipment is concerned (as the traffic is seasonal and the equipment is therefore not utilised throughout the year – hence even more fixed costs compared to road). It is also cyclical, thereby exacerbating all these challenges. In addition, the sector reaches equilibrium points, where neither imports nor exports of commodities are necessary, directly influencing the share of transport versus production.
- Rail's share of mining remained static. As most mining commodities are exported from fixed points of production through fixed harbours, this is by nature rail's bread and butter transport.
- Rail's share of manufacturing declined by a fifth. This could be due to structural problems, but it is seriously questioned whether the total loss could be for this reason. By now the railways are complaining about competition and are clearly observing the trend. The fairly ridiculous

situation in which manufactured transport continues to subsidise low-value transport and then declines because of service issues (return is invested in agricultural transport through cross-subsidisation) continues, without serious management of the problem.

The issue of agricultural market share and the development of branch lines was always a political one. It only changed in the 1980s as South Africa and Transnet were preparing for change. As far back as 1928, and before formal road transport regulation, Frankel reported:

> Instead of the decisions on new railway construction being left to an expert body acting on commercial principles and co-ordinating the expenditure on it with the capital expenditure necessary in other directions, not only is the amount to be spent every year decided mainly by the Minister of Railways and Harbours and the Government, but it appears that even the decision as to which of the proposed lines of railway are to be constructed depends largely on the wishes of the minister…..the building of branch lines has become a matter of annual competition in Parliament for the favours of a Minister cajoled and threatened by a large number of politicians, each clamouring for a line in his own constituency.[169]

These issues require management and should have been considered with the other data relating to Verburgh's initial summary of the situation. The data are also confirmed by the reaction of freight owners, with approximately 20% of all manufacturers, retailers and wholesalers complaining about delivery area exemption certificates at this time.[170]

The other reasonably obvious extrinsic consideration is the unnatural spatial problems that South Africa faces. The country is now preparing for inter-metropolitan traffic and faces spatial problems that no other comparatively sized developed country on earth faces, i.e. long-haul corridors between six

[169] Frankel, 1928, p. 113-114.
[170] Verburgh, 1958, p. 196-197.

metropolitan centres, i.e. Cape Town, Durban, Johannesburg, Port Elizabeth, East London and Bloemfontein. This spatial organisation and the data that could support it actually point to a sensible network design. This design should concentrate on heavily engineered rail corridor connections between metropoles and between mining deposits and manufacturing centres and ports. This network should be supported by a secondary feeder road system supported by branch lines, where densities allow for it. Whilst the export of mining commodities is important from a development perspective (and the feeder option would today be labelled part of the second economy), the corridor element will be important for the first economy of the future – the data therefore point to a future structural problem, when unsustainable rail business receives investment (branch lines to remote agricultural areas over routes of light density) and future, sustainable rail business (heavy haul corridors) receives less investment.

4.3.2.3 Verburgh's conclusions of 1958

Verburgh's survey methods of 1957 (the year in which the survey was done) were based on a special study of the Transportation and Communications Commission of the United Nations Organisation. This study suggested that in most countries the technique of sampling and limited period questioning provided the best method to obtain road transport performance figures.[171] Verburgh and his team at the Bureau for Economic Research at the University of Stellenbosch drew a sample of private and ancillary road transport service providers to develop an understanding of the industry.

Pertinent statistical conclusions on market share from Verburgh's study undertaken in 1957 are as follows:[172]

- About 8 000 firms were involved in haulage for reward in 1957. They operated 12 000 lorries, 1 500 mechanical horses and 4 500 trailers with an average carrying capacity of 5 tons for lorries and 10 tons for

[171] Verburgh, 1958, p. 210.
[172] Some of these statistics were calculated from Verburgh's data by the candidate, as not all relevant calculations necessary for future reference were done by him.

trailers. Only 20% (2 400) of the lorries had a carrying capacity of more than 2.5 tons, but 55% of trailers had a carrying capacity of more than 8 tons. Only 8% of the private hauliers (about 64 firms) owned more than three vehicles;

- These firms, together with road transport done by the railways (about 10% of total haulage for reward), transported 67 million tons in 1957 compared to railway traffic of about 75 million tons.

These statistics enable the calculation of market share as depicted in Table 6.

	Tons				Ton-kilometers			
	Rail	**Road for reward**	**Road ancillary**	**Total**	**Rail**	**Road for reward**	**Road ancillary**	**Total**
Millions	75	67	113	255	32 000	1 955	1 960	35 915
%	29	26	44	100	89	5	5	100

Table 6: Modal market share in 1957[173]

Transport supply in 1957 was therefore 255 million tons and 36 billion ton-kilometers[174]. R659 of gross domestic product at constant 1995 prices were therefore produced for every ton that was shipped and R4.68 of gross domestic product for every ton-kilometer performed.[175] The dominance of rail in 1957 is clearly evident. Infrastructure decisions as far as long-haul freight transport goes are still essentially rail decisions. If this is transposed to average transport distance, the figure for rail is 427, for road for reward 29 and for road ancillary 17.

Average transport distances are in balance with a “pipe and feeder” system, where railways are the pipe, fed over shorter distances by road transport for

[173] Calculated from Verburgh's (1958) distribution of vehicles per firm type (p. 21), average distance loaded per annum (p. 217) and ton-miles per vehicle (p. 168). Verburgh excluded fuel, farming, service and farming vehicles.

[174] This figure is about 20% of supply today for tons and 5% for ton-kilometers. For a spatially challenged economy the problem became exponentially worse over 50 years – stressing the issue of long-term planning. This will be further discussed later in this study.

[175] Comparisons between transportable volumes and the transportable portion of the GDP will be developed in later parts of the study

reward and very short distances by freight owners' own ancillary transport systems.

Verburgh does not specifically calculate and compare the percentage distribution between cargo types within 50 km and beyond 50 km for transport for reward, but it can be done from his data[176] (Table 7).

Distribution	% Within 50 km	% Beyond 50 km
Household removal	0	1
New furniture/household goods	1	0
Metals/machinery	3	4
Aggregate	53	27
Building material	23	11
Coal	4	24
Oil	0	2
Ores	1	0
Agricultural products	4	8
General Cargo	13	23

Table 7: Distribution of road transport for reward within and beyond 50 km zones in 1958

Aggregate has low value and transport drops off, but so does coal which is transported over longer distances by road.

The primary goal of Verburgh's work was to balance supply and demand. This was, however, done from the perspective that insufficient supply should be provided by the extension of road transport, not from the perspective of balancing the transport modes. This is clearly the Archimedean Point[177] of Verburgh's study. Verburgh complains about Local Road Transportation

[176] Calculated from Verburgh, (1958), cargo tons within 50 miles (p. 101) and cargo tons further than 50 miles (p. 103).

[177] The Archimedean point is described by Dooyeweerd as the "standpoint which transcends modal (in this case thought structure and not transport modes) aspects", that "may not be divorced from our own subjective self, but is still subject to the law (in this case scientific structure)" Dooyeweerd, 1969, Volume I, pp. 8-12.

Boards' lack of experience and inconsistent application of regulations. He refers to price collusion, a small amount of price regulation and cut-throat competitive practices in the road industry. This leads to many haulier business failures, in general due to over-cropping. He campaigns for quality standards and more freedom for larger firms to develop longer-distance routes, exactly for the reason that standards can be developed and over-cropping minimised. He explains freight owners' disadvantages because of these circumstances. Through this study, Verburgh's pioneering work has set a clear and unambiguous benchmark for road transport evaluation. However, by not following through on a wider modal balancing approach, his study does not succeed in providing long-term infrastructure planning frameworks. At the same time, though, Verburgh's work, which is 50 years old at the time of the candidate's research, is the first and last attempt in the history of macro-transport logistics measurement in South Africa that tries to develop a detailed strategic perspective.

4.4 Transport and distribution logistics during the market economy phase

4.4.1 Introduction

A physical infrastructure landmark that inaugurated the market economy age in the first world is the "American interstate system of highways" bill that was passed by congress in 1956.[178] Another landmark of this era is the introduction and, by the end of the 1960s, widespread use of container technology.[179] It is ironic that, although the combination of freeway calibre roads, containers and installed technologies, i.e. railways and shipping, clearly pointed the way towards a new era of intermodalism, South Africa never really caught on to this concept. Intermodal systems benefit all stakeholders (business, the public, freight owners, distributors and freight service providers), but as Alan Jorgenson maintained in 1999:

[178] Coyle et al. p. 6.
[179] Baluch, 2005, p. 126.

> This potential, already successfully implemented in the America's, Europe and Australasia, has unfortunately, not been realised in Southern Africa.[180]

The initial reason for this is provided by Mitchell, who says:

> During the first two decades of this new regime[181] a programme was put into place to restore and upgrade infrastructure which had become run down during the war years. However….no coordinated, integrated or even rational approach to the provision of infrastructure was apparent – both between modes and between authorities. The general approach was mainly ad hoc responses to specific issues, and most definitely there was no overall transport infrastructure funding strategy in place.[182]

Two reasons could be postulated for this state of affairs, i.e. that strategy follows vision and research[183] (which were both absent to some degree) and that intermodalism of this nature in South Africa would have required macro-economic intervention, which was absent.

The issue of the relative share of "high-rated" traffic on railways was finally understood *to some extent* in this era as rail's tonnage share of said traffic rose from around 18% in the beginning of the 1970s to about 20% in the middle of that decade and then fell to 12% at the end of that decade. Revenue share for this traffic declined from around 50% to about 40% during the same time period.[184]

As far as road transport and intermodalism are concerned, Jones reports that during this era:

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[180] Jorgensen, 1999, p. 1.
[181] Mitchell refers to the regime of the Nationalist government that came into power in 1948, soon after the Second World War, and therefore refers to the 1950s and 1960s.
[182] Mitchell, 2004, p. 2.
[183] Havenga and Hobbs, 2004, p. 58.
[184] Jones, 1999, p. 181.

> A detailed picture of modal shares in land transport has been notoriously difficult to construct in South Africa, principally because of the paucity of robust road transport data.[185]

This apparently leads to a similar "paucity" in his own work on intermodal discussion (irrespective of the title of the relevant chapter). Unfortunately, both the absence of intermodal discussions and the lack of robust road transport data remain a problem to this day, despite the efforts of some researchers and Statistics South Africa. It is one of the objectives of this study to suggest solutions to these issues, as will be discussed in later sections of this work.

This era, when the market economy took off, was a time when the United Nations was thinking about containerisation and its role in intermodality, and especially its role in developing countries, where infrastructure development is expensive:

> Therefore, any programme for the improvement of transport should be considered in the context of the entire economic and social system of the area concerned and drafted within the general development programme of the area. Transport studies and surveys of any kind should not be regarded as isolated actions, but guided by the policy and targets of a long-range transport plan based on the future transport needs and available resources.[186]

4.4.2 Verburgh's 1968 contribution

In 1968 Verburgh, 10 years after his initial work, is again one of the only researchers in South Africa who considers transport data and attempts a research-driven approach to current and future problems. The opening statement of his work is a landmark in itself:

[185] Jones, 1999, p. 186.
[186] Traut, 1967, p. 8.

> The pre-requisite to decision-making on matters of transport policy, particularly where the infrastructure is involved, is a well-conceived anticipation of not only the long-term development of the traffic, but also the distribution of this traffic among the various forms of transport.[187]

He also says that:

> One of the major problems encountered in the process of planning the nation's transportation facilities was the lack of basic data of tendencies in respect of the volume, composition and 'desire lines' of the demand for transport and goods.[188]

Evidently this is a problem with a 40-year history and no solution yet.

Verburgh suggests through this statement a possible change in his Archimedean Point. He believes research data should not only be developed to inform road liberalisation, but that infrastructure planning, based on future demand determination, should also play a role. The forecast nature of this work confirms his change in approach. The work, however, is based on another critical assumption, namely that it is limited to middle- and long-distance transport and that this transport is provided by rail as rail transport is sufficiently representative of the total demand.[189]

The main thrust of Verburgh's study was to determine the adequacy of rail infrastructure over the 10 years following his study. It is therefore possible to test Verburgh's forecast for rail transport for this 10-year period,[190] compared to the actual rail data. The deviations from his forecasts are represented in Table 8.

187 Verburgh, 1968, p. 1.
188 Verburgh, 1968, Foreword.
189 Verburgh, 1968, p. 1.
190 Verburgh, 1968, p. 61.

	Rail forecast			Rail actual			% Deviation		
	Mining	Agriculture	Manufacturing	Mining	Agriculture	Manufacturing	Mining	Agriculture	Manufacturing
1965	50 491	15 854	24 521	50 491	15 854	24 521	0	0	0
1966	51 709	16 171	25 222	52 666	14 478	25 071	2	-12	-1
1967	52 925	16 488	25 922	54 347	16 804	25 300	3	2	-2
1968	54 142	16 805	26 623	54 159	20 010	26 381	0	16	-1
1969	55 360	17 122	27 323	57 082	19 568	27 396	3	13	0
1970	56 576	17 412	28 025	59 383	16 716	29 321	5	-4	4
1971	57 793	17 756	28 726	57 813	14 419	27 724	0	-23	-4
1972	59 011	18 073	29 426	58 244	15 846	28 282	-1	-14	-4
1973	60 227	18 390	30 127	60 053	18 378	28 134	0	0	-7
1974	61 444	18 707	30 827	61 466	14 903	29 323	0	-26	-5
1975	62 662	19 024	31 528	64 078	17 125	29 535	2	-11	-7

Table 8: Verburgh's forecasts for rail transport in tons ('000) vs. actual data[191]

The cyclical nature of agricultural demand and supply, and its effect on forecasting, is clearly evident from the data (exacerbating rail infrastructure planning and cost coverage problems). Mining forecasts seem to be generally in line, but manufacturing transport by rail shows a steady decline when compared to forecasted volumes. This could be an indication of what was previously discussed regarding Verburgh's first study and the incorrectness of the core assumptions around modal roles, the poor infrastructure decisions by government and the lack of multi- and intermodal planning.[192] It could, however, be that manufacturing (and other sectoral) production lagged forecasts. It is therefore necessary to compare Verburgh's forecasts of total production in the economy with actual data.

[191] Verburgh's data had to be normalised to fit actual rail tonnages for 1965. The normalisation is applied to the complete subsequent analysis of the data and is therefore comparable.

[192] Both multimodal (the provision of the applicable modes to supply transport effectively) and intermodal (the supply of effective linkages) are important in this regard.

Table 9 represents Verburgh's forecast for physical production in the economy for the ten years following his study,[193] the actual data and deviation from forecasts.

	Economic production: forecast			Economic production: actual			% Deviation		
	Mining	**Agriculture**	**Manufacturing**	**Mining**	**Agriculture**	**Manufacturing**	**Mining**	**Agriculture**	**Manufacturing**
1965	76 763	17 835	26 081	76 763	17 835	26 081	0	0	0
1966	80 309	19 143	26 976	79 025	22 612	28 126	-2	15	4
1967	84 017	20 547	27 901	83 239	19 427	29 521	-1	-6	5
1968	87 898	22 054	28 859	87 273	20 701	32 543	-1	-7	11
1969	91 958	23 672	29 848	90 910	20 701	34 774	-1	-14	14
1970	96 204	25 408	30 874	98 109	23 568	37 052	2	-8	17
1971	100 647	27 272	31 933	81 839	24 842	38 493	-23	-10	17
1972	105 295	29 272	33 028	103 682	20 383	42 026	-2	-44	21
1973	110 158	31 420	34 160	110 474	20 064	44 723	0	-57	24
1974	115 250	33 725	35 334	123 154	26 115	46 489	6	-29	24
1975	120 568	36 198	36 546	133 902	26 434	47 605	10	-37	23

Table 9: Verburgh's forecasts for economic production in tons ('000) vs. actual data

The evidence is quite clear: by the end of the 10-year period rail transported 7% less manufacturing commodities than forecasted by Verburgh, but production in the manufacturing sector outstripped Verburgh's projections by 23%. The market economy had truly arrived in South Africa. The manufacturing economy was doing everything it could to move away from subsidising farmers by creating its own transport and logistics solutions and highlighting the poor state of intermodal planning by government.

Verburgh's final conclusions are interesting. He does not consider modal balancing, but he does talk about the adequacy of rolling stock, fixed infrastructure and marshalling yards (although he suggests mechanisation)[194]

[193] Verburgh, 1968, p. 61.
[194] Verburgh, 1968, p. 82-83.

and sounds a word of warning that none of these can work effectively without adequate manpower, management and planning.[195]

4.4.3 Smith's contribution

In the early 1970s Verburgh's initial work of 1958 was repeated in detail by Smith. Smith cites difficulties at the Department of Statistics, high percentage of business mortalities and the "stringent limitations" of the effects of the 1930 Act which regulated road freight transport as the core issues that led to his study.[196] Similar to Verburgh's work of 1957, Smith's work was based on 329 returned questionnaires (Verburgh 403) from a sample of 4,000 out of the deemed 12,000 road hauliers, which resulted in a response rate of 8% (Verburgh 16%). (Smith's study is silent on many of the ancillary or freight-owner transport statistics that Verburgh did report on, but it was possible to reconstruct some trends and data from his base data.) The study was therefore essentially a supply-side study, as was Verburgh's.

Recreating core statistics from Verburgh's data (which Smith – although referring to Verburgh extensively – interestingly doesn't do) made it possible to do the comparisons between the two studies for:

1. Ton and ton-kilometer (Table 10)
2. Market share (Table 11)
3. Average transport distance (Table 12)

[195] Verburgh, 1968, p. 83-84.
[196] Smith, 1973, p. 1-2.

	Million Tons				Million Ton-kilometers			
	Rail	**Road for reward**	**Road ancillary**	**Total**	**Rail**	**Road for reward**	**Road ancillary**	**Total**
Verburgh – 1957	75	67	113	255	32 000	1 955	1 960	35 915
Smith – 1971	100	245	279	624	53 000	7 850	6 387	67 237

Table 10: Modal market share[197]

In fourteen years tons shipped more than doubled and ton-kilometers nearly doubled. Road activity grew exponentially.

	Tons - % market share				Ton-kilometers - % market share			
	Rail	**Road for reward**	**Road ancillary**	**Total**	**Rail**	**Road for reward**	**Road ancillary**	**Total**
Verburgh – 1957	29	26	44	100	89	5	5	100
Smith – 1971	16	39	45	100	79	12	9	100

Table 11: Modal market share in percentage

Rail market share declined markedly, even considering that it came from a low base; both road for reward and ancillary road market share doubled. The growth in average transport distances compared to the faster growth in tons shipped versus ton-kilometers performed is counter-intuitive. This is, however, a direct result of the changing structure of the market.

	ATD – km		
	Rail	**Road for reward**	**Road ancillary**
Verburgh – 1957	427	29	17
Smith – 1971	530	32	23

Table 12: Average transport distance

197 Smith, 1973, p. 139-140. Ancillary transport statistics calculated from average distance and tons per vehicle per annum (p. 144-145), per industry group and vehicle fleet composition from growth rates in commercial vehicles, NAAMSA, and certificates issued (p. 5).

Economic performance in terms of gross domestic product per ton shipped has now deteriorated to R542 (from R659 in 1957) at constant 1995 prices, but in terms of ton-kilometer delivered the performance improved to R5.03 (from R4.68). This is an interesting phenomenon, because even when the average transport distance for all modes increased, the average transport distance in the economy decreased from 141 kilometers to 108 kilometers. This is a phenomenon of urbanisation, but could also be a lead indicator of specialisation, following urbanisation, in a multi-metropole economy that should predict corridor formation.

Smith does not attempt the same level or depth of economic analysis as Verburgh and no further clarification of his interpretations is possible as he is almost completely silent on many of the salient issues that his research could uncover. The data do point to an increase in road activity over rail; especially as "rail captured" traffic picks up and manufacturing transport does everything possible to no longer make use of the rail mode. He does, however, make an interesting observation:

> As long ago as 1957, the Minister of Transport indicated that he had given instructions to the National Transport Commission to conduct a survey of all road traffic. As far as can be ascertained, such a survey has never been successfully completed by any Government department.[198]

The issues that were overlooked in the previously mentioned research and planning were beginning to emerge in the 1970s. Jones refers to a view of the "separation of modes as an artificial one"[199] that emerges in the 1970s, as "rail grapples with an increasingly uneasy competitive relationship with road transport" and being "increasingly at odds with its changing tariff base." This happens at a time of coal and iron export line development and containerisation projects, which drive these changes even further.[200]

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[198] Smith, 1973, p. 4.
[199] Jones, 1999, p. 176.
[200] Jones, 1999, p. 177.

Jones quotes interesting performance figures for rail in this period, namely that tonnages shipped increased by 50% over the decade and ton-kilometers by 63%. Average transport distance grew faster, because of the export lines and more cross-border traffic. What Jones picks up, however, is that high-rated traffic's contribution to tonnages and rail revenue peaked during the middle of the decade and then declined. Jones' illustrative figures are depicted in Figure 13.

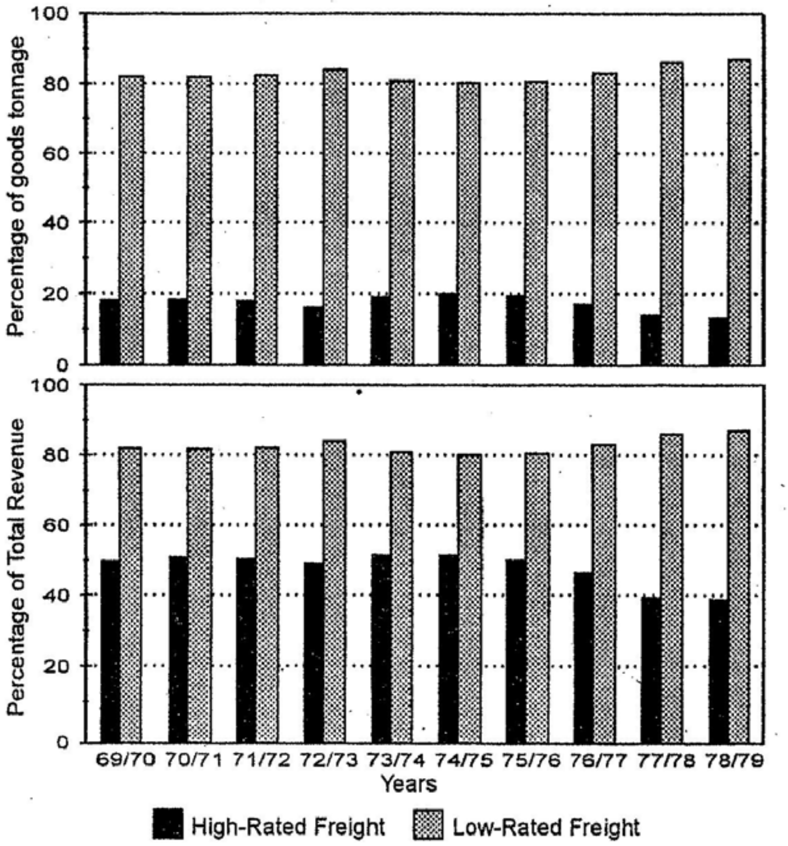

Figure 13: Jones's analysis of traffic (note uneven distribution in ton and income).[201]

The question arises as to whether this is because of market structure or market share changes? For the only available comparison, Verburgh's original data are extended to the end of the 1970s and are depicted in Figure 14 (note that Verburgh created the first base data sets, but did not analyse the data in this fashion).

[201] Jones, 1999, p. 181.

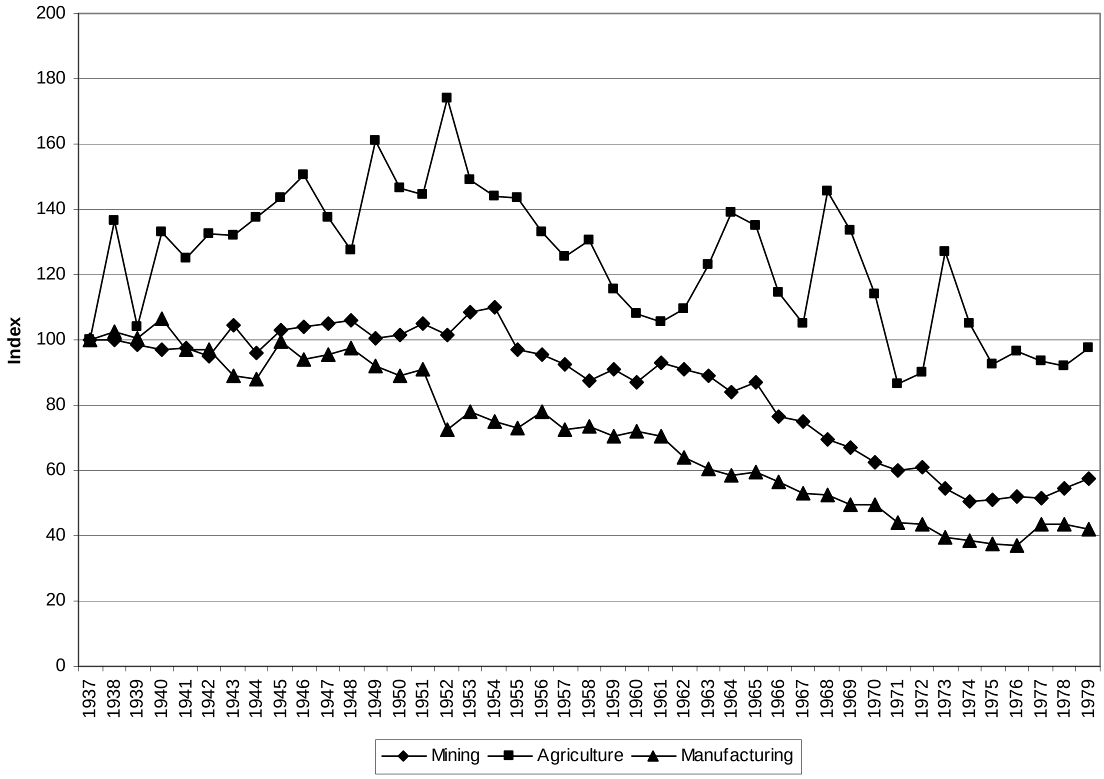

Figure 14: Rail transport as percentage of transportable GDP (indexed 1937=100)

The flattening of manufacturing "market share" is clearly evident, as is the peak that Jones refers to, i.e. the relationship and correlation between performance data and market share by proxy, seems to be in place. Jones discusses the rate problem in detail: (i) in terms of price elasticity, the railways' assumption that high-value cargo is price-inelastic and the subsequent cross-subsidisation phenomenon, which was by then clearly installed; and (ii) in terms of the difficulty of the railways to continue defending this position during the 1970s.[202]

Jones makes no specific attempt to measure market share, but quotes Van der Veer's[203] market share figures and states that it is a "crude indicator" and that "market share figures are notoriously difficult to obtain". At least by now the principle of integrated and inter-modal planning as a necessity has been confirmed and has the fact that information is an important prerequisite to make it work.

[202] Jones, 1999, p. 183-184.
[203] Van der Veer, 1982, pp. 19-26.

Van der Veer compares 1972 to 1981 and reports the following market share figures (Table 13):

	Rail	Road for reward	Road ancillary
1972	61%	4%	35%
1981	51%	12%	37%

Table 13: Van der Veer's market share figures of 1981

Van der Veer's figures include pipelines in road for reward, but because this figure is known, as is rail tonnages, a complete picture (which he didn't draw), comparing his figures with those of Verburgh can be calculated (Table 14).

	Million Tons			
	Rail	**Road for reward**	**Road ancillary**	**Total**
1957 – Verburgh	75	67	113	255
1972 – Van der Veer	102	7	59	167
1981 – Van der Veer	176	41	128	345

Table 14: Comparison of Van der Veer's 1981 figures with those of Verburgh

Jones warns that Van der Veer's data should be interpreted with great caution, but they are the best that he could find. Van der Veer's calculations are unknown, but the emerging problem according to Jones is quite clear, i.e. that intermodal planning is important (to solve the tariff issue) and that reliable data do not exist.

By the beginning of the 1980s the cross-subsidisation issue and the tariffing process became rather ridiculous and a self-fulfilling disaster, as the age of logistics and total cost of ownership approached. Kennedy quotes a road transport board official who maintains that:

> ...if a company needs road transport to stay in business, it is a marginal firm and probably should not be in business anyway.[204]

He continues to cite another event where:

> ...an applicant at another board who justified his application with 170 pages of railway documentation showing erratic transit times and substantiated damage claims paid by the railway. It was also shown that the actual loss incurred as a result of the frequent damage to the commodity was twice the amount paid by the railways in claims. Using this evidence, the applicant showed that by using the railway, his profit margin on his product fell from 56 cents to 6 cents per unit.[205]

He got a permit.

By now cross-subsidisation became untenable, as service standards of the railways fell behind at the same time that the road mode increasingly became a viable option. This clearly caused a road vs. rail debate rather than a road and rail debate, especially as a result of the absence of research and strategy.

4.4.4 Hamilton's first study

In 1983 Hamilton repeats Verburgh's methodology in response to a request from the South African Transport Services (who were then the operator of South Africa's railway) organisation. He states that the survey is needed for planning and that a geographical distribution of the results will also be attempted, as well as commodity and route descriptions.[206] Two other important aspects about Hamilton's survey approach and mandate need to be mentioned:

- The Road Freight Association, which initially promised co-operation, withdrew their support;

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[204] Kennedy, 1982, p. 19.
[205] Kennedy, 1982, p. 19-20.
[206] Hamilton, 1983, p. 1-2.

- Hamilton questions the validity of the Central Statistical Services' list of professional hauliers – an important consideration for later developments.

Both these incidents led to a low response rate for his survey.[207]

Hamilton's survey is once again a supply-side survey of road hauliers and ancillary hauliers in South Africa. He considers South Africa's commercial vehicle population and professional haulier addresses as retrieved from the Central Statistical Service, and the addresses of ancillary transport users as received from various sources. It is important to note that the addresses were stratified and that no stratification based on certificates, i.e. the more detailed stratification data available based on exemption certificates issued to road hauliers, (which proved to be differentiated and therefore important), was done.

By the time that Hamilton completed his survey he realised that his sample was too small and erratic to distinguish between road for reward and ancillary transport. He therefore assumes his figure as a total figure and determines ancillary transport by subtracting the Central Statistical Services' figure (supposed to be the transport for reward figure) from his total figure. The net result of this was that Hamilton never reported on commodity or route distribution, and that his usage of the Central Statistical Services' information to determine ancillary transport figures is highly suspect. The summarised results were startling (when compared to Verburgh's 1957 survey and Smith's 1971 survey – refer Table 15.

[207] Hamilton, 1983, p. 4-5.

	Million Tons				Million Ton-kilometers			
	Rail	Road for reward	Road ancillary	Total	Rail	Road for reward	Road ancillary	Total
Verburgh - 1957	75	67	113	255	32 000	1 955	1 960	35 915
Smith – 1971	100	245	279	624	53 000	7 850	6 387	67 237
Hamilton - 1981	185	239	2 204	2 628	98 406	27 515	136 007	261 928

Table 15: Hamilton's modal market share figures compared to Verburgh and Smith

Since Hamilton's data are suspect, it was decided to analyse his findings in more detail, in order to learn from possible problematic issues in his approach.

Hamilton provides a breakdown of fleet sizes, number of vehicles per fleet size per category, tonnage for November 1981 (the month in which the sample was surveyed), carrying capacities per vehicle group in each fleet size and average transport distance per vehicle group in each fleet size (Table 16).[208]

Fleet size	Trips per day	Average trip length
1	7	25
2-10	16	67
11-20	5	110
21+	12	73

Table 16: Fleet performance calculations based on Hamilton's 1981 data

From these data vehicle performance data per fleet size could be calculated. It is inconceivable in 1981 that this level of productivity could be achieved, i.e. that a vehicle can be loaded and off-loaded 16 times per day (i.e. 32 load handlings) and travel 67 km between each loading. As in Smith's study of 1971, Hamilton provides little interpretation of his results, especially in the

[208] Hamilton, 1983, fleet sizes (p. 32), number of vehicles per fleet size per category (p. 26-31), tonnage for November 1981 (p. 37), carrying capacities per vehicle group in each fleet size (pp. 26-32).

macro-economic sense, but urges policy makers to improve information gathering.[209]

In the last decade of what could be described as the development of a market economy, between 1980 and 1990, quite a few changes occurred in South Africa.

The new General Manager of the South African Railways and Harbours, Bart Grové, a transport economist, took over from Kobus Laubscher (a mechanical engineer). Grové promised to change the organisation into a market-driven business. One of the key initial steps was to change its name to South African Transport Services to ensure the inclusion of all modes in this new market-driven vision. The key objective for the railway specifically was to prepare it for competition.

Kuhn's overview provides an overview of the work of the National Institute for Transport and Road Research at the CSIR, and discusses new government priorities that require the transport system to be better utilised.[210] Kennedy did a detailed analysis of road and rail costs in 1984 and highlights the two reasons for road transport regulation, i.e. to protect the railway's traffic base and delay the deterioration of the road network.[211] He highlights the fact that the railways had not been balancing their books during preceding years (due to cross-subsidisation within rail and from other modes within Transport Services). According to him, the transport system was therefore not working. He suggested that road levies charged at true usage costs will protect the road system.[212]

Kennedy's work is extensive, but does not consider externalities and makes an interesting comment on the resultant traffic loss of the railways (if full deregulation is implemented and full costs are charged to both the railways

[209] Hamilton, 1983, p. 22.
[210] Kuhn, 1983, p. 201.
[211] Kennedy, 1984, p. 57.
[212] Kennedy, 1984, p. 57-58.

and road). The comment refers to the loss of income of the railways and the resultant effect on the railways' cost base:

> A very short time after such traffic losses, several days or weeks, there will be likely to be very little cost reduction, apart from reduced energy usage and damage inflicted upon the track structure. After several months, if the traffic reductions are significant on certain routes, the scheduling of trains, assignment of motive power and the organisation of yard and station forces can be adjusted to meet the new traffic levels.[213]

Kennedy ignores the fact that most rail costs are fixed over the long term (they are sunken to some extent) and that all railways require high densities for them to be successful. He does not consider intermodality and future freight levels that could possibly change the income structure of a railway over dense long-haul corridors.

4.4.5 Hamilton's second study

In 1985 Hamilton repeated his study of 1981, once again for the sole purpose of defining the extent of the road haulage industry. He admits shortcomings in the 1981 study, which he attempts to overcome. His objective is again to determine origin/destination data by commodity, as well as the modal structure of all surface freight in South Africa (except finally consumed product).[214] Hamilton mentions in passing why some of the conclusions of the 1981 survey were suspect, i.e.:

- That fleet sizes were used as a sampling unit rather than vehicles, and that the number of operators per fleet size was difficult to establish;
- That vehicles with a gross mass of less than 5 ton are often registered as utility vehicles or in the name of private persons or other non-

[213] Kennedy, 1984, p. 100.
[214] Hamilton, 1986, p. 1. (Hamilton defines public road transport as a transport operator who possesses a motor transport certificate and whose main activity is transport for reward, and ancillary road transport as a business institution trading for profit but who transports his own goods not for reward.)

transport bodies such as municipalities, statutory bodies, vehicle dealers, etc. (i.e. part of transport of finally consumed produce or for other purposes).[215]

Hamilton's approach is once again to survey road for reward and ancillary operators with a questionnaire, which means that the basic supply-side approach did not change from Verburgh, Smith and his own first study. He achieves a high response rate of 13.5% (due to a shorter questionnaire and follow-up interviews), but this response rate represents only 113 satisfactorily completed questionnaires.[216]

Hamilton's survey indicates the following modal market share results (compared to Verburgh, Smith and his own first study - Table 17).

	Million Tons				**Million Ton-kilometers**			
	Rail	**Road for reward**	**Road ancillary**	**Total**	**Rail**	**Road for reward**	**Road ancillary**	**Total**
Verburgh – 1957	75	67	113	255	32 000	1 955	1 960	35 915
Smith – 1971	100	245	279	624	53 000	7 850	6 387	67 237
Hamilton – 1981	185	239	2 204	2 628	98 406	27 515	136 007	261 928
Hamilton – 1985	170	263	241	674	91 861	31 297	14 219	137 377

Table 17: Modal market share in 1985 (Hamilton)[217]

The modal market share in tons can also be expressed in percentage terms (refer to Table 18).

[215] Hamilton, 1986, p. 3-4.
[216] Hamilton, 1986, p. 7.
[217] Hamilton splits tons between road for reward and road ancillary, but not ton-kilometers. Based on previous studies' split between the ATD of these two categories, a rough estimate of the ton-kilometer split was possible.

	Tons – (% market share)				Ton-kilometers – (% market share)			
	Rail	**Road for reward**	**Road ancillary**	**Total**	**Rail**	**Road for reward**	**Road ancillary**	**Total**
Verburgh – 1957	29	26	44	100	89	5	5	100
Smith – 1971	16	39	45	100	79	12	9	100
Hamilton – 1981	7	9	84	100	38	11	52	100
Hamilton – 1985	25	39	36	100	67	23	10	100

Table 18: Hamilton's modal market share % of 1985

From the available data, average transport distances can also be calculated (Table 19).

	ATD – km		
	Rail	**Road for reward**	**Road ancillary**
Verburgh – 1957	427	29	17
Smith – 1971	530	32	23
Hamilton – 1981	532	115	62
Hamilton – 1985	540	119	59

Table 19: Hamilton's average transport distance per mode

The results of the 1985 study seem to indicate an arrest of the deterioration of the railways' performance, apparently confirmed by an improvement in market share. However, if the approximately 40 to 50 million tons transported on the export lines at this stage (the export lines had begun functioning since the 1971 survey) is taken into account, as well as the natural growth in other mining commodities, this is not the case and rail market share remained flat at best. In fact, at this stage the original Verburgh data sets of 1958 (Figure 14) could be considered again and extrapolated up to 1985 to get a better picture of market share by proxy for the three transportable economic sectors (Figure 15).

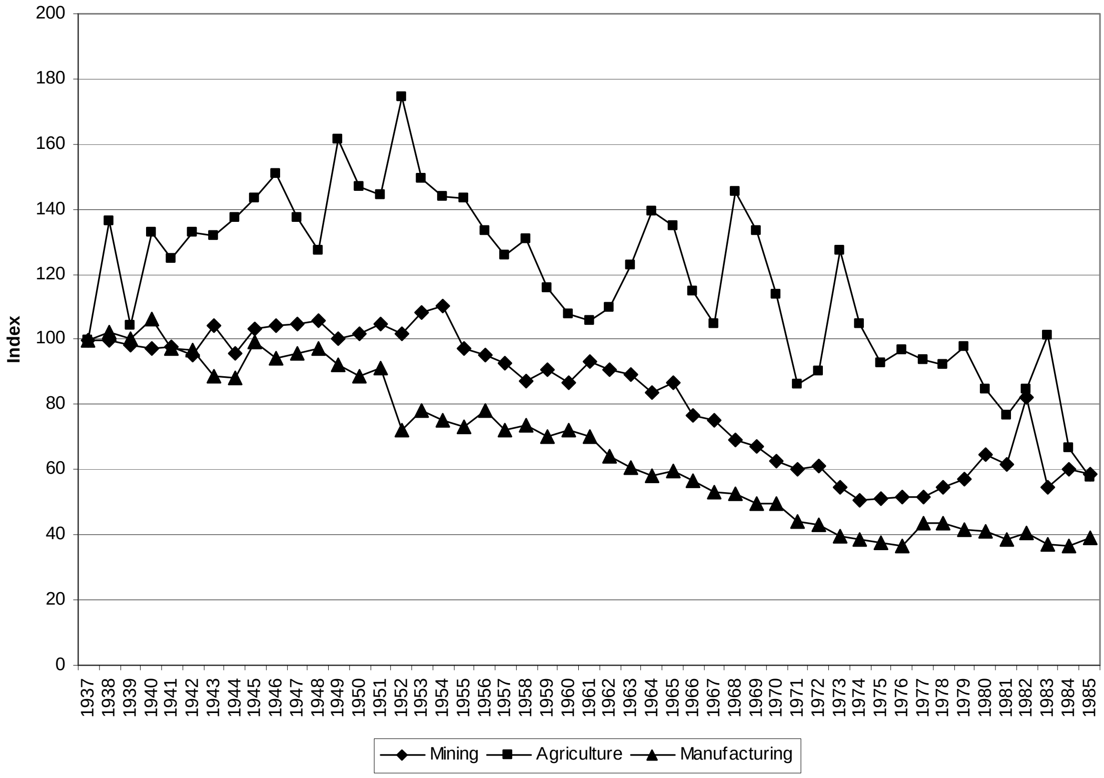

Figure 15: Extrapolation of Verburgh's original 1957 data sets (indexed 1937=100)

These figures do point towards a flattening of the downward trend of rail performance since 1957 during the 1970s and early 1980s, and therefore seem to correspond well with Verburgh's, Smith's and Hamilton's second data sets.

If Hamilton's first study is ignored and the second study accepted, initial performance calculations are possible (Table 20).

Year	GDP per ton	GDP per ton-km	ATD
1957	R659	R4.68	141
1971	R542	R5.03	108
1985	R717	R3.52	204

Table 20: Economic performance related to transport input

The trend from 1957 to 1971 is now exactly reversed from 1971 to 1985. GDP per ton improved, but deteriorated per ton-kilometer. This is attributable to the building and commissioning of mass low-value export systems, which are ton-kilometer "hungry", but produce low relative income.

Once again Hamilton makes no strategic deductions from his survey or offers any strategic infrastructure suggestions. He does ask for the co-operation of associations such as the Public Carriers Association and Association for Private Transport Owners, which was once again lacking during the research.[218] In spite of this he believes that the study will now be repeated often.[219]

As the world was changing at the end of the 1980s from the bi-polarity of two superpowers and the Cold War between them into a more "open village", systems changed into collaborative and integrated electronic communities. South Africa experienced multiple changes in society and the market economy slowly changed into a market, channel and cluster economy. Many economic clusters (such as grain, fruit, wine and transport) were preparing for deregulation, government businesses (such as Sasol, Iscor and the S. A. Transport Services) for privatisation, and the economy as a whole for globalisation.

At this time the transport sector had little understanding of where it fitted into this picture. Research was scant, unformalised, not trusted and poorly managed from a central point (different, for instance, from that of the clusters such as mining, fruit, chemicals and fuel). Researchers provided little strategic context for their work and hardly ever showed how it should be applied and what role it should play in planning. It was accepted practice to some extent that the researcher should be distant from application and context, but this only works if central planning is effective. Transport was poorly managed in South Africa from a central point of view and this affected all aspects of the management cycle. Research, claimed by all researchers to be important, therefore had to show for itself why it mattered - and it was not able to.

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[218] Hamilton, 1986, p. 28.
[219] Hamilton, 1986, p. 28.

Smith talks about freight transport in 1980:

> The conveyance of goods is not a subject that is receiving much public attention in the Republic…..In the Republic research has revealed that heavy vehicle movement problems are largely in urban areas.[220]

He doesn't specify the research that he refers to, but the absence of real guidance for macro-planning from proper research is clearly evident. The densification of corridors, problems with high-rated traffic and a huge outcry for exemption certificates from road users, if not total deregulation, was taking place and it is hardly conceivable why it did not lead to a more critical view of the total freight transport system, except for the fact that the research society itself did not sound any alarm bells.

4.5 Integrated trading platforms during the establishment of electronic communities

4.5.1 Introduction

Banfield "announces" this era of electronic integration with a statement about transformation in strategic supply management:

> Fundamental change – nothing short of transformation – has occurred. The result of this transformation is a new way of doing business. Collaboration is the key behaviour change.[221]

The customer-centric behaviour of the market era never changed, though. More than ever customers were important, but the benefit of collaboration was cost cutting, often achieved through supply-chain streamlining as internal process views took root, redundant work was eliminated and different organisations within the supply chain gained clarity about their roles.[222]

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[220] Smith, 1980, p. 10.
[221] Banfield, 1999, p. 4.
[222] Banfield, 1999, p. 13.

A core driver is the information revolution. New communication technologies impact on logistical improvements to the same degree as the microprocessor did a few decades ago.[223] Bar-coding, electronic data interchanges and tracking and tracing technologies provide opportunities for process integration which remains the “one aspect of logistics that continues to improve.”[224]

In this era most industries rely on information technology as a core driver of change, but these industries also have other core drivers unique to each industry to drive intra-industry (cluster) behavioural changes. In transport logistics the global era of containerisation and intermodality has arrived as the tool for collaboration in higher value and seamless logistics. Containerisation revolutionised freight during the preceding decades,[225] but it came into full global play in this era and was shown to have cost advantages in all aspects of intermodalism.[226]

This improvement from secrecy and cut-throat competition to collaboration presented opportunities for an improved transport interface not only between marine and overland modes, but also between overland modes.[227]

In the 1980s Coyle et al. described how “intermodal or multimodal transportation has been long hailed as offering significant potential to improve transportation services with lower cost.”[228] They do, however, refer to “potential that wasn’t attained though”; they attribute the problem to regulation and emphasise how this failure to achieve efficiencies through intermodal transport was beginning to “change vastly” with deregulation. They predicted that the “time was ripe for significant growth in intermodal traffic” and that the “environment was right for intermodal advances.”[229]

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[223] Bowersox and Closs, 1996, p. 16.
[224] Bowersox and Closs, 1996, p. 16.
[225] Baluch, 2005, p. 127.
[226] Kuo, 1987, pp. 86-89.
[227] Jorgensen, 1999, p. 1.
[228] Coyle et al., 1986, p. 493.
[229] Coyle et al., 1986, p. 494.

Globally freight developed around intermodality, regional logistics hubs and integrated road, rail and sea movements. Intermodality in domestic transport, such as in Europe, meant accompanied and unaccompanied[230] combined transport movements[231] that contributed to seamless collaboration, decongestion and cost efficiency in the networks.

Globally the information era also revolutionised research in all aspects of transport logistics. In North America a special agency was created that reported to the President and Congress annually on modal market share, intermodal developments and infrastructural requirements. Research in Europe reached levels where the European Commission was able to understand the exact trade-off between the levels of congestion and rail subsidies in Europe. Nelldal et al. propose that Europe should consider even shorter distance intermodality:

> In the US the concept of large-scale systems is well-developed – long trains carrying Double-Stack Containers, i.e. two container layers on each wagon. This is working well with large traffic volumes over long distances, in fact very much like a container ship ashore! As to Sweden and other parts of the European continent, it should therefore be of interest to have alternative concepts also, working jointly with trucking over shorter distances and offering an increased number of destinations, where the major markets are.
>
> By means of "liner train traffic", meaning that the train makes a number of intermediate stops under way, a larger market share may be achieved. This requires simple terminals situated at train sidings with both ends connected to the main line, so that the train will not have to be shunted. An example of this is the "Light Combi" system employed in Sweden. A fork lift truck is carried in each train, and this is operated

[230] Intermodal transport is mostly referred to in Europe as combined transport and categorised as either accompanied (when drivers accompany their trucks that were loaded on a rolling highway train – "Rollende Landstrasse") or unaccompanied (when containers, trailers or swap bodies are lifted on trains and therefore disconnected from truck tractors).

[231] Baluch, 2005, p. 130.

by the loco driver himself, who loads and unloads the swap bodies. “Light Combi” is in fact used for sending consumer goods – a market that was lost by most railways long ago.

The “Light Combi” concept may be competitive within the 300 to 400 km range, while traditional intermodal concepts often require twice that distance. Note that “Light Combi” may be the answer to two different needs – satisfying smaller traffic flows over short and medium-length hauls, or being a feeder to heavy-haul intermodal traffic. By adopting “Light Combi”, traditional intermodal services may be concentrated to large terminals only, improving their profitability.[232]

In South Africa progress is painfully slow in terms of intermodality. During the 1990s no direction was given and no research developed on which to base a change in policy.

> The current policies are not effective for a variety of reasons including previous distortions in the policy formulation process, in that modes were considered in isolation. Ineffective implementation of policy, and political and sectional pressure, all led to a lack of a holistic, sustainable, multimodal transportation policy.[233]

The railway is considering change and many business cases for intermodal options are considered, but all eventually rejected. Only the maritime container option remains, and domestic container movements are all but non-existent. By the end of the 1990s Parker interviewed Leo Petkoon, then the container terminal and operations General Manager of the railways:

> Petkoon said that by leaving road transport to its own devices, Spoornet had put its greatest emphasis on its own ability to provide mass transport of bulk loads and sensible economies of scale over long and even medium distances. ‘The ideal solution for many customers is an intermodal one, combining the benefits of road and

[232] Nelldal et al. 2000, p. 1.
[233] TMT Projects, 1995, p. 1.

> rail'. A harmonious relationship between the two modes is not only possible, but is in fact a 'match made in heaven'. It will be a positive step if national transport policy encourages this kind of relationship.[234]

In other words, the railways were waiting for national policy to indicate a way forward and support this development. Moving South Africa did address this issue, but a lack of research and government inertia meant that nothing was done. The Minister of Transport's intermodal cargo transfer policy discussion document of 2006 does little to provide the direction required and once again focuses on mode balancing rather than real intermodalism. The policy proposal merely requests that transporters "migrate, where possible, certain categories of cargo from road haulage back to rail haulage."[235]

In 1990 Pretorius referred to the Demand Modelling Work Group's (a sub-committee appointed by the National Transport Commission to study rural road needs) proposal, in 1982, to the effect that a national flow model be developed but that a shortage of funds meant that it was never done.[236]

4.5.2 Freight Transport Data Bank

Towards the late 1980s the Research Unit for Transport Economic and Physical Distribution Studies of the Rand Afrikaans University developed a database to fill the gap for "reliable information relating to the macro as well as the micro economic aspects of freight transport activities."[237] The report provides the first reference to "macro" issues; it is extensive, provides some forecasts and develops indicators. The samples on which the surveys were based were initially extensive – close to 40 000 in 1985, 1986 and 1987 – but were reduced (after "more knowledge about the composition of the population was obtained") to below 10 000 in 1988, 1989 and 1990.[238] The stratified

[234] Parker, 1999, p. 1.
[235] Transport Analysis Unit, 2006, p. 21.
[236] Pretorius, 1990, p. 20.
[237] Pretorius, 1991, p. 1.
[238] Pretorius, 1991, pp. A.1-A.7.

random sample considered population, gross geographical product and commercial vehicle population.[239]

The results of the work were extensive and added for the first time “Rental” transport (i.e. ancillary transport, but not with its own equipment) to the road modes. Two important transport performance parameters were unfortunately missing, i.e. ton-kilometers and origin-destination pairs. The results for tons on a macro level are shown in Table 21 (rental is excluded from this table as it was small and not comparable to other studies).

	Million Tons			
	Rail	**Road for reward**	**Road ancillary**	**Total**
1985	176	239	363	778
1986	131	220	412	763
1987	157	199	437	793
1988	187	168	414	769
1989	155	134	382	671
1990	164	131	353	648

Table 21: Pretorius' modal market share 1985-1990[240]

The only known data for this time period are rail tonnages and Pretorius depicts the sample’s response and then compares this with actual rail tonnages,[241] but never discusses the dissimilarities between the two data sets (which were quite extensive). It seems as if the deterioration in the sample size did not influence the reliability of the data too much as rail’s performance as reported by the sample undercounts rail’s actual performance by 12% on average. (Pretorius does not provide this analysis.) The difference is depicted in Table 22.

[239] Pretorius, 1991, p. A.2.
[240] Pretorius, 1991, Appendix 2, Table 2.1-2.8.
[241] Pretorius, 1991, p. 31.

	Rail – Pretorius (mt)	Rail – Actual (mt)	Difference (mt)	% Difference
1985	176	182	6	3
1986	131	178	47	26
1987	157	188	31	16
1988	187	187	0	0
1989	155	179	24	13
1990	164	184	20	11

Table 22: Undercounting of rail performance in Pretorius' sample

A comparison of Pretorius's work with all the previous market share work reported is provided in Table 23.

	Million Tons			
	Rail	**Road for reward**	**Road ancillary**	**Total**
Verburgh - 1957	75	67	113	255
Smith – 1971	100	245	279	624
Hamilton - 1981	185	239	2 204	2 628
Hamilton - 1985	170	263	241	674
Pretorius - 1985	176	239	363	778
Pretorius - 1986	131	220	412	763
Pretorius - 1987	157	199	437	793
Pretorius - 1988	187	168	414	769
Pretorius - 1989	155	134	382	671
Pretorius - 1990	164	131	353	648

Table 23: Modal market share from 1957 - 1990 based on all available sources

The data represent an interesting picture. If Hamilton's first survey is ignored (because of intrinsic problems identified by analysis and admitted by him), Pretorius's rail data are replaced with actual data, and if road transport data are "normalised" with the 12% undercounting observation for rail, the following picture emerges (Table 24).

	Million Tons			
	Rail	Road for reward	Road ancillary	Total
Verburgh - 1957	75	67	113	255
Smith - 1971	100	245	279	624
Hamilton - 1985	170	263	241	674
Pretorius - 1985	182	272	414	868
Pretorius - 1986	178	251	470	899
Pretorius - 1987	188	227	498	913
Pretorius - 1988	187	192	472	851
Pretorius - 1989	179	153	435	767
Pretorius - 1990	184	149	402	735

Table 24: Modal share - Hamilton's first study ignored and Pretorius' data normalised

The "split" between road for reward and road ancillary provides a good approximation of two thirds/one third which, together with propensity to outsource, could provide some indications for future studies. At best Pretorius's data could be quoted to say that on the eve of deregulation the economy required around 700 to 800 million tons of freight transport, with ancillary road accounting for about 50% of the share and road and rail each approximately 25%.

Pretorius's surveys continued for a few years and were then discontinued. Once again it is assumed that the lack of strategic context, lack of funding and lack of interest from the Department of Transport led to the survey's demise. The data sets and analysis that compare the history of surveying (as provided above) were never constructed. These data are also the last semi-reliable data that existed before the study in this dissertation was initiated. Another application of the data are to correlate the indicated transport volumes with physical production of the GDP, i.e. to try and determine an indicator for future reference. This indicator will then estimate the number of times that each ton of output of the economy is shipped (Table 25).

Year	Shipment frequency
1957	2.48
1971	2.45
1985	1.45
1985	1.86
1986	1.93
1987	1.96
1988	1.76
1989	1.57
1990	1.53

Table 25: Shipment frequency of the transportable GDP

4.5.3 Land freight transport statistical review

Statistics South Africa also produced a survey of road transport for reward, but this survey was discontinued in 2003. The purpose of the survey was to sample "private sector enterprises (firms) primarily engaged in the conveyance of goods for remuneration in South Africa."[242] The survey reported figures that were much higher than other available data and it was always in dispute. Closer analysis revealed that the sample was dated and reverted back to a time when a lot of transport for reward was carried out by bus companies and small operators, i.e. before the emergence of mega-carriers. The results were often based on returns from mega-carriers and then extrapolated to account for a number of smaller enterprises who couldn't or wouldn't respond, or no longer existed. This could account for higher than expected figures.

The surveys quote tonnages and gross income for road hauliers for various commodities. This makes it possible to calculate rand per ton for the last bulletin published in 2003 (Table 26).

[242] Statistics South Africa, 2003, p. 4.

	Tonnage '000	Income R000	Rand per ton
Livestock, fresh produce and crops	3 952	101 055	26
Mining and quarrying products	10 409	96 255	9
Food, beverages and tobacco products	2 619	144 821	55
Textiles, clothing and leather goods	1 206	15 692	13
Wood, products of wood and cork	1 367	40 735	30
Paper and paper products	810	27 834	34
Coke, petroleum, chemicals, rubber and plastic products	8 772	227 761	26
Non-metallic products	4 663	103 263	22
Basic metal products	932	28 917	31
Electrical machinery and electronics	2 734	52 768	19
Furniture	1 581	68 720	43
Parcels	4 567	326 574	72
Other goods	2 317	78 296	34
Total	**45 929**	**1 312 691**	**29**

Table 26: Commodity transport income for reward - Statistics South Africa 2003 data[243]

These figures are completely unlikely for any operator over any distance (the cheapest transport in South Africa, i.e. iron ore transport over the Sishen-Saldanha export machine, was already at this stage achieving more than R30 per ton). The review also reports the number of vehicles in operation (31 830) and kilometers travelled by all these vehicles, laden (128 262 000) and unladen (64 748). Ton-kilometers cannot be calculated, but to achieve the ton-kilometers reported by Hamilton in 1985, each vehicle had to travel 4 030 km per month laden and 2 034 km unladen, which is possible, but when laden each of the vehicles would have to carry an average of 21 tons all the time, which seems highly unlikely. This data was therefore obviously seen as flawed and Statistics South Africa discontinued the survey.

[243] Statistics South Africa, 2003, p. 13.

4.6 Globalised systems during the globally networked economy (2000-2020) and the expectations around global bio-engineering

As South Africa enters the globally networked economy, questions are being asked about the competitiveness of the country's economic system, the maintenance of its physical infrastructure and whether South Africa's transport network will support the country in these global challenges. Change is necessary not only to fix design inefficiencies and a backlog of economic infrastructure supply, but also to prepare for some switches to more sustainable forms of transport, but no data exist to inform a new strategy. This study aims to fill this gap.

In many countries in the first world the debate around global competitiveness has moved on, away from national priorities to global sustainability issues. This does not mean that measurement on a macro scale will become less important, but rather that the word "macro" will get a new global significance. As Kyoto, or at least the principles of Kyoto, become accepted (and everybody expects that they eventually will be accepted), nations will have to, rather than develop national competitive stances, adhere to national limiting norms. Emissions will be tracked and monitored, emissions trading will become the norm and the sustainability issues around wealth distribution and environmental damage will become more onerous and transparent.

The World Business Council for Sustainable Development admits that transport's functions are essential, but that:

> "...in performing these essential functions, mobility must not sacrifice other essential human or ecological values, today or in the future."[244]

The Council continues to report on seven goals for 2030, i.e.:

1. Reduced emissions;
2. Limited greenhouse gasses;
3. Reduced transport-related deaths and injuries;

[244] World Business Council for Sustainable Development, 2006.

4. Reduced transport-related noise;
5. Mitigated traffic congestion;
6. Narrowed mobility divides between rich and poor;
7. Improved mobility opportunities in developing societies.[245]

The Council also addresses freight mobility specifically in its extensive 2001 report and admits the necessity of freight mobility, although it consumes 43% of all transportation fuel.[246] It does, however, raise the same concerns about congestion, infrastructure, security, stability and sustainability that exist for transport in general. It also proposes three overarching strategies, i.e.:

1. Cleaner and more fuel-efficient trucks for urban areas;
2. Intermodal systems;
3. Modern heavy-haul rail corridors.[247]

Stigson highlights the core requirements for managing these goals and strategies, i.e. "informed and well researched descriptions of mobility" and "modelling challenges to measuring the gap between where we are, and where we want to be."[248]

South Africa's measurement backlog will become a real albatross around the country's neck as externalities that the country has absolutely no sense of at the moment will also be a consideration in all measurement. The worst problem of all is that the network configuration that the country develops today (not even based on proper intrinsic data) will be subjected to the sharp edge of both intrinsic and extrinsic factors in the next two to three decades. The next generation will therefore inherit the worst possible position, if something is not attempted right now.

[245] World Business Council for Sustainable Development, 2006.
[246] Sustainable Mobility Working Group, 2001, p. 6-1.
[247] Sustainable Mobility Working Group, 2001, p. 6-16.
[248] Stigson, 2004, p. 1.

4.7 Lessons learned

The history of freight transport measurement on a macro scale in South Africa may be chequered, but lessons can be learned to prepare for the future and define achievable research objectives. Looking at the history one of the greatest lessons is summarised well by Darwin, when he analyses the development of intellect and reasoning:

> Little is known about the functions of the brain, but we can perceive that as the intellectual powers become highly developed, the various parts of the brain must be connected by intricate channels of the freest intercommunication; and as a consequence each separate part would perhaps tend to be less well fitted to answer to particular sensations or associations in a definite and inherited – that is instinctive – manner. There seems even to exist some relation between a low degree of intelligence and a strong tendency to the formation of fixed, though not inherited habits, for as a sagacious physician remarked to me, persons who are slightly imbecile tend to act in everything by routine or habit; and they are rendered much happier if this is encouraged.[249]

The biggest mistake is therefore not to learn from history, but to keep repeating the same mistakes over and over again, and therefore regressing. To remain in the same place is not being static; it is falling backwards into a deep abyss of incompetence. The lessons learned should therefore be collected and understood to arrive at a set of guidelines, as discussed in the next chapter.

[249] Darwin, 1901, p. 103.

Chapter 5 - Research objectives and methodology

5.1 Introduction

An understanding of the history of modal market share research, the macro issues at hand and the role of the logistics discipline in resolving these issues indicate the way towards possible solutions for the continuous measurement of macro-logistics performance. Past research in this field, even if considering a narrowly defined field in logistics, has been scant and consistently non-performing. In addition, even if the field of research within logistics might seem small – and to some, even unimportant – significant questions are confronting the discipline at this specific point in South Africa's history. These questions include an understanding of current network design and its performance, future demand and where investment would be required, how performance in this regard will be measured and, finally, how the transition to sustainable technologies will be managed.

The fact that these answers are not readily available is an obvious shortcoming of the management and strategic planning around South Africa's transport and logistics infrastructure, but the academic management of the discipline should surely also take responsibility. All indications are there that these questions will continue to be asked in the future as global challenges of disparity between development and scarce resources, between rich and poor nations, and between global order and national objectives peak in the next two to three decades.

Any attempt to answer these questions should carefully consider the task and its challenges, and what might have caused past failures in this regard. Lessons from history usually contribute towards better solutions.

5.2 Problems identified in past research

Macro-economic transport and logistics measurement could at the very least be described as having a chequered history. It is important to summarise lessons from this history and, based on these observations, identify some objectives for future research in this regard.

5.2.1 Methodology

All past research (including the work by Statistics South Africa that was discontinued) utilised a questionnaire-based methodology. The approach is valid, but expensive, cumbersome and fraught with the dangers and difficulties caused by secrecy in the industry and unwillingness to co-operate. These difficulties can be mitigated by large sample sizes, personal interviews or even personal follow-ups of non-responses, but these interventions are time consuming. All research suffers from the trade-off between speed, cost and quality (Figure 16), and the methodology that could provide the most effective trade-off should be identified. The position (identified as "poor" in the diagram), where research is expensive, slow and of low quality, is probably an exception (especially if the researcher is effective and efficient). At the same time achieving the cost-effective, fast and high-quality position could be difficult. It is important, however, for the researcher to understand this position, especially in areas such as macro-logistics measurement, where funding is difficult to obtain.

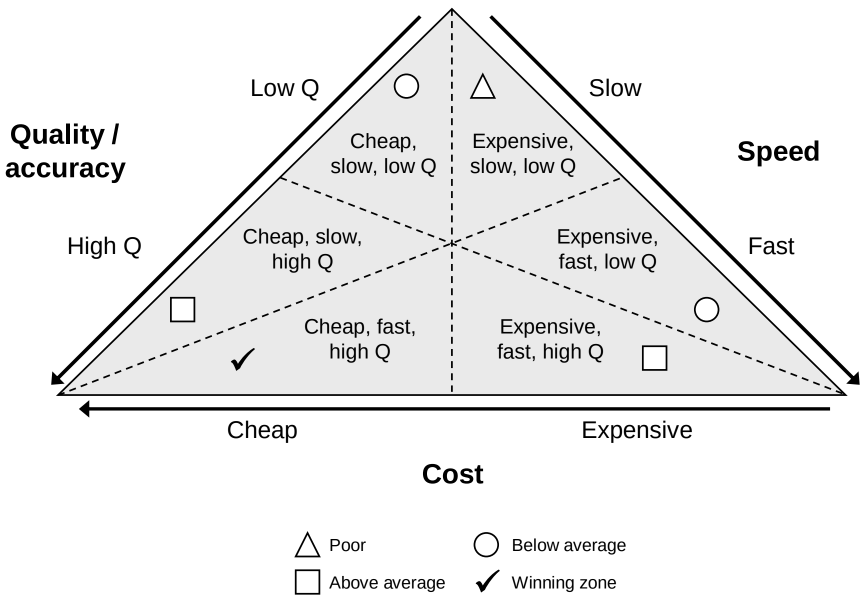


Figure 16: Research trade-offs[250]

5.2.2 Repeatability

Measurement should be repeated annually and with the same methodology. In the absence of repeat data, the data itself falls into disuse. The Verburgh, Smith and Hamilton studies provided a continuum to some extent, but over too many years. It is also virtually impossible to maintain methodology in the exact same state over so many years (1957–1985), which made comparisons between the surveys difficult. In this regard the Pretorius surveys between 1985 and 1993 did achieve repeatability to some extent and were used widely at that time, but also failed eventually because of other problems.

5.2.3 Scope

The scope of the surveys changed between surveys and addressed macro-economic issues in different fashions. All the surveys included questions on many variables which probably contributed to the fact that many were not completed. It would be advisable, under these circumstances, to concentrate on what is important and endeavour to resolve these important issues

[250] Havenga and Hobbs, 2004, p. 55.

effectively, rather than to include questions on areas that simply can't be answered or are not so important.

Outsourcing, for instance, is a difficult phenomenon to measure and understand. The outsourcing of an activity does not remove the specific activity, but rather just the management of, or responsibility for, the activity. If Sasol, as happened recently, outsources X percentage of their workforce, does it mean that X percent less people are needed to deliver the output that the business usually produces? If total output were Y, does it mean that productivity improved by X/Y? In the same sense the outsourcing of transportation services does not impact on the number of ton-kilometers required in the economy directly, but it could improve their performance, which is an entirely different issue.

5.2.4 Context

The Verburgh survey was the only survey that provided a strong context and *raison d'etre* for its existence. The state of transport planning in South Africa, the relative weakness of the Department of Transport (compared, for instance, to the vigour with which fiscal policy and its effect are measured and delivered by the treasury, and how monetary policy and its effect are measured and delivered by the Reserve Bank) and the absence of research make it impossible for researchers to adopt an "ivory tower" approach. Research is worthless if not used and should be undertaken only to either improve the discipline or lead to better decision making. Research as such is a processing function, which is informed by vision or "sense" and in turn should inform vision in order to make decisions. These decisions should in turn always lead to the resourcing and communication of the decision (Figure 17).

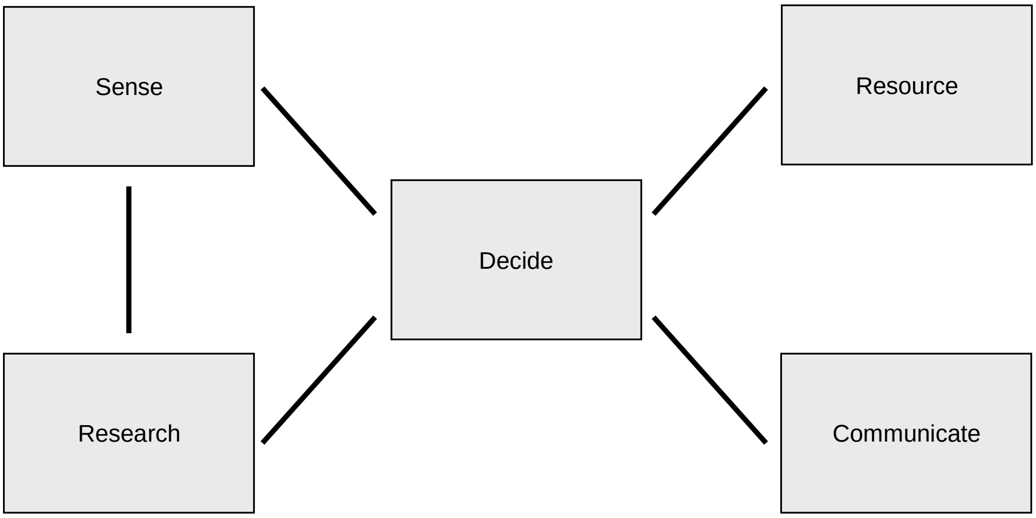


Figure 17: The role of decision making in the strategic process[251]

Without understanding the context and application of research, this loop is broken and the research will fall into disuse.

In addition, by failing to contextualise research within other economic data, a research "island" is created. Users find it difficult to relate the use and interpretation of the data with other constructs in the economy and this causes disuse and also poor funding of research.

5.2.5 Micro-economic detail

All research requires accuracy and quality effort from the researchers, and modellers strive to develop models that depict and predict reality as closely as possible. It is a fact, however, that many macro-economic models are approximations and cannot achieve the same level of accuracy as is possible in the micro-economic field. It is important to make a distinction between absolute accuracy (which is unfortunately always impossible in the macro-economy) and consistency of assumptions. Some research work (not necessarily the four studies discussed in more detail in this dissertation[252]) which attempts industry-level understanding of the state of logistics often

[251] Havenga and Hobbs, 2004, p. 58.
[252] Verburgh, 1957; Smith, 1971; Hamilton, 1981 and 1985; Pretorius, 1985 to 1990.

suffer from the researchers' unwillingness to engage in the macro-economic side of the research for the reasons mentioned above. Industry-level studies are therefore often incomplete and lack a holistic view of the industry.

Even in the micro-economy on business level the "industry architects" (firms that distinguish themselves as leaders) will know the size, drivers, constructs, volumes and forecasts for their industries, and will manage their businesses in the light of this knowledge. The logistics industry within a nation should, at least, together with its distinct capability to model macro-logistics provide the macro answers, even if these are not 100% correct.

5.2.6 Systemic relationships

Logistics forms a systemic relationship with other parts of a firm and value chain in the business and industry context. It is a process-orientated discipline that targets least total cost through trade-offs between all the functions involved in solving time and place disparity, contingent on specific customer service levels for maximum competitive advantage.

In order to do this, intra-systemic relationships between functions such as transportation, distribution and materials management exist, but also inter-systemic relationships between functions such as logistics, marketing, manufacturing and finance. These relationships are always considered in micro research and should always be considered in macro research, albeit on a higher level. This means that macro research should inform questions such as the link between a nation's logistics facilities (e.g. ports, roads, railways and transhipment hubs), production facilities, spatial organisation and manufacturing practices, as well as the cost trade-offs in decision making around these constructs.

Previous research seemed to have concentrated on only one isolated aspect of macro-logistics (Verburgh's study is a possible exception) and failed to deliver on these systemic relationships.

5.2.7 Global links and benchmarking

Some macro-economic intelligence on logistics systems is emerging globally. This creates opportunities for benchmarking as well as incorporating the theoretical part of South Africa's macro-logistics systems into a more global relationship. The size of the global logistics marketplace, its future and its structure are becoming more and more known as some researchers reveal total tonnage, ton-kilometers, GDP and global growth. It therefore becomes possible to measure a nation's performance and productivity in this regard.

5.2.8 Memories of the future

Research must lead to a view of the future. Forecasting is a core and critical component of economics and it is expected of macro-economists to have a view of the future in order to make it possible for monetary authorities, industry and large business planners to prepare for future events. In-depth forecasting should also be scenario-based (Figure 18) and describe the underlying assumptions of each scenario.

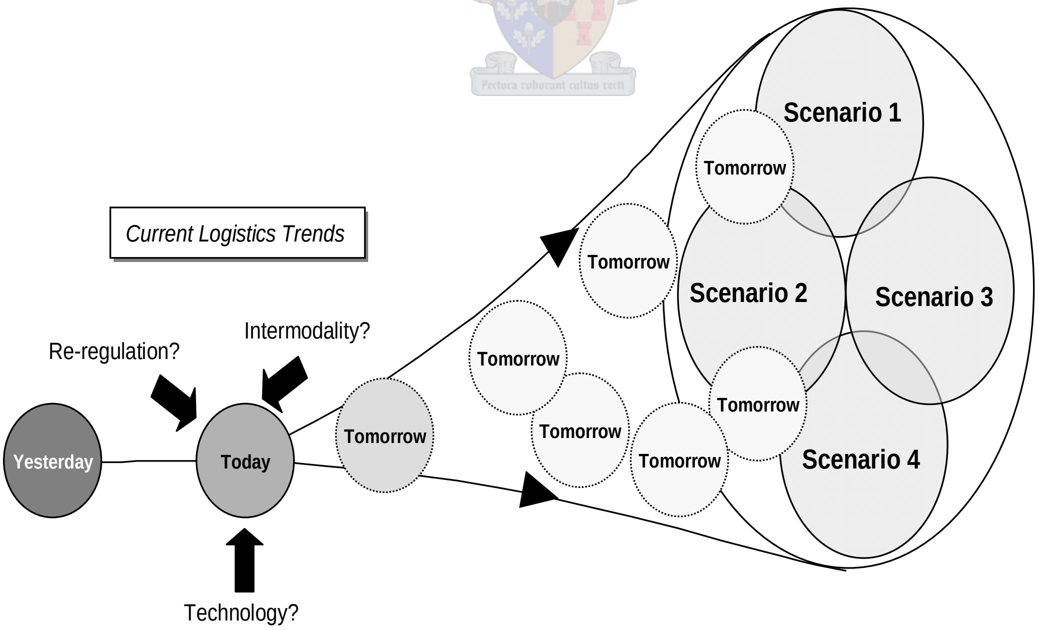


Figure 18: Scenarios of the future[253]

[253] Havenga and Hobbs, 2004, p. 86.

5.2.9 Scalability

Qualitative discussions are important, but in the final instance measurement by numbers is required. Scalability is the ability to access large datasets, in terms of either the number or the dimension of individual data elements, and the ability to grow the data in various directions as the field of research grows, without losing the core relationships within the data. This means, for instance, that if the ton-kilometers on a specific corridor is understood, it should also relate to ton-kilometers on other corridors, to the metropolitan areas where it originates and ends, to the total ton-kilometers in a region and even to the ton-kilometers in the world. It is an expansive rather than reductionist approach.

5.3 Overarching methodology

The overarching methodological approach of this dissertation is therefore to describe the constructs of logistics, and especially transport, in South Africa and scale it in order to understand current and future demand. This requires a view of what is produced and consumed (by weight), how it is moved (modal market share), where it is moved (typologies) and what is moved (commodities). This raises the question that, if economists can value the economy, why can macro-logisticians not weigh it. If economists can report on national, regional and district economic performance, why can logisticians not report on spatial performance such as corridors and hubs? Ultimately these aspects should be measured in terms of relative performance in, and contribution to, the economy as well as forecasted into the future to enable planning and investment.

Economists often use models to develop these answers and the approach in this dissertation will also be modelling, enhanced with desktop research in certain cases. The models must be repeatable annually, based on the same assumptions, relate to the other aspects of the macro-economy, create forecasts and enable global comparisons. With these objectives in mind the actual model development can be discussed.

Chapter 6 - National freight flow model

6.1 Introduction and background

The first objective of the overarching methodology is to achieve a valid and repeatable picture of modal market share in South Africa. The Verburgh, Smith, Hamilton and Pretorius research projects all attempted to arrive at some approximation of modal market share and size, but achieved this objective with varying degrees of success. The work was, however, not repeatable on an annual basis. It is hypothesised that this is because of the huge effort required to do the research but that the results never produced what the researchers tried to achieve. The fact that the work was never repeated therefore also meant that it couldn't be used for planning purposes nor for measuring economic performance on a consistent basis. Their attempts to measure traffic flows with some approximation of origin and destination points all failed.

The objective of the national freight flow model is therefore to fill this gap and provide the first repeatable observations on modal market share and freight flows in South Africa. It is believed that this work could easily be repeated annually and therefore used for infrastructure policy decisions, planning, and as a lead and lag indicator of the performance of the network.

6.2 The structure of the national freight flow model

The national freight flow model utilises the South African National Roads Agency's (SANRAL) Traffic Count Yearbooks compiled by Mikros Traffic Monitoring, as well as actual freight flow data obtained from Spoornet, as basis to develop a current and historical view of freight traffic flows in South Africa.

6.2.1 Rail freight flows

The rail freight data obtained by previous researchers were one-dimensional, i.e. they reported only volumes shipped and not rail traffic flows between origins and destinations. As traffic flows can be developed from Spoornet's data, this will be the first step in the process. Once road freight flows have been determined, a matching between the two data sets will have to be achieved.

6.2.2 Road freight flows

Comprehensive traffic observations started in South Africa in 1984, when a pilot study was conducted on the 600 km N3 route between Johannesburg and Durban. As a result of the success of this study the National Transport Commission (now SANRAL) decided in June 1985 to expand the Traffic Counting Network to traffic counting stations.[254]

SANRAL now repeats this work annually and a reasonable degree of stability in the work process has been achieved since the 1990s. The main objective of SANRAL's efforts is not to develop freight flows, but to understand congestion points and enable planning in terms of all vehicular flows in South Africa (of which heavy vehicles are only a subset). No attempt has ever been made to use the information for freight flow purposes and a reasonable amount of modelling of the available data are therefore necessary.

The SANRAL Traffic Counting Yearbook is a compendium of traffic information obtained at traffic counting stations on primary roads, 255 highlighting the latest available traffic characteristics. A station is an installation on a road which enables the collection of data; both permanent and secondary stations are utilised. A permanent station is one where continuous traffic observations are made. A secondary station is one where traffic observations are made on a sampling basis for at least 168 consecutive

[254] Mikros, 2006, p. iv.
[255] Primary roads refer to all declared national roads and to other roads of strategic or economic importance (Mikros, 2006, p. i).

hours per annum. The Yearbook contains information on 398 permanent stations and 430 secondary stations. The stations are placed on selected links of the national and primary road network and yield information such as Average Daily Traffic and Average Daily Truck Traffic.[256]

The sampling base for the model therefore compares well with previous work, where questions were asked from a small sample of actual hauliers, but often for just a short period of time. The traffic counts for permanent stations are continuous, while for a secondary station the counts are made on a sample basis for at least 168 hours, which compares well with the previous sample studies, where data for only one week were collected. The counting station data are also automated and therefore far less prone to human error as would be the case in a sampling framework where a human response is required. The data are also available annually, which means that a validated model would be easily repeatable and would be more permanent and stable as a base, provided that a link between the traffic counts and freight volumes could be found.

6.3 Calculation of road tonnages

The number of counting stations per year analysed in this dissertation is shown in Table 27.

Year	Number of stations
1990	346
1993	368
1997	239
2003	626
2004	583
2005	521

Table 27: Number of CTO stations per year analysed

[256] Mikros, 2006, pp. i-ii.

The data from all these counting stations were obtained from SANRAL and captured in an Excel database. SANRAL unfortunately does not provide computerised data sets in a usable Excel format. It is a secondary objective of this work, if successful, to negotiate the electronic provision of data from SANRAL to facilitate the repetition of this work through limiting opportunities for human error and also fast-tracking data capturing.

The modelling approach followed to calculate road tonnage from traffic observations is described below.

- SANRAL allocates counting stations to specific routes across the country e.g. N1, R30, etc. in a geographical order, e.g. on the N1 stations start in Cape Town and end in Beitbridge.
- The average daily truck traffic (ADTT) (i.e. number of trucks) and the percentage split of these trucks between short, medium and long trucks (SMLT) are captured per counting station per route from SANRAL data. The SANRAL counting methodology enabled the counting monitors at the stations to distinguish between trucks and passenger vehicles by the length of the vehicle. The trucks can then also be categorised further in terms of axles. This provides a good approximation of vehicle type, especially compared to the uncertainty in Hamilton's work in this regard on what should be included as a true freight vehicle and what not. Hamilton decided in his second survey to exclude all trucks of five tons and smaller, as these were, according to his qualitative research, mostly in the hands of final consumers and mostly not used for freight and ancillary freight transport. SANRAL's split excludes only the very small vehicles in this base, but it is assumed that only the very small vehicles actually conform to Hamilton's assumption. Vehicles from four tons and higher could therefore be included in the research.
    - ADTT is the total number of trucks observed in each direction during the actual period monitored divided by the total number of hours monitored multiplied by twenty-four.
    - SMLT truck split percentage is the percentage of trucks in each direction which fall into each of the following categories:

    - A short truck is typically a rigid-chassis two-axle vehicle designed for transport of goods, or a bus with at least one axle with four wheels;
    - A medium truck is typically a truck-tractor, plus semi-trailer combination;
    - A long truck is typically a combination of a truck-tractor plus a semi-trailer and a full trailer.
  - The indicated split is established from the combination of measurements of vehicle length and chassis height as follows:
    - A vehicle shorter than 4.6m is always regarded as a light vehicle, not a truck;
    - A vehicle between 4.6 and 11.0 m long is classified as a short truck if the signal indicating the chassis height is "high". (If the signal indicated a "medium" or "low" chassis height the vehicle is considered to be a long light vehicle e.g. a car towing a caravan.);
    - A vehicle between 11.0 and 16.8 m long is classified as a medium truck, irrespective of the chassis height;
    - A vehicle longer than 16.8 m is classified as a long truck, irrespective of the chassis height.[257]
- The number of trucks had to be translated into the actual weight of the freight. For this purpose two figures were calculated – the total weight (truck + freight) and the truck tare (only truck weight) – the difference between the two will then be the actual weight of the freight.
  - The average total ton per SMLT was calculated from (Road Freight Association) RFA data. (Table 28). The total weight per SMLT was calculated by multiplying the truck mass with the number of trucks.

[257] Mikros, 2005, p. 10.

Truck type	Average ton
Short	18.8
Medium	42.4
Long	51.6

Table 28: Average gross ton per truck type as calculated from RFA data

- The tare for SMLT was then calculated based on the average tare per vehicle type as published by the Road Freight Association (Table 29).

Truck type	Tare
Short	5.1
Medium	14.1
Long	18.2

Table 29: Tare based on vehicle concepts published by the Road Freight Association

- Useful analysis can, however, only be conducted if the data per counting point are translated into corridor, metropolitan and rural totals.
- For the national routes, counting stations were depicted graphically to determine the split between metropolitan peaks, rural traffic and long distance (corridor) traffic.
- The assumption is that corridor traffic is indicated when a "flattening" of traffic counts occurs, while other stations are either metropolitan or rural, depending on their count size and location:
  - Corridor traffic: The stations where flattening occurred were allocated to national routes. The average of the annual weight for all the counting stations per corridor was calculated to reflect the tonnage per corridor;
  - Metropolitan traffic: The key metropolitan areas were identified (through sharp peaks in traffic counts). Different routes lead into these metropolitan areas. For each route the annual average was calculated. The annual totals per route were then added together to obtain total metropolitan traffic;

- The remaining stations were allocated to rural traffic. Similar to metropolitan traffic (where a group of different routes combine to form a metropolitan infrastructure typology), each province has a number of rural routes that also combine to form a rural infrastructure typology. For each route, the annual average was calculated. The annual totals per route were added together to obtain total rural traffic;
- Discussions with SANRAL indicated problems with some counting stations. Extreme outliers were therefore excluded from the analysis (i.e. counting stations significantly higher or lower than other stations on the same route, and often significantly different from a series of adjacent stations, also clearly visible in the graphs).

Figure 19 to Figure 22 below show the graphical depiction of Cape Town-Johannesburg and Durban-Johannesburg for 2004 and 2005. (All routes are depicted graphically in this fashion to determine corridor flows, but only the two main corridors are illustrated in this research.)

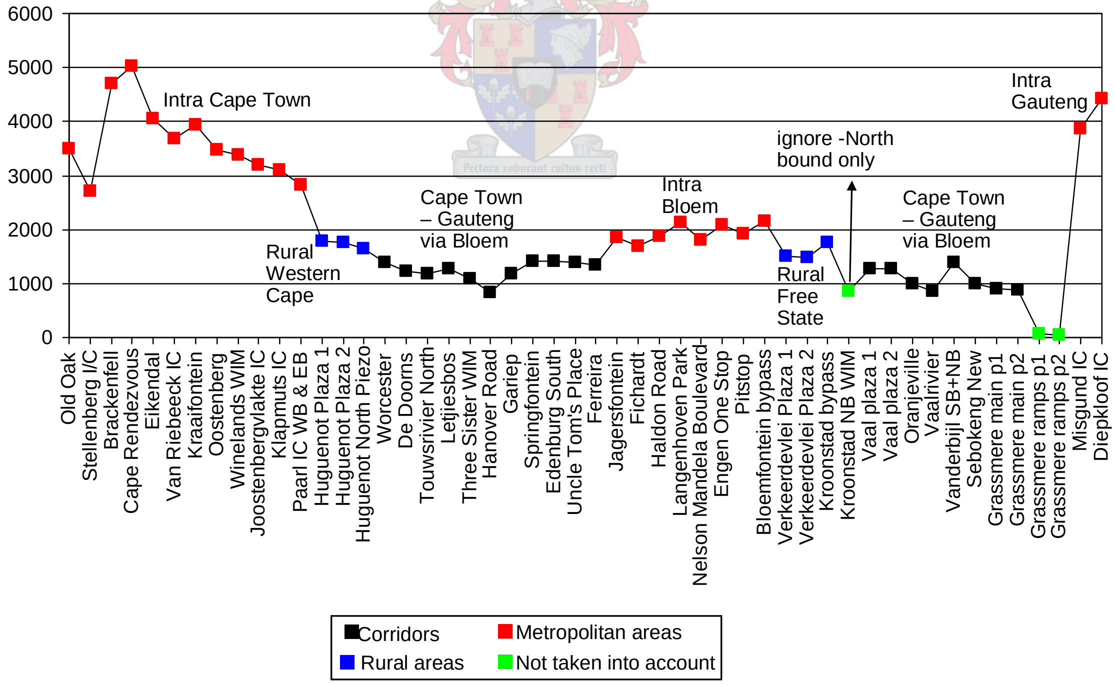


Figure 19: Average daily truck traffic N1 Cape Town-Johannesburg (bi-directional) – 2004

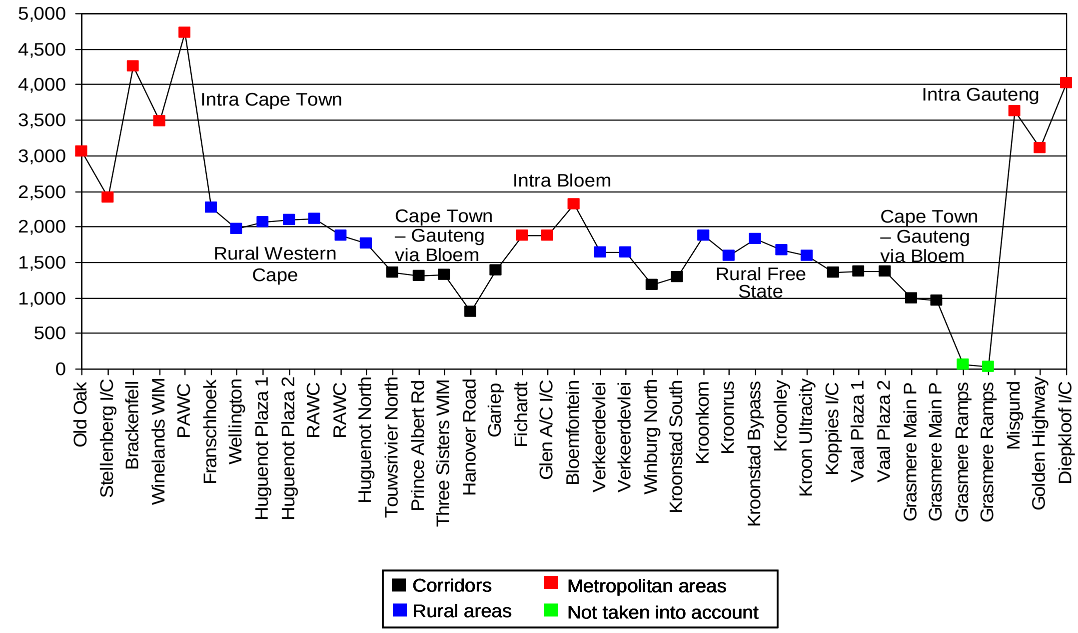


Figure 20: Average daily truck traffic N1 Cape Town-Johannesburg (bi-directional) – 2005

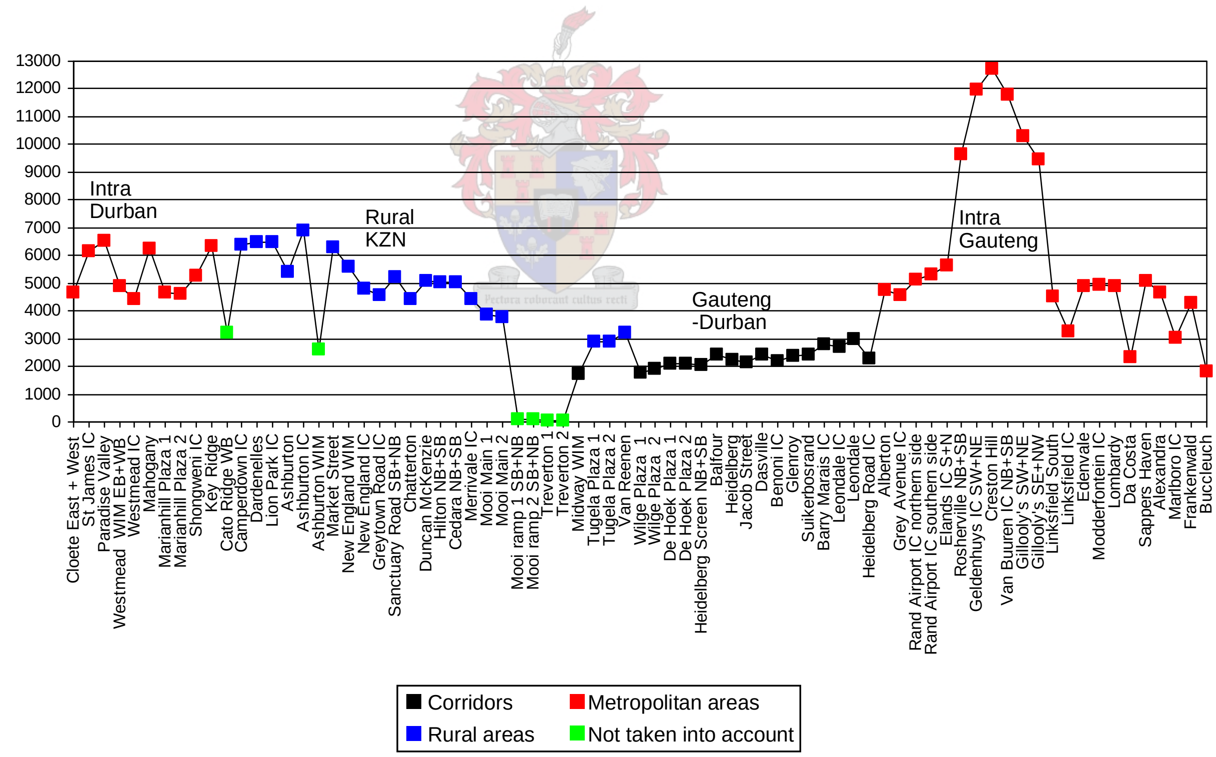


Figure 21: Average daily truck traffic N3 Durban-Johannesburg (bi-directional) – 2004

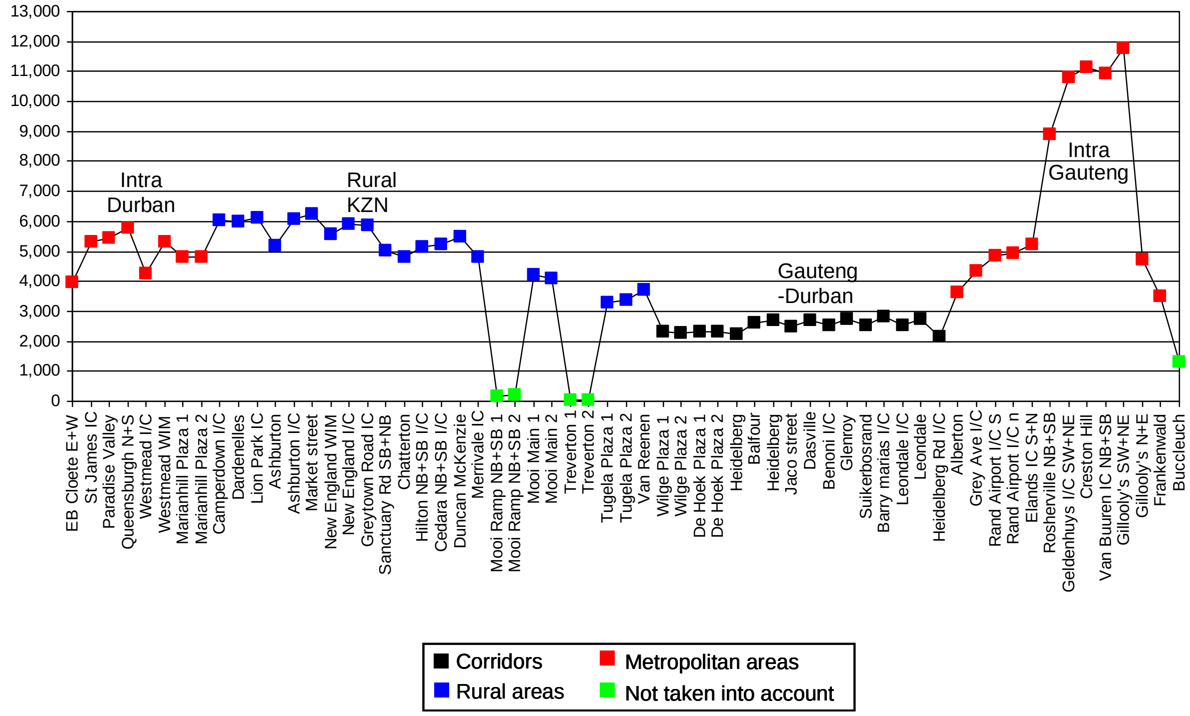


Figure 22: Average daily truck traffic N3 Durban-Johannesburg (bi-directional) – 2005

6.4 Calculation of rail tonnages

Actual rail data are available per commodity and per origin-destination station. Rail data therefore do not have to be modelled. The Spoornet origin-destination station pairs, however, had to be allocated manually to the same corridor, metropolitan and rural classification as the SANRAL counting stations to enable comparison.

6.5 List of corridors, metropolitan and rural areas

The above analysis resulted in the definition of the following corridors, rural and metropolitan areas for analysis.

- Corridors (bi-directional):

  The corridors were grouped with a specific typology in mind that would enable reporting on more than one of the overarching groupings, i.e. Western, Eastern, Northern, etc. The two main corridors (i.e. Gauteng-

Durban and Gauteng-Cape Town) deemed to carry the heaviest traffic, however, were kept separate. The following typology was therefore used (Table 30):

ROUTE SUMMARY	ROUTE DETAIL
Durban-Gauteng	
Cape Town-Gauteng	
Gauteng-Richards Bay	
Coastal	Cape Town-Port Elizabeth
	East London-Port Elizabeth
	Durban-East London
	Cape Town-Durban
	Durban-Richards Bay
Eastern Corridors	Gauteng-Witbank
	Gauteng-Nelspruit
	Gauteng-Swaziland
Western Corridors	Gauteng-Upington
	Cape Town-Upington
	Gauteng-Lobatse
Eastern/Southern Cape-Gauteng	from/to Port Elizabeth
	from/to East London
	from/to Mossel Bay
Northern Corridors	Beitbridge-Gauteng
	Gauteng-Polokwane
Cape Town-Namibia	

Table 30: Corridors

- For metropolitan and rural areas the following typology was used (Table 31):

Metropolitan	Intra Gauteng
	Intra Cape Town
	Intra Durban
	Intra Bloemfontein
	Intra Port Elizabeth
	Intra Witbank/Middelburg
	Intra East London
Rural	Rural Eastern Cape
	Rural Free State
	Rural Kwazulu Natal
	Rural Limpopo
	Rural Mpumalanga
	Rural North West
	Rural Northern Cape
	Rural Western Cape

Table 31: Rural and metropolitan areas

6.6 The national freight flow model

The results from the national freight flow model were tabulated to provide modal market share per corridor, rural and metropolitan area in South Africa. The developed model was applied to counting data from counting stations and actual Spoornet data for 1993, 1997, 2003 and 2004. This application would therefore indicate whether (i) a comparable link with the previous sporadic surveys that ended in 1990 could be established; (ii) whether the measures from the late 1990s up to 2004 have a reasonable correlation with GDP; and (iii) whether the 2003 and 2004 data (when the model was applied annually) seem stable and useful enough to serve as the basis for an annual model. The results from the modelling exercise are reported in the next chapter.

Chapter 7 - National freight flow model results and strategic interpretation

7.1 Introduction

The national freight flow model (NFFM) was applied to data from Spoornet and SANRAL for 1993, 1997, 2003 and 2004.[258] The results produced the most complete picture of surface freight yet produced in South Africa, including modal market share, and was the first successful attempt to model and report on flow data in the country. The data were tested for internal consistency, compared with other economic data and also with the Verburgh, Smith, Hamilton and Pretorius studies for relative performance comparisons. The results are also applied to initiate the process of generating economic performance data for transport in the economy.

7.2 Total supply of, and demand for, surface freight transport

The most definitive measures of surface freight transport supply are ton and ton-kilometer. Two of the initial objectives that the candidate attempted to determine were the tons shipped in the economy and the ton-kilometers of transport that were delivered. The data collection methodology of the data used in this model, however, means that it was not possible to determine where freight counted specifically originated per load and what the destination was going to be. Certain trucks counted could therefore have been traversing more than one of the three typologies, i.e. corridor, rural or metropolitan, and even more than one sub-typology within the main typologies without the specific distinctions being noticeable.[259] In terms of all three of the typologies that the overarching measurement is trying to achieve, this is not a problem. It merely means that freight, in situations like these, impacts on more than one

[258] The candidate was assisted in the application by his collaborator, Ilse Hobbs.

[259] This means, for example, that if a specific load originated in Caledon in the Western Cape and was sent to Johannesburg, it will be observed by the model as a rural Western Cape load and a load that used the Cape Town to Gauteng corridor. In another example, if a load originated in Durban and was sent to Beitbridge, it will be observed as using both the Durban to Gauteng and Gauteng to Beitbridge corridor.

classification, which is actually technically correct. The specifics of this observation should, however, always be remembered and, when the model application is repeated, the same set of assumptions should be applied. The correct measure description therefore is tons shipped and ton-kilometers performed over every classification of the freight network of South Africa, i.e. corridors, rural areas and metropolitan areas.

In terms of this description the tons and ton-kilometers obtained from the modes (supplied) in South Africa for the years of measurement are depicted in Table 32.

	Road total	Rail (excluding export machines)[260]	Rail (export machines)	Total
1993	692	107	72	870
1997	848	120	85	1 053
2003	1 026	105	94	1 225
2004	1 105	106	96	1 307

Table 32: Surface freight supply in South Africa between 1993 and 2004 (million tons)

The above data produce the following market share figures (Table 33).

	Road total	Rail total (excluding export machines)	Rail (export machines)
1993	79%	12%	8%
1997	81%	11%	8%
2003	84%	9%	8%
2004	85%	8%	7%

[260] "Export machines" refers to the railway's dedicated coal and iron ore export lines

Table 33: Surface freight market share between 1993 and 2004

The surface freight transport supply from this model can be compared to previous surveys, as depicted in Table 34.

Million ton	Rail	Road	Total
1957 – Verburgh	75	180	255
1971 – Smith	100	524	624
1985 – Hamilton	170	504	674
1985 – Pretorius	182	686	868
1986 – Pretorius	178	720	898
1987 – Pretorius	188	725	913
1988 – Pretorius	187	663	850
1989 – Pretorius	179	588	767
1990 – Pretorius	184	552	736
1993 – NFFM	178	692	870
1997 – NFFM	204	848	1053
2003 – NFFM	199	1026	1225
2004 – NFFM	202	1105	1307

Table 34: Survey comparison: All surveys[261]

A market share comparison of all surveys is depicted in Table 35.

[261] Hamilton's flawed survey of 1981 excluded and Pretorius's data normalised with actual rail data.

	Rail	Road
1957 – Verburgh	29%	71%
1971 – Smith	16%	84%
1985 – Hamilton	25%	75%
1985 – Pretorius	21%	79%
1986 – Pretorius	20%	80%
1987 – Pretorius	21%	79%
1988 – Pretorius	22%	78%
1989 – Pretorius	23%	77%
1990 – Pretorius	25%	75%
1993 – NFFM	20%	80%
1997 – NFFM	19%	81%
2003 – NFFM	16%	84%
2004 – NFFM	15%	85%

Table 35: Market share comparison: All surveys (based on tons)

Irrespective of the flaws of previous surveys, the definite downward trend in rail market share is clear. Unfortunately, because of the flaws of previous surveys and the absence of flow data, the specifics of this decline were never really understood. If the effect of the rail transport of ring-fenced commodities (i.e. bulk commodities that came on stream in the 1970s) is added, the decline of rail is much more pronounced (Table 33).

Growth rates for constant GDP at 2000 prices, physical production in the economy and tons transported can now be compared between the national freight flow model and the previous studies analysed. This is depicted in Table 36.

	Constant GDP at 2000 prices	Physical volume of production in the economy	Million tons transported	Million tons transported (known errors removed)
CAGR - Verburgh 1957 to Hamilton 1985	3.85%	5.54%	3.53%	3.53%
CAGR - Pretorius 1985 to 1990	1.67%	0.61%	-3.59%	-3.27%
CAGR - 1993 to 2004 NFFM application	3.15%	1.71%	3.77%	3.77%

Table 36: GDP growth rate comparison[262]

The survey methods followed by Verburgh, Hamilton, Smith and Pretorius are essentially the same and could therefore serve as a good base for comparison.

The **Verburgh to Hamilton survey results** perform satisfactorily in this comparison as the growth in tons transported correlates well with the growth in GDP. The faster growth in the physical volume of production in the economy (compared to GDP and transport growth), however, could not be explained by the commissioning of South Africa's two export machines in the 1970s, i.e. the Richards Bay coal line and Sishen to Saldanha iron ore line,[263] because in both these cases it should also have translated into higher transport volumes. It is also hypothesised that more double handling of goods in a more mature economy (caused by specialisation) should occur, which means that tons transported should probably grow somewhat faster than the physical volume of production in the economy.

The **Pretorius surveys** did not do well in these comparisons. Constant GDP growth in South Africa (1.67%) was slow in the years just before the

[262] Hamilton's flawed 1981 survey excluded.
[263] It is indicative of the impact of these "export machines"that more than 10% of the transportable economy is shipped on these two lines today.

unbanning of the ANC and the release of Nelson Mandela, and the physical volume of production slowed down to a compound annual growth rate of a mere 0.61%, but a negative correlation of more than 3% with tons transported is highly unlikely.

The national freight flow model correlation performs well in all comparisons. Constant GDP grows faster than the physical volume of production as the economy matures and the tertiary sector expands. The expected increase in double handling results in a faster transport growth rate than that of physical production, but more in line with GDP growth.

A more precise measure of correlation would be to measure the correlation coefficient between the various data sets. This calculation is depicted in Table 37.

	Studies		
	Verburgh, Smith and Hamilton	**Pretorius**	**NFFM**
GDP to physical production	0.992	0.935	0.986
GDP to tons transported	0.627	-0.811	0.996
Physical production to tons transported	0.653	-0.720	0.985
GDP to tons transported: Known errors removed	0.933	-0.868	0.996
Physical production to tons transported: Known errors removed	0.874	-0.794	0.985

Table 37: Correlation coefficient comparison for all surveys

Only limited data points are currently available, but initial observations for 2005 and 2006 indicate that the same high correlation for the national freight flow model results persists. The data have been workshopped amongst peers at the CSIR, Transnet, the Department of Trade and Industry, the Department of Agriculture and Spoornet, and current indications are that the high correlation will continue in future applications of the model. As the work continues, the academic soundness of the research should be continuously tested and reported on in due course to determine if the positive correlation is valid for longer time series.

The total supply of transport in 2004 for all typologies has been established to be 1,307 million tons and 336 billion ton-kilometers. The next section describes supply within these typologies and the salient features of each one.

7.3 Typologies and the current distribution of freight

In South Africa 336 billion ton-kilometers of freight movement is provided to the economy, compared to the approximately 15,000 billion ton-kilometers supplied in the world. South Africa has just less than 1% of the world's population, produces less that 0.4% of the world's GDP, but requires more than 2% of global transport in terms of ton-kilometers (Figure 23) – the country's transport demand is therefore excessive in the light of these indicators.[264]

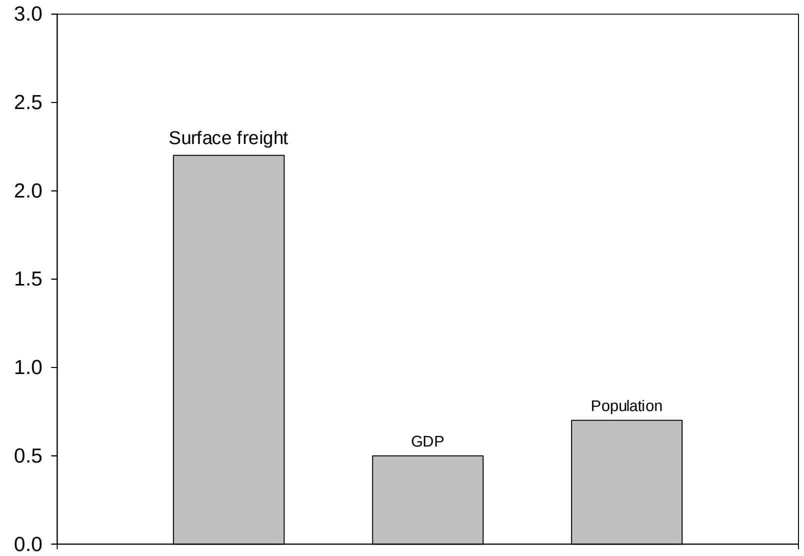


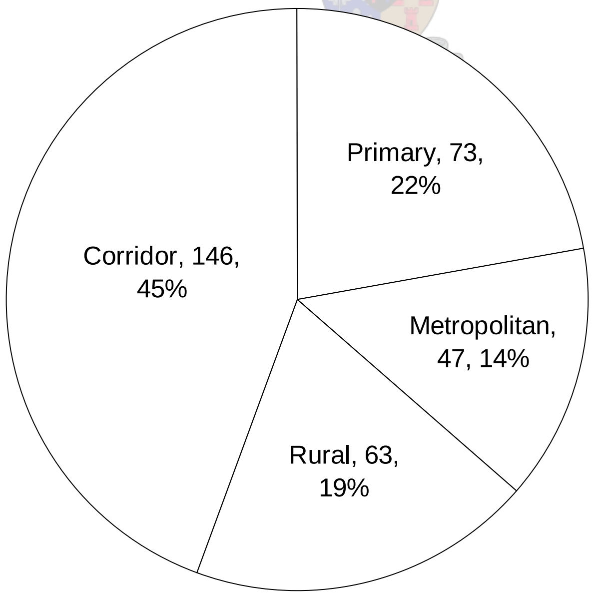
Figure 23: South African indicators as a percentage of world indicators

[264] Calculated from Rodrigue, et al, 2005, Gielen, D. 2004, and State of Logistics Survey (CSIR, 2005) modelling.

This situation arises from the country's economic development history that resulted in production and population development far from coastal areas, in a relatively open mineral export economy, and a beneficiated product and energy import economy (because of minerals found far from the coast), thereby creating long export and import corridor requirements.

This situation places, *ipso facto*, a massive burden on transport infrastructure and (because of the poor productivity[265]) specifically a need for excessively cheap transport. The South African economy is still relatively primary, especially when compared to developed economies, and a better understanding of the specifics of the typologies is required in order to formulate an appropriate freight transport strategy.

The 336 billion ton-kilometers of freight can be divided into four distinct typologies i.e. primary, metropolitan, rural and corridor (Figure 24).



[265] The global economy produces $2.76 per required ton-kilometer, compared to South Africa's $0.65 for each ton-kilometer provided (calculated from global and domestic GDP data).

Figure 24: Freight typologies (ton-kilometers and percentage share)

The primary typology describes the world-class one-directional bulk transport corridors to move South Africa's low-value mining commodities efficiently to the coast for export, and to internal beneficiation facilities. Approximately 85% of this typology is supplied for iron ore transport from Sishen to Saldanha and coal from Mpumalanga to Richards Bay. Efficiency is crucial in order to compete with other deposits around the world that are mostly closer to the coast (in the country of origin – therefore requiring less land transport) and often closer to global demand points (therefore requiring less maritime transport). Origin-destination pairs, which facilitate bulk heavy-haul, are usually few in number.[266] This typology is typically rail-orientated and migration to the road mode is practically impossible. Schematically it can be described as a pipe with two fixed ends, as depicted in Figure 25.

Figure 25: Schematic of primary traffic

The metropolitan typology describes transport in metropolitan areas over shorter distances. It often relates to local deliveries from intermediate production points and distribution centres to final points of consumption as well as transport between intermediate demand and supply points. This freight traffic causes congestion because of the many origin-destination pairs distributed over small areas; it is expensive (both from a capital supply and usage point of view) and is typified by rapid growth in South Africa. This typology is predominantly road-based, but rail-based solutions where traffic behaves like primary traffic are possible to alleviate congestion.[267]

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[266] Fewer origin-destination pairs for bulk movements mean that unit trains with a ring-fenced wagon fleet, requiring little or no shunting, can be used, drastically reducing the cost of rail transport.

[267] Examples include the bale-by-rail solution that was developed for Vissershok in Cape Town, where a ring-fenced fleet delivers baled waste over defined and limited origin-destination pairs to a landfill site outside Cape Town.

Schematically this can described as a circle with many origin-destination pairs inside, as depicted in Figure 26.

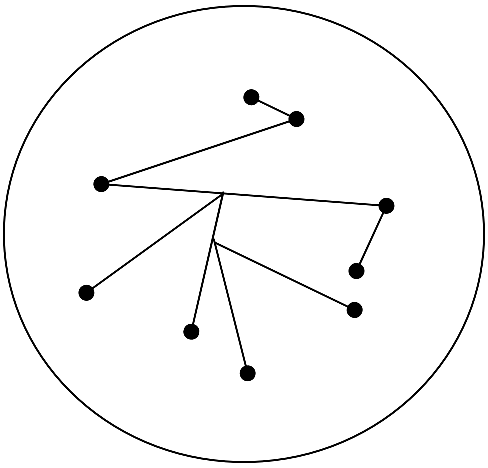


Figure 26: Schematic representation of metropolitan traffic

The corridor typology describes transport over long distances *between* metropolitan production and consumption centres. More than 40% of current corridor demand is for freight flows between Gauteng and the Durban and Cape Town metropoles. Origin-destination pairs for the longer part of the journey are few and distances long, but with distributed local collection and delivery points. The long-distance portion of the freight could theoretically be transported more cost effectively by rail, but the many origin and destination points make this difficult. Rail transport between the convergence points only would mean the double handling of break bulk. This situation makes corridor demand an ideal candidate for *intermodal* solutions to avoid double handling or excessive long-haul road demand. Schematically this can be described as a pipe which is exactly the same as the schematic for primary traffic, but connected to a metropolitan circle with convergence points at the end points as depicted in Figure 27.

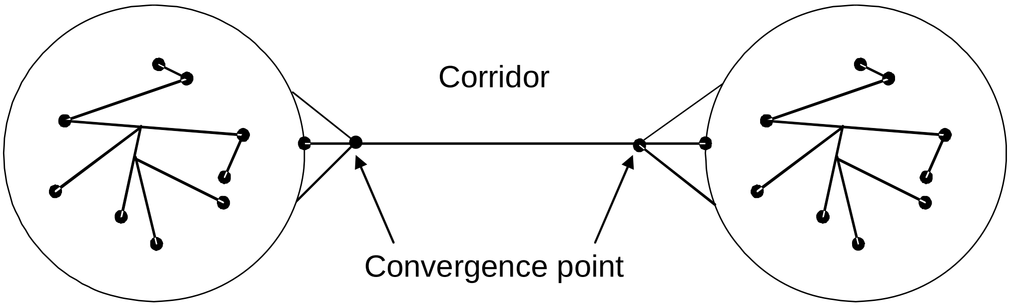


Figure 27: Schematic representation of corridor traffic

The rural typology is a longer-distance typology than metropolitan traffic, and could be shorter or longer than corridor traffic. It describes transport within rural areas, between rural areas and from rural areas to connection points on corridors. This typology is currently significantly under-supplied in South Africa, with the consequence that commercial farming feels the strain of a deteriorating rural transport infrastructure network. The provision of rural freight transport is a core requirement for enabling the “second economy” as South Africa tries to elevate subsistence farming to commercial farming. Many origin-destination pairs are distributed over large, sparsely populated areas. This typology is primarily road-based as the development of new rail networks is not justified by low densities, but better rail solutions are possible where infrastructure is in place. Schematically this can be described as the pipe and circles of corridor traffic, but without convergence points. Rural traffic is rather independent from the pipe and circles in terms of origin-destination pairs, although it could sometimes be linked to the corridor traffic, at many different and often independent connection points (Figure 28).

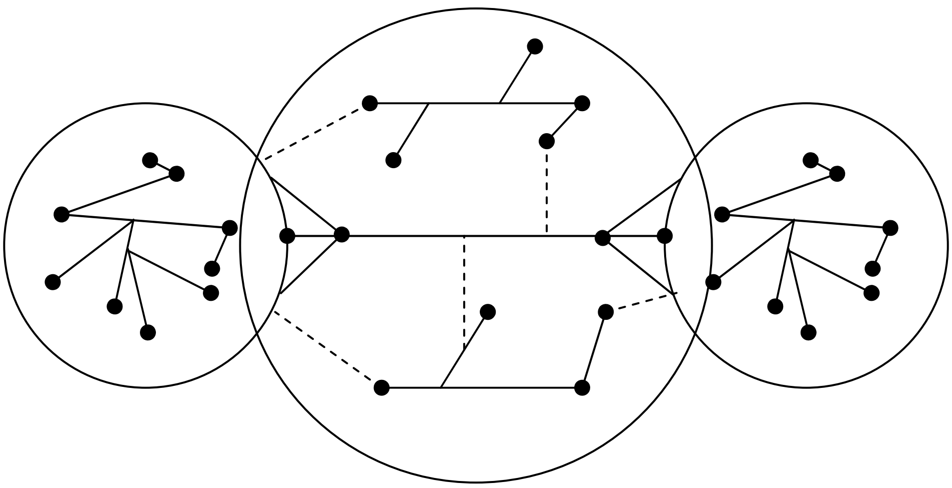


Figure 28: Schematic representation of rural traffic

The characteristics of the various typologies are summarised in Table 38.

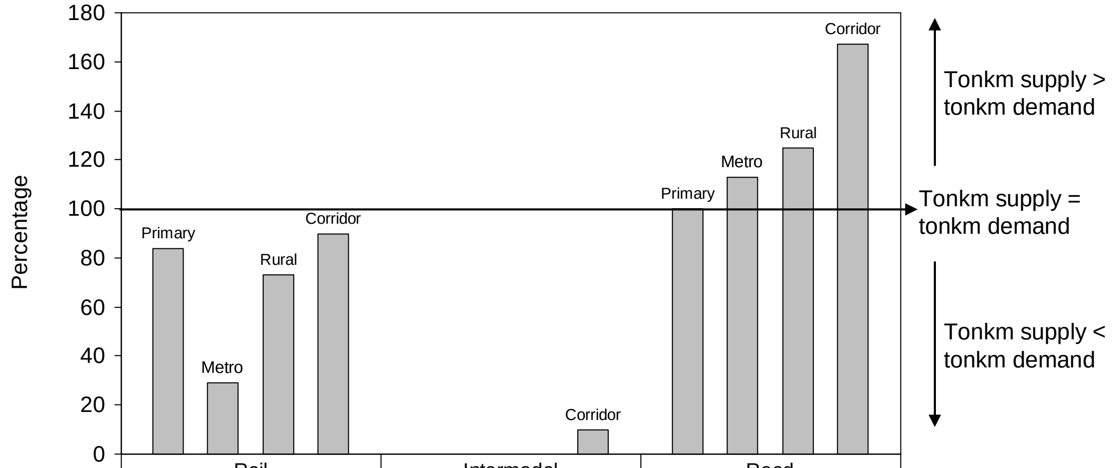
	Primary	Corridor	Rural	Metropolitan
Traffic type	Bulk (rail only, mainly export coal & iron ore)	Mostly manufacturing, some agriculture	Mostly agriculture	Mostly final delivery
Distance	Long	Long & short	Medium & short	Short
OD's	Few, one-directional	Long distance, few ODs; short distance: many OD's	Many	Many
Major challenge	Global competitiveness	Spatial organisation, efficiency	Development	Congestion alleviation
Possible logistics approach	Ring-fenced, bulk rail systems	Intermodal solutions	Effective road feeder system	World-class commuter systems amidst effective freight delivery

Table 38: Summary of typology characteristics

Supply and demand for the typologies per mode can be calculated as supply equal to observed behaviour and demand equal to what primary customers report (i.e. what freight owners indicated they have available for transport), what intermodal best standards would indicate for corridor traffic and what the distribution between rail and road should be, given certain densities on corridors and rural areas. This is depicted in Figure 29

The data from Table 32, Table 33 and Table 35 compared to the current structure of the transport market in South Africa as depicted in Figure 29, point directly to the decline of the rail transport mode in South Africa with no concomitant rise in intermodalism as in the rest of the world. The issues of high-rated traffic initially cross-subsidising agriculture (i.e. causing investment in an unprofitable and unnecessary rural rail network), and the absence of research and planning based on the research, led to this distortion in South

Africa's economy, where transport efficiencies, because of the spatial challenges, are of critical importance.



	Rail	Intermodal	Road
Primary	84	0	100
Metro	29	0	113
Rural	73	0	125
Corridor	90	10	167

Tonkm supply expressed as % of tonkm demand for each mode

Figure 29: Supply and demand of modes in the typologies[268]

7.4 The current position of rail

The economic causes of rail supply are best described by a *theoretical* case, which provides a good average of the situation in South Africa as well as an understanding of the drivers of rail sustainability.

In the average theoretical case for South Africa, prior to the deregulation of the transport sector, a theoretical assumption of the transport of 10 million tons over a 1 000 km corridor per annum, i.e. 10 billion ton-kilometers, can be made. Income and costs are more or less in balance before deregulation (with some inefficiencies, but a lower profit drive), which means that capital replacement cost, maintenance and running cost covers the income – in this theoretical case this would be (at an assumed 20c per ton-kilometer) around R2 billion (at today's prices).

[268] Supply in the typology is calculated from known observations. The intermodal supply typology can be calculated from known rail volumes. Demand is calculated conservatively assuming 25% of traffic being high-value with road as a balancing element. The primary rail demand is calculated from reports of under-supply by large-volume exporters of mining commodities.

In normal rail economics about 75% of costs would be fixed over the short term and 50% over the medium term. What would happen during deregulation is that traffic would begin to shift from rail to road (especially time- and value-sensitive cargo) – and this movement will be accelerated and pronounced in the absence of intermodal solutions.

Corridor traffic in South Africa could have shifted far beyond 50% from rail to road in a relatively short period, but assuming a 50% shift, this would mean a loss of R1 billion income on the theoretical corridor and only a reduction of R0.25 billion of costs in the short term and R0.5 billion in the medium term. This means that R0.75 billion would have to be cross-subsidised from rail "captured" freight in the short term and R0.5 billion in the medium term. In the absence of cross-subsidisation the remaining traffic would have to carry a tariff of 35c per ton-kilometer in the short term and 30c in the medium term (an immediate tariff increase of between 50 and 75%).

Invariably in South Africa the following hybrid, unsystematic strategy was followed to alleviate this situation:

1. Cross-subsidisation did occur to some extent, making South Africa's "captured" rail traffic slightly less competitive – this was partly offset by state of the art world-class engineering, especially on the export lines;[269]
2. Relative tariff growth on some higher-value, time-sensitive freight did occur at faster than PPI growth rates, but this led to a worsening of the problem as more traffic left the railway;[270]
3. The complete difference could never be earned, resulting in declining investment and expenditure on maintenance, inducing further freight losses and a never-ending downward spiral.

[269] It is common knowledge that Spoornet at some stage in the late 1990s made a profit of R1 billion on the export coal and iron ore lines and a loss of R1 billion on its general freight business. Strategies exist to eradicate this cross-subsidisation, but it still persists to some extent.

[270] Total road rand per ton costs increased by 3.7% from R108.36 to R112.39 from 2003 to 2004. Total rail costs increased by 12.2% over the corresponding period from R67.99 to R76.26. The cents per ton-kilometer figure for road showed a 0.7% increase from 57.3c to 57.7c, whilst rail increased by 10.4% from 11.5c to 12.7c. Note the still comparatively low figure for rail, if all traffic is included in the equation.

Globally this problem usually has three possible outcomes:

1. Railway decline on shorter haul is allowed to continue and the railways concentrate on bulk heavy haul over long distances (the American model);
2. Investment in intermodal solutions to get the best of both possible worlds (part of the European and American models);
3. Re-regulation (part of the European model).

The first option could be expensive for the economy and could be identified with the typical “conspicuous consumption” culture of North America. Congestion and social factors in South Africa necessitate the adoption of Europe’s option. The problem is that South African railway management in the mid-1990s planned for the American option, even though this would have been impossible to implement. It does not fit South Africa’s objectives, would cause job losses and place unnecessary strain on the economy. This means that the “normal” problems of transport deregulation were compounded by poor strategy and that assets were allowed to deteriorate even further to the brink of collapse. No investment in intermodal solutions occurred and these problems were even further compounded by an absence of guidance from the policy makers, lack of the development of a revised National Transport Policy following the De Villiers deregulation report and lack of implementation of MSA initiatives.

One of the major causes of this situation was a poor understanding of the network typologies, the real trends in transport for these typologies and the limited or erroneous assumptions that followed this shortage of information. The belief in the economy was that rail decline was “normal” (erroneous - it shouldn’t have been so pronounced for corridors and especially long-haul corridors) caused by poor service (erroneous – poor service was definitely not the only cause of decline as the theoretical example shows) and not rapid (erroneous – masked by the rise of “rail captured” export machines and the concomitant absence of a network view).

The drivers of rail sustainability are best described by comparing or offsetting the positive contribution of a railway to an economy with its disadvantages. A railway will, under the right circumstances, save an economy money, provide systemic access for freight and passenger movements, and provide environmentally sustainable transport solutions. These advantages should be offset or compared to its major disadvantage, i.e. that it provides only one degree of freedom of movement. The only way in which the advantages of rail can be monetised in spite of the disadvantage is by not competing with other modes directly, but by exploiting the intrinsic technologies of rail, i.e. its bearing, guiding and coupling technologies compared to the capacity that it can leverage. Bearing, which indicates the weight of axle load that can be maintained (and therefore volumes) and guiding, which indicates the wheel on track differentials (and therefore speed of movement) are added to coupling, which means long trains with massive volumes (therefore combining high volume time and long-distance solutions).[271] These intrinsic technologies consequently describe two drivers of rail technologies, i.e. the speed of guiding and the axle load of bearing (Figure 30).

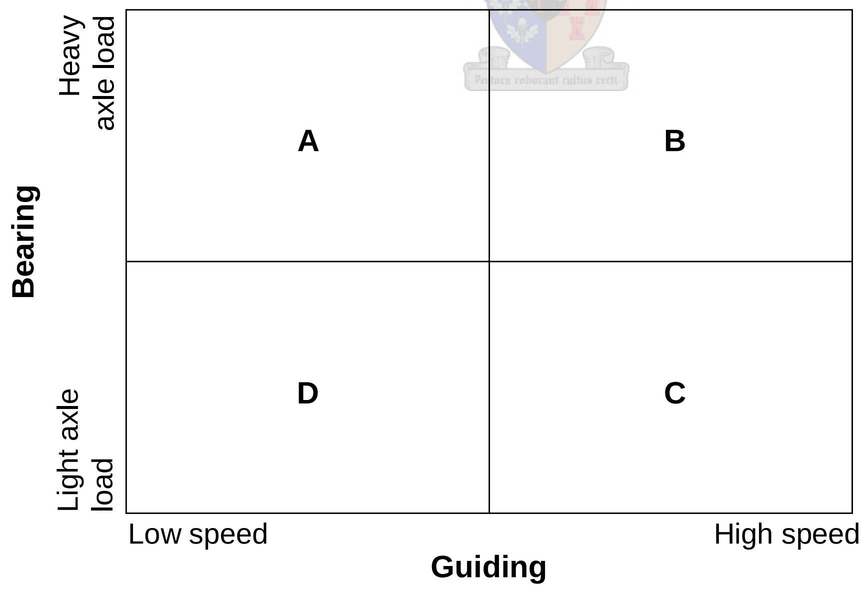


Figure 30: Rail competitiveness and sustainability[272]

[271] Van der Meulen, 2007.
[272] Van der Meulen, 2007.

The four areas of competitiveness in this depiction of drivers indicate that position:

- A is suitable for heavy haul traffic;
- B is suitable for heavy intermodal traffic;
- C is suitable for fast intercity high-value traffic or passengers;
- D is suitable for general freight solutions in a regulated environment.

Van der Meulen maintains that all railways in the D group (where South Africa's rail system is located) will gradually become redundant and that the problem can only be solved at the state level, where it was created (i.e. by redesign).[273]

South Africa's rail system was designed without A, B and C in mind, was highly regulated for a long time (and could therefore survive for a long time), but was destined to fail with deregulation. This failure is therefore a combination of the incorrect application of rail economics caused by de-densification of loads (as a result of deregulation), which in turn was caused by the absence of intermodal solutions, and gauge and network design errors. All of these errors could have been avoided by macro-economic research on actual demand, coupled to design options to meet that demand in a sustainable package of solutions and design.

Macro-economic research of this kind requires time-series information, and to understand this it is necessary to see the detailed picture that underlies the typologies and the trend in traffic movement over the typologies within the national freight flow model's measurement history.

7.5 Trend in freight movements over the typologies

The growth in tonnages over the various typologies is depicted in Table 39.

[273] Van der Meulen, 2007.

		1993	1997	2003	2004
Corridor traffic	**Road**	96	122	142	166
	Rail (excluding dedicated export lines)	54	61	57	56
Rail (dedicated export lines)		72	85	94	86
Rural traffic	**Road**	208	243	306	328
	Rail	33	39	34	37
Metropolitan traffic	**Road**	387	483	578	612
	Rail	20	20	13	13

Table 39: Tonnage growth over various typologies (million tons)

The change over time can also be depicted as market share within each typology (Table 40).

		1993	1997	2003	2004
Corridor traffic	**Road**	64%	67%	71%	75%
	Rail (excluding dedicated export lines)	36%	33%	29%	25%
Rail (dedicated export lines)		100%	100%	100%	100%
Rural traffic	**Road**	86%	86%	90%	90%
	Rail	14%	14%	10%	10%
Metropolitan traffic	**Road**	95%	96%	98%	98%
	Rail	5%	4%	2%	2%

Table 40: Percentage market share within typology

The issue around real rail decline is now clear, indisputable and entirely scalable. The results of these observations can now be compared to the typology challenges as summarised in Table 38 and the specific and known challenges of the South African economy in terms of transport.

All growth over dense corridors occurred in the road mode, which expanded by more than 70% over eleven years. This growth would be understandable if the corridors in question were short or the density per corridor low. In this instance the economy will have to absorb this growth in the road mode. Cheaper options are, however, available in intermodality, if the density per corridor can be calculated as sufficiently high. In South Africa’s case, as observed by the national freight flow model, the spatial efficiency objective of the corridor typology is not achieved. If this density is sufficient to entertain an intermodal solution, future investment should consider investing in such solutions. This could release funds for the development of the second economy in rural areas, which is a major objective of the country at the moment.

Rural road traffic grew more slowly than corridor traffic (less than 60% growth) which correlates with the hypothesis that South Africa is not succeeding in the stimulation of rural economies as desired. A major cause of this failure is declining road infrastructure, the impact of which can now for the first time be measured. The development objective of this typology is therefore not achieved. Metropolitan growth is also slower than corridor growth.

The detailed results per typology will point towards specific issues and possible solutions. These results are discussed in the following sections.

7.6 Trends in movement over the various corridors

The various corridors performed differently in terms of growth over the past 11 years. The growth is depicted in Table 41.

		Gauteng-Durban	Eastern corridors	Gauteng-Cape Town	Northern corridors	South Eastern	Western corridors
1993	**Road**	21	18	8	11	6	5
	Rail	14	9	2	5	3	1
1997	**Road**	20	24	12	17	9	7
	Rail	16	12	2	5	3	1
2003	**Road**	25	27	15	23	10	6
	Rail	13	13	3	4	3	1
2004	**Road**	32	28	18	25	11	8
	Rail	12	11	3	3	4	1

Table 41: Corridor growth from 1993 to 2004 (million tons)

Growth on the most dense corridor, the route between Gauteng and Durban, was relatively slow (26%), but this is also the corridor that is probably the most overstretched in the country because of current density. Alternative routes (even as far afield as the Energy-Demoina route - the alternative route between Gauteng and Durban over Piet Retief that is much longer) are often used because of *inter alia* lack of policing, lower density and fewer toll roads. From this high base, if the road/rail market share position should continue, major long-haul congestion problems will arise in the future.

The Eastern corridors describe the roads to Witbank, Nelspruit and Maputo from Gauteng. There has been a major initiative over the past few years to develop this corridor, but freight has grown by only 46% (the 2nd lowest and slower than economic growth) over the time period. The expected growth in rail traffic has also not been realised yet.

The Gauteng to Cape Town corridor achieved 135% growth over the time period, almost all on road. This is perhaps the greatest error in South Africa's infrastructure planning framework, as this is also the longest corridor and should, by any standard, be more rail-bound than the rest.

7.7 Trends in movement in the various metropolitan areas

Almost all known areas (or areas usually classified as metropolitan) experienced growth of between 50% and 60% over the period, as depicted in Table 42.

		Gauteng	Durban	Cape Town	PE	Bloem-fontein	Witbank [274]	EL
1993	Road	216	61	61	20	17	11	2
	Rail	11	2	2	1	Neg	3	1
1997	Road	267	76	76	23	24	12	3
	Rail	12	2	2	1	Neg	4	Neg
2003	Road	317	89	97	29	28	12	6
	Rail	6	1	1	1	Neg	4	Neg
2004	Road	331	103	99	32	27	13	6
	Rail	6	1	1	1	Neg	4	Neg

Table 42: Metropolitan freight transport growth between 1993 and 2004 (million tons)

This downward pattern of rail freight decline is probably quite normal for the shorter distances involved and might seem acceptable to planners, but it should be remembered that dense metropolitan areas are growing from an already high base (given the current available infrastructure that is installed and planned). In addition, 86% of all metropolitan freight in South Africa moves within three metropolitan areas and 41% of all freight shipped in South Africa originates and terminates within one of these same three metropolitan areas.

7.8 Trends in movement in the various rural areas

The biggest rural growth was experienced in KZN, where rural freight movements grew three times faster than in the Eastern Cape, as indicated in Table 43.

[274] Witbank includes the Witbank and Middelburg areas.

		Gauteng	KZN	Mpuma-langa	Free State	North West	Limpopo	Western Cape	Eastern Cape	Northern Cape
1993	**Road**	54	29	44	23	16	19	13	9	1
	Rail		9	1	8	11	Neg	4	Neg	1
1997	**Road**	61	41	46	23	21	23	18	9	1
	Rail		10	1	10	12	Neg	5	Neg	Neg
2003	**Road**	72	60	54	31	29	27	19	12	2
	Rail		6	1	8	11	Neg	8	Neg	Neg
2004	**Road**	75	67	58	33	30	28	22	14	2
	Rail		7	1	8	12	Neg	9	Neg	Neg

Table 43: Rural freight transport growth between 1993 and 2004

Government's failure to deliver on objectives for the rural Eastern Cape region is clearly evident.

7.9 Developing transport performance measures

The application of the national freight flow model as lead indicator has now been adequately defined, given the specific planning information for the typologies that was generated. Possibilities also exist to use the data to develop lag indicators that can measure the performance of the economy in terms of transport consumed. GDP data, physical production data and sectoral GDP are known and a calculation is therefore possible (Figure 31).

Figure 31: Constant rands (2000 figures) produced in the South African economy per ton[275]

The time-frame over which the performance of the national freight flow model is measured is short (with only five data points), and the previous measurements erratic and unreliable. The increasingly poor performance of the economy in terms of transport productivity is, however, clearly visible where the economy generated less than R800 for each ton transported in 2005. This measure over time could inform the spatial performance of the economy (about which only hypotheses have existed up to now) and contribute towards a better understanding of the spatial dilemma. As the tertiary sector in a mature economy grows, the measure should actually improve and, furthermore, also improve with increased productivity in transport. This is, however, not the case in South Africa.

The measure can be extended to indicate measures for the transportable economy (Figure 32). This measure also indicates a declining trend and the poor performance of spatial reorganisation, spatial requirements and transport productivity in South Africa.

[275] Per ton moved for distinct typologies and for the sub-typologies within each typology. (note unequal intervals between years).

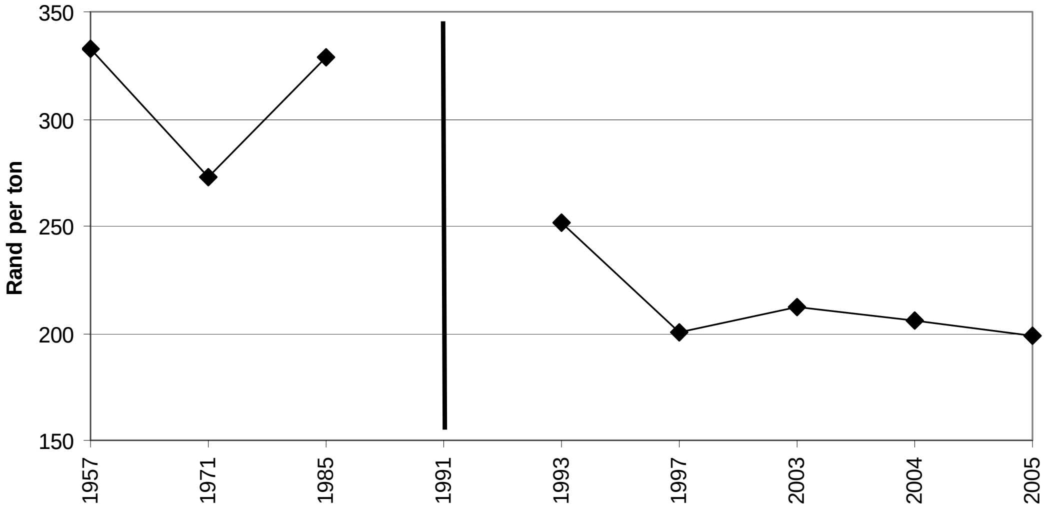


Figure 32: The performance per ton of the transportable economy in GDP terms[276]

7.10 Infrastructure planning

The lead indicators (modal market share in total, modal market share per typology and correlation of freight transport with GDP per typology) which could inform transport and logistics infrastructure planning, and the lag indicators (performance of GDP and transportable GDP per ton) that measure past performance of transport in the economy have now been defined.

The lead and lag indicators that were informed by the application of the national freight flow model not only prove to be a highly reliable measure of transport, but they also lead to the development of data that can begin to inform infrastructure decision making based on the structure of transport in the economy, trends and performance indicators. In order to look into the future of South Africa's economic infrastructure requirements, a more detailed view of future transport requirements will be necessary, specifically around the commodities that are transported now and those that will require transport over the next two decades. The model developed for this purpose is discussed in the next chapter.

[276] Per ton moved for distinct typologies and for the sub-typologies within each typology (note unequal intervals between years).

Chapter 8 - Commodity flow model methodology

8.1 Introduction and background

The development of freight flow data in South Africa was an important first step towards producing intelligence for future infrastructure planning and performance measurement of transport in the economy. For the first time transport supply and modal market share can be measured reliably and flows of freight determined, as discussed in Chapters 6 and 7. These flows are, however, for total freight without an indication of the composition of this freight (which is not possible given the methodology). An important missing link in the picture is therefore the determination of commodity flows over the typologies. Just as freight flow determination was attempted by previous surveys and all failed in this regard, so determining commodity flows was also attempted, but with no success.

A commodity flow model was therefore developed to quantify commodity flows over the typologies that were developed in the national freight flow model. The commodity flow model should also provide forecasts that can be used to model various future infrastructure solution scenarios as well as developing low road, likely road and high road scenarios of commodity transport demand in the future.

The core modelling process is based on 354 magisterial districts, resulting in finely granulated data sets for flow modelling. The process followed is depicted in Figure 33.

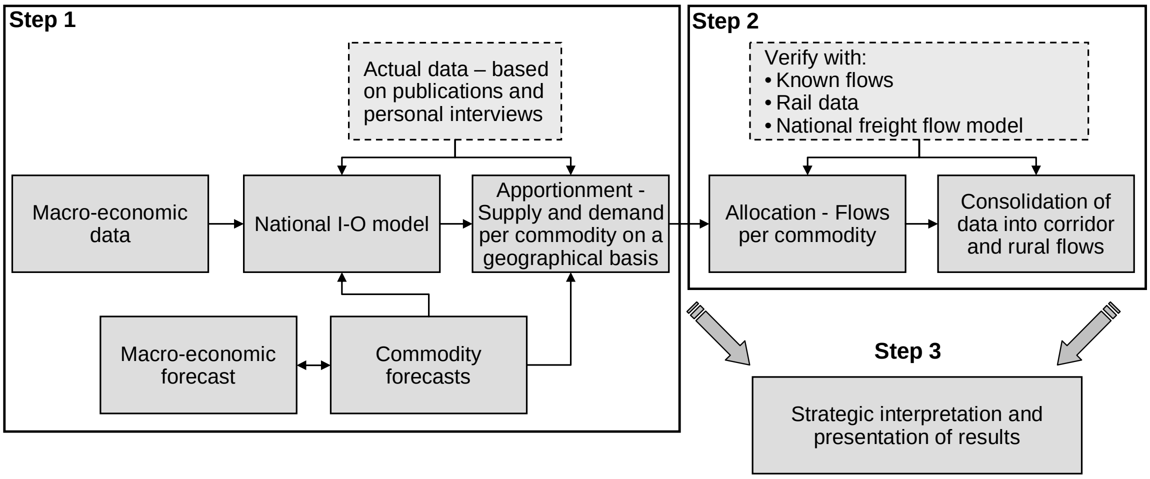


Figure 33: Commodity flow modelling methodology

8.2 Supply and demand per commodity on a geographical basis

8.2.1 Inter-sectoral tons moved

The modelling of supply and demand on a geographic basis per commodity uses, as a first step, the input-output table (I-O table) of the economy as a platform.

A modern I-O table is a tool in economics by which a system of national accounts is extended, classified and depicted in tabular format. The basic structure of an I-O table is based on the same framework as Leontief's original statistical I-O table, which quantifies all transactions that took place between the main economic stakeholders or industries in a particular year.[277] The key feature of the table is that it divides these economic transactions into the main sectors of the economy, starting with Agriculture, Forestry and Fishing right through to Community Services. The I-O table is therefore an extension of the National Accounts of a country, i.e. disaggregating National Accounts into the various sectors of the economy. Thus by its nature the I-O table gives detailed information on the intermediate and final demand components of each commodity in the economy.

[277] McDonald and Punt, 2005, p. 65.

De Jong et al. discuss the various options for supply and demand modelling (in their case called production and attraction); they state that advantages of input-output models are the link to the economy, the possibility of getting land-use interactions and the policy effects of elastic coefficients. The listed disadvantages are the need for an input-output table (which could be constructed in this case), the demands for multi-regionality (it is often not possible to distribute inputs and outputs over various sub-regions of a country, but it was possible for South Africa to be divided into 19 sub-regions and magisterial districts), restrictive assumptions (which were solved by enhancing the models with desktop research) and the need to identify imports and exports (which is possible for the South African economy).[278]

For the analysis two models needed to be developed. Firstly, a customised model, based on the I-O table of the economy to estimate the supply and demand,[279] in volumetric terms, according to product type on a national level. Secondly, a model was developed to disaggregate these national figures on a regional and magisterial district basis.[280]

Step 1 – Setting up the base year (2006)

A 2006[281] I-O table was used as the basis for the model. The 2006 I-O table from Quantec shows imports as an aggregated single figure in the production process for each sector. For the purposes of this model, the I-O table had to be transformed to accommodate the flow of imports into the economy in each of the transactions that occur in the economy. Import coefficients were developed using the proportion of imports to production. These import coefficients were multiplied across the matrix to incorporate imports. The following equation was used to develop the import coefficients:

278 De Jong et al. 2004 p. 108.

279 Demand and supply are disaggregated into the following components. Supply components: imports and production. Demand components: intermediate demand, exports, investments and consumption expenditure.

280 I-O modelling was done with the assistance of Conningarth Economists. The objective of the dissertation is to develop a modelling system, and not to contribute to the specific I-O modelling system

281 The 2006 I-O Table was developed by Quantec, a South African firm that specialises in data analyses.

(P+IM)/P

where

P=Production

IM=Imports.

Step 2 - Forecasting

This step involved creating I-O tables for each year from 2004 to 2025. This was achieved by using forecasts of local demand, exports, imports and output for each year.

Forecasting is designed to help decision making and planning in the present. Forecasting is by nature rooted in uncertainty. In order to arrive at the best possible answer, a combination of forecasting techniques was used in this model. Three different methodologies around forecasting were followed for the three different transportable sectors of the economy, because of the inherently different structures of these sectors. Agricultural forecasting is the most difficult and requires specific treatment with respect to the unpredictable nature of the sector. Mining output is highly predictable and planned as continuous production runs years in advance. Manufacturing output is a combination of the two, but it is not dependent on weather and meteorological factors. The manufacturing sector is also well forecasted in the economy, with reliable models that can be used. It should be noted that the primary objective of this study is not forecasting output per se, but developing a model that translates forecasts of output into flow forecasts per typology for the various commodities in the economy.

This dissertation has argued that the researcher, especially in this specific field where strategic guidance from the regulator is observed to be poor, should become involved in the strategic positioning of the research. The down side (and especially if the involvement is too intense and close to management of infrastructure planning) is also a possibility, i.e. scientists involved in future studies have indicated that the future that is forecast in such a case could be expressed as a desire to create that specific future. Scientists often refer to "creating the future" – in the words of physicist Dennis Gabor "the future is invented, not predicted".[282] Stakeholders' current and medium-term actions will therefore influence the future that is created.

8.2.1.1 Forecasting agriculture sector

In this sector available forecasts differ widely and it was therefore decided to use the consensus method amongst experts to obtain valid forecasts.

The consensus method involves seeking expert opinions from more than one person. Each is an expert in his own discipline, and it is through the synthesis of these opinions that a final forecast is obtained. This was attained in the model by the involvement of experts from various industries and disciplines within the agricultural sector during workshop sessions and individual interactions. This included developing a narrative of the future, which could later be translated into an actual figure. The results of these sessions were compared to historical trends (trend extrapolation) and debated by agricultural experts to ensure that all known current and future events are discounted in the three forecasting scenarios.

8.2.1.2 Forecasting mining sector

Various published industry sources that are publicly available were used to determine mining output. Where uncertainty existed, specialists within the industry were consulted. Thereafter a consensus forecast was generated between a group of economists and the Department of Mineral and Energy's mineral economists in charge of various mineral groups. Forecasts were compared to historic trends as well as information published by the Department.

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[282] Source: StatPac Inc, http://www.statpac.com.

8.2.1.3 Forecasting manufacturing sector

Standard manufacturing output forecasting models like those of ABSA are available and were used. These forecasts are the results of an elaborate system of quantitative analyses coupled with, and to some extent controlled by, qualitative evaluation of each sector's unique characteristics.

8.2.1.4 Intermediate transactions/demand in the economy

Sections 8.2.1.1 to 8.2.1.3 describe the methodology to forecast the three main sectors individually. However, it is important to take note that these sectors have an interrelationship. An example of this is the agriculture sector that buys materials from the manufacturing sector (for instance, chemicals, fertilizers and fuel) to produce agricultural products. If the agriculture sector expands in terms of certain products, this will have a positive effect on certain manufacturing industries.

The input-output model was used to calculate these various interrelationships by making use of the standard input-output formula to calculate the output per sector by taking into account the interrelationships in the economy. The equation is as follows:

$$q_t = [I-A_t]^{-1}*f_t$$

where

- q = the vector of total sectoral production;
- I = the identity matrix;
- A = the matrix of technical coefficients;
- f = vector of final demand by sector;
- $[I-A]^{-1}$ = Inverse of technical coefficient matrix measuring direct and indirect effects.

The final demand vector f consists of individual demand elements, which are indicated by the symbols c, g, i, s, e and m, where:

c	=	final sales/outputs from the different sectors to households;[283]
g	=	current purchases by the government sector from the different sectors;
iI	=	gross domestic fixed investments (sales/outputs by the different sectors) which are regarded as capital goods;
s	=	changes in inventories. The relevant figure can have either a positive or negative value, depending on whether inventories increased or decreased in the various sectors. The changes in inventories in the Input-Output Table denote the total change of a specific product irrespective of the sector of the economy where the changes occurred;
e	=	exports by the different sectors;
m	=	imports by the different sectors.

If intermediate demand that takes place in the economy is taken into account it could be expected that production of the individual sectors that was originally forecast for the economy, would differ from the results of the input-output system. An iterative process was followed to reconcile the two approaches in the end. The advantage of the Input-Output Model approach is that in the end demand and supply must totally balance, which is the prerequisite of the freight modelling system which follows the forecasting process.

8.2.1.5 Verifying forecasting

Forecasting for all commodities in the model was verified by the Bureau of Economic Research (BER) at the University of Stellenbosch.

It is emphasized again that the objective of this study was not forecasting commodity output, a well researched field in many cases, though detailed commodity forecasts on some commodities are not readily available, but

283 The term “household” implies private consumption expenditure.

rather the modelling methodology required to translate commodity forecasts into commodity flow data. The BER model is discussed in more detail in section 4.

This exercise was undertaken for three scenarios – low road, likely road and high road.

Step 3 – Changing monetary terms to weight

The objective of step 3 is to convert the I-O tables for each year from monetary terms into volumetric terms. The estimation and projection of commodity markets are normally expressed in monetary terms. For this reason most of the modelling is done in monetary terms. However, to facilitate analysis in the transport sector, it is more practical to express production magnitudes in volumetric terms. It was at this point that the production and demand components of the I-O table were converted from monetary to volumetric terms using a rand per ton ratio. This allows for the generation of the total volume (tonnage) that is produced in the economy, which ultimately needs to be transported by South Africa's transport network.

8.2.2 Estimation of freight on a regional basis

The next task was to distribute this national supply and demand on a magisterial district basis.

Step 1 – Regionalising volumes: Identifying regions

Step 1 involved identifying and defining practical and workable regions that could be used to illustrate freight in South Africa transported on a regional basis. Nineteen regions were identified for this purpose. The nineteen regions are based on the 1998 Development Profile, compiled by the Development Bank of South Africa (DBSA), where the provinces of South Africa were divided into a number of sub-regions. The DBSA, in collaboration with development organizations in the various provinces, subdivided the provinces into functional sub-regions for analytical and planning purposes. Some of these sub-regions were then aggregated together to make them even more applicable for transport and planning purposes. They were aggregated on a homogeneous structure from an economic point of view. Areas of similar agricultural economic activity were grouped together. For example, areas in the Eastern Cape comprised mainly of Karoo-type vegetation, where sheep farming is the prominent economic activity, were grouped together. Areas of predominantly grasslands-type vegetation, consisting mainly of cattle ranching, were also grouped together. However, the boundaries of the original sub-regions set out by the DBSA were not broken; the sub-regions were merely added together, creating 19 larger sub-regions (listed in Table 44 and depicted on a map in Figure 34).

Code	Region description	Province
1	Sub-regions 1 and 3 – PE	Eastern Cape
2	Sub-regions 2, 4 and 5 – EL	Eastern Cape
3	Gauteng	Gauteng
4	West Coast – Saldanha	Western Cape
5	Cape metropole & winelands	Western Cape
6	Southern Cape	Western Cape
7	Free State	Free State
8	Eastern, Far Eastern and Central	North West
9	Western and Southern	North West
10	Bo-Karoo, Diamond Fields & Kalahari	Northern Cape
11	Namaqualand, North	Northern Cape
12	West, Lower Orange	Northern Cape
13	Bushveld & Western	Limpopo
14	Northern, Lowveld, Central, Southern & Central	Limpopo
15	Zululand	KwaZulu Natal
16	Thukela, Port Natal, Southern Natal, East Griqualand, Natal Midlands	KwaZulu Natal
17	Lowveld	Mpumalanga
18	Highveld	Mpumalanga
19	Eastveld	Mpumalanga

Table 44 : Regional descriptions

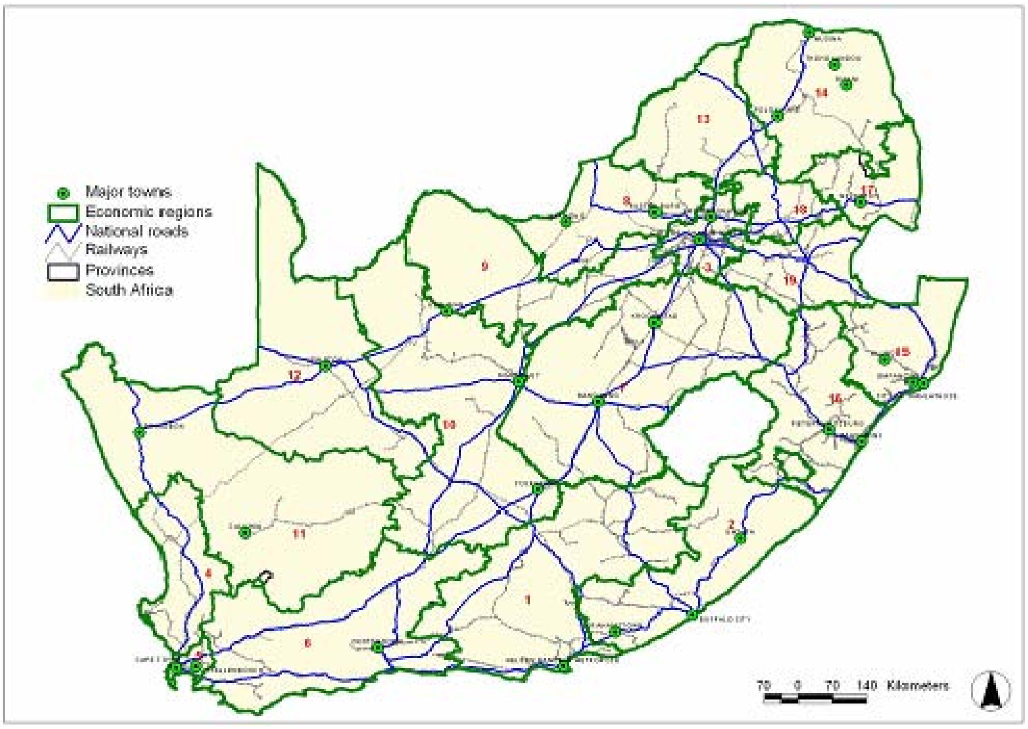

Figure 34: Cartographical indication of regions

Step 2: Regionalising volumes: Apportioning volumes

In this step supply and demand needed to be apportioned to the different regions. The lack of data on a regional basis necessitated the use of secondary keys in certain cases to apportion supply and demand. An approximation method was then used to apportion the demand and supply of a product in these 19-sub regions. The analysis was done on an individual demand-and-supply basis.

An example of this approximation method can be shown by looking at private consumption expenditure. There are no figures available for private consumption expenditure on a product basis in a specific region. Thus various secondary keys were used to develop a structure whereby private consumption of a product can be apportioned to various regions. In the case of motor vehicles for private use, keys such as the following can be used: the distribution of higher-income people in the country; household income, consumption of electricity; car ownership; and the GGP of transport. These secondary keys are then integrated by using weights assigned to each key according to its importance relative to other keys. The total consumption or production of a product was then apportioned on a regional basis using this calculated structure. However, in certain cases, such as for instance the production of maize, there was no need to use this method, as it is possible to identify where maize was produced.

Another example is the case of the intermediate use of coal, whereby intermediate use is estimated from the production of, for instance, electricity (specific coal-fired power-stations and other industries such as Sasol 1, 2 and 3). The location where such industries are situated is known.

Step 3 – From regions to magisterial districts

In this step the apportionments to the 19 sub-regions were advanced to 354 magisterial-district levels. The same essential methodology was used. Magisterial districts are the smallest available geographical unit on which some forms of data are available from time to time. To achieve the scalability objective this is therefore the natural smallest unit that could be used.

8.3 Estimation of flows per commodity

8.3.1 Modelled flows

Estimation of flows per commodity is possible through a gravity modelling approach using supply and demand data. The candidate tested this approach with visualisation tools depicting areas and the application of gravity decay or transport resistance rules per commodity manually on a large-scale map of the country commodity by commodity. (This process involves taking each commodity and writing each supply and demand weight of a commodity on each region in different colours and then doing the gravity-deduced flows according to specified rules manually. The derived flows are then tested and compared with known flows. The process worked, but was far too time-consuming as a tool for the magnitude of the flows in question - theoretically

125 316 flows per commodity). A software program specifically designed for gravity modelling was therefore used with the help of Stephan Krygsman of the Department of Logistics at the University of Stellenbosch.

Gravity-based approaches (according to Krygsman[284]) are based on the premise that trade flows between origins and destinations are determined by measures of supply and demand, and a measure of transport resistance. In such models, according to Rand Europe, “the flow between zone i and zone j is a function of the product of production and attraction measures of zone i and zone j respectively divided by a some measure of the (gereralised) transport cost.”[285] Production and attraction models are derived from zonal trip rate models or Input-Output tables and related models. Input-Output models have been discussed and zonal trip rates for production and attraction “are usually derived from classifying cross-sectional data on transport volumes to/from each zone in the area under investigation into a number of homogeneous zone types.”[286]

These measures can be given in monetary values (values of interaction flows between supply and demand) or in trade flow tonnage, disaggregated per commodity type.

Krygsman[287] further explains that the amount of interaction – freight flows – between two areas is therefore presumed to be directly related to the attraction of the areas and inversely to the distance (or other resistance measure) between the two. The fact that the amount of interaction is related to the distance between origins and destinations means that the attraction value of a destination is inversely proportional to the distance between origins and destinations. And inversely, the interaction between an origin and its surrounding destinations decreases as the destinations are further away from the origin. The function describing the attraction value between origins and destinations within a certain distance is called a distance decay function. The

[284] Krygsman, 2006.
[285] Rand Europe, 2001, p. 7.
[286] Rand Europe, 2001, pp. 4-5.
[287] Krygsman, 2006.

principle of this function is derived from physics, specifically from the law of gravity formulated by Newton.

The measure of transport resistance refers to a transport cost variable of overcoming the spatial distribution between supply and demand locations. Travel time (measured in minutes) or travel distance (measured in kilometers) or a more complex generalised transport cost function combining travel time and cost is often used as transport resistance. The modelling rules for decay in freight transport specifically that arose from the manual test performed by the candidate are:

- Granularity of commodity – Where commodities are defined homogeneously, decay functions are high. This means that commodities that are exactly the same will always be consumed where the demand is closest to production. In cases where the commodity description is broad, decay functions are lower. This means that commodities are often exchanged between regions, because supply and demand that might be in geographical proximity are not necessarily for the same sub-type of the commodity;
- Brand considerations – Brand considerations work in the same way as granularity, except that certain high-value commodities, such as cars, might have a fine granularity of description, but very high brand affiliation;
- Value – Value combines granularity and brand in that low-value commodities will tend to increase the decay function irrespective of brand;
- International borders and geographical and other spatial characteristics can also advance the decay function.

In the application of these rules on the computer model, three types of distance decay functions are usually used (and tested for appropriateness):

- A neutral function. This is used only to demonstrate that there actually is distance decay. It was only used to test various trade flows and whether or not any distance decay does exist;
- An exponential function. Compared to a power function (see paragraph below), an exponential function represents a quickly declining distance

decay. Based on Spoornet data, various commodities were modelled using this function;

- A power function. Compared to an exponential function (see paragraph above), a power function represents a gradually declining distance decay. This is often the case with commodities such as manufactured foods.

The functions used in this specific model are summarised in Table 45. The generation of decay functions is a specific study in itself and the research in this dissertation did not include further analysis of the appropriateness of specific techniques to develop these functions. This a suggested topic for further research and for that reason the decay functions actually used are given. A follow up study in the use of gravity modelling for freight flow quantification per commodity could research this specific aspect further.

Commodity	**Distance Decay Function**	**Distance Decay Parameter (Beta)**
Manganese	Exponential	0.0009675
Cement	Exponential	0.0064419
Bricks	Exponential	0.035
Other chemicals	Exponential	0.035
Coal mining	Exponential	0.0417226
Stone quarrying: Other	Exponential	0.0417226
Stone quarrying: Limestone	Exponential	0.0417226
Other basic iron and steel products	Exponential	0.0417226
Mining of chemical and fertilizer minerals	Exponential	0.0417226
Industrial chemicals	Power	0.01
Automotive	Power	0.01
Processed foods	Power	0.15
Beverages	Power	0.15
Break bulk	Power	0.15
Dry bulk	Power	0.15
Perishables	Power	0.15
Wood and wood products	Power	0.5
Other non-metallic minerals	Power	0.5
Crude petroleum and natural gas	Power	0.5
Non-ferrous metal basic products	Power	2
Fertilizer	Power	2
Fuel & petroleum products	Power	2

Chrome	Power	2.041654
Iron ore	Power	2.776749
Maize	Power	4
Sugar cane	Power	5.6

Table 45: Decay functions for various commodities

In general, one of the generic approaches available consists of three formulas:

$Tij = Ai.Bj.Oi.Dj.f(Cij,b)$……………………………………………………(1)

$Ai = 1/(Sj.Bj.Dj.f(Cij,b))$…………………………………………………(2)

$Bj = 1/(Si.Ai.Oi./f(Cij,b))$…………………………………………………(3)

$f(Cij,b) = \exp(-b.Cij)$ in case of an exponential function

$f(Cij,ß) = Cij^{-ß})$ in case of a power function

where:

Tij = the estimated number of trips between origin i and destination j

Ai = the balancing factor for origin i

Bj = the balancing factor for destination j

Oi = the constraint value for origin i

Dj = the constraint value for destination j

b = the distance decay parameter

Cij = The distance between origin i and destination j

The balancing factors ensure that the sum of the estimated outflows per origin equals the known origin total, and the sum of the estimated inflows per destination equals the known destination total.

Formula 1 calculates the actual trips in the origin/destination matrix. Formula 2 equates the total number of trips from origins in the matrix to the set number (the “origin constraint”). Formula 3 equates the total number of trips to the destinations in the matrix to the set number (the “destination constraint”).

The value of the distance decay parameter should be known before the equations above can be solved.

In order to derive a distance decay parameter, observed freight flow information and distance or travel time between the various supply/demand locations are required. The latter requires, for each origin-destination pair, a distance/travel time measure of separation. The travel time/distances can be based on airline (straight line) distances or on a transport (rail/road or intermodal) network. As no suitable (that is connected or cleaned network) rail network existed, a national rail network had to be constructed for South Africa. Travel distances between all origins and destinations were derived using this network. Transport costs (or a generalised cost) could not be derived as costs (freight rates per commodity per distance) were not available.

In addition to the rail network, a detailed national road network was also constructed. This allowed road travel times (and costs) to be estimated between the various origins and destinations. While this is not directly relevant for this study, it does allow researchers to assess the travel time differential between road and rail for the origin-destination pairs. The travel time differentials (and function derivatives such as the travel time ratio = travel time by road divided by travel time by rail) has been known to play a key role in road/rail mode choice decisions. This information will be incorporated in future versions of a commodity flow model.

Observed (i.e. rail) freight flows provided information on the travel distance that freight was moved. Existing freight flow information is used to calculate the mean trip length (MTL) of the observed trips. With this information the distance (decay) freight will be transported (for the different commodities) can be calculated. The calculated mean trip length of observed freight flows and the origin/destination distance matrix is subsequently used as input to calculate the distance decay function.

Unfortunately, due to the fact that only actual rail freight flow information is available (which in most instances accounted for only a small market share), the distance decay could not be derived (for all commodities) from these observed data. Based on hypothesized distance decay supported by theoretical knowledge gained from the visualisation exercise, various distance decay parameters were tested (and compared where possible) with rail data. The 'best fitting' distance decay parameters were subsequently selected.

Gravity models, as discussed above, are the most widely used approaches internationally to distribute freight flows between origins and destinations and have been operationalised in various international freight flow models, including the Dutch SMILE (Strategic Model for Integrated Logistics Evaluations) and TEM (Transport Economic Model),[288] the Finnish study on different distribution models and the Great Belt traffic model.[289]

8.3.2 Enhancing modelled flows based on the Pareto process

Once commodity flows were estimated, the top 23 commodities by weight (approximately 90% of total weight) were investigated further by desktop research and interviews to compare modelled data with what could be established in real life. All discrepancies were investigated to:

- Improve the modelled data in the I-O approach, but also to improve the actual workings of the model – this means that the data were improved for the commodities investigated, but the improvement of the model also caused improvement of data for commodities that were not investigated, through application of the rules that could be generated by the research.
- Improve the modelled data of the flow model, but also improve the actual workings of the model – with the same data improvements for uninvestigated data as for the I-O model relating to decay functions.

The approach therefore allowed for both highly reliable models and flow data.

288 Raha and Williams, 2002, pp. 38 and 40.
289 Rand Europe, 2001, p. 7.

8.4 Long-term forecast of the South Africa economy – the validation process

The BER's (Bureau of Economic Research) long-term forecast of the South Africa economy was used to validate the forecasts used in the I-O model.

8.4.1 Broad methodological processes

The BER's methodology broadly consists of three processes.

- Generating a standard macro-econometric forecast of the SA economy over the forecast horizon, 2006 to 2025. Assumptions are made for the exogenous variables in the model; simulations were run and then subjectively adjusted by BER researchers. The output of the model consists of the main expenditure components of GDP (household expenditure disaggregated into 22 sub-components; fixed investment into 5 asset categories), imports, exports, balance of payments data, price and financial variables (see a description of the model below). A long-term forecast is essentially a trend forecast. It is not possible to project the business cycle over a 20-year period, something which can be done over a 5-6 year forecast period. It is therefore acceptable to provide projected growth rates in 5- or 10-year averages. It is also important to conduct a proper supply-side analysis from a growth accounting point of view. This entails an analysis of the economy's production potential, being a function of three variables, i.e. the growth in the fixed capital stock (determined by the fixed investment rate), the growth in the labour force (or employment) and, thirdly, the growth in Total Factor Productivity. The BER's macro-econometric model contains such a (Cobb-Douglas) production function.
- The expenditure component forecasts were then fed into Quantec Research's RSA Inter-Industry input-output model to estimate real value-added, output, employment, import and export growth across 46 industry groups based on the BER demand-side forecast.
- These projections were then evaluated and adjusted where necessary by BER researchers.

For the purpose of this study, where the BER had been tasked to evaluate the macro-economic assumptions and projections underlying the freight flow projections, a demand-side macro-econometric long-term forecast was compiled (2006-2025) and used to recalibrate an existing supply-side projection compiled in January 2006. Given the nature of the macro-econometric modelling, the BER could not evaluate the projections for the individual commodities. The BER/Quantec projections were used as a control for the aggregated sector projections.

8.4.2 The BER's macro-economic forecasting model

The broad structure of BER's model can be described as that of a demand-orientated macro-econometric model. Although the model essentially determines South Africa's gross domestic product (GDP) from the demand side (i.e. GDP is determined as the sum of final consumption expenditure by households, final consumption expenditure by general government, gross fixed capital formation, inventory investment and exports of goods and services, less imports of goods and services), specific supply elements in the form of a measure of potential output and economy-wide capacity utilisation have been included in an attempt to capture the production side of the economy. Capacity utilisation, which is measured as the inverse of the gap between actual and potential output, enters the equations for imports and prices as a variable supply constraint.

The BER's model of the South African economy contains 135 equations, of which 30 are econometrically estimated equations and 105 are identities and transformations. The latest version of the E-views econometric package, E-Views 5, was employed to estimate the equations and to compile the model. Co-integration techniques were used to estimate the majority of the behavioural equations in the BER's model. These techniques have several advantages compared to the standard techniques such as Ordinary Least Squares (OLS). The most important advantages are that they provide an answer to the so-called spurious correlation problem and provide for specification of both the long-run theory-based relationships between the variables as well as the short-run dynamic relationships.[290]

The BER also verified the sectoral forecasts (i.e. on a sector level rather than commodity level).

8.5 The final model output

The final model output was a 2006 view as well as a forecast view of 2006-2020 of all land freight transported in South Africa, per commodity, between 354 possible locations (origins or destinations). This specific output provided, for the first time in South Africa's history, an answer to a question posed by Verburgh in 1957 and for which Verburgh, Smith, Hamilton and Pretorius sought to find a solution, but couldn't with the survey approach that they used. This made it possible to at least begin to make infrastructure investment decisions based on what the economy would require rather than what politicians dictate.

[290] Laubscher, 2006.

Chapter 9 - Commodity flow model results and strategic interpretation

9.1 Introduction

The application of the commodity flow model to the South African economy requires a few initial modelling rules around scenario delineation. Commodity-level forecasts were produced for three growth scenarios, i.e. low growth, high growth and likely growth. The underlying macro-economic assumptions for the scenarios assume ongoing political stability and that the government continues to provide market-friendly economic policies. Furthermore, it is assumed that the new economic growth strategy (ASGISA) and its successors are reasonably well implemented and supported by the private sector and other stakeholders. Monetary policy will continue to be conducted within an inflation-targeting framework and the target remains at the current 3-6% range. Fiscal policy also continues to be characterised by disciplined expansion as has been the case since 2001, resulting in budget deficits ranging between 0 and 3% of GDP. These broad assumptions were therefore accepted as the likely scenario for the forecasting framework in which the model was developed whilst more onerous assumptions as a low growth scenario were used.

The assumptions and scenario delineation were discussed with economists in detail, but it is once again emphasised that the objective of the modelling exercise was not forecasting per se, but the creation of the tool. (It is true that the tool will be worthless without decent forecasting, but the process of forecasting is not the focus here.)

9.2 Analysis of the economy by weight

The first consideration of this process is to model the weight of the GDP of South Africa, i.e. to determine the total tonnage produced and imported into South Africa or consumed and exported from South Africa. Although total production and imports were 575 million tons in 2004, with mining supply at 379 million tons, agricultural supply at 55 million tons and manufacturing supply at 142 million tons, the fastest growth rate over the past 70 years was achieved for manufacturing (Figure 35).

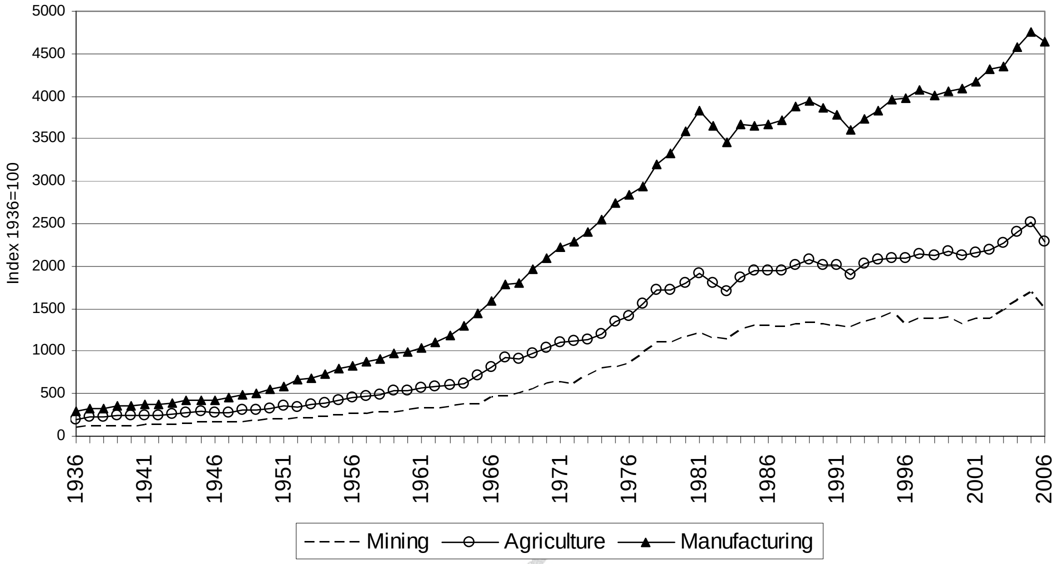

Figure 35: Growth rate of economic sectors by weight

Transport strategy in South Africa up to 1990 was to concentrate on agricultural transport in rail, to develop mining rail solutions and ignore densification of the manufacturing economy on corridors. An analysis of growth rates in the economy by weight alone and coupled with the now known growth rates and modal shifts on corridors, indicates the inappropriateness of this strategy, to some extent because it was informed by little or no research data.

The results of the forecasting generate the following view of the future economy in terms of supply in tons (Figure 36).

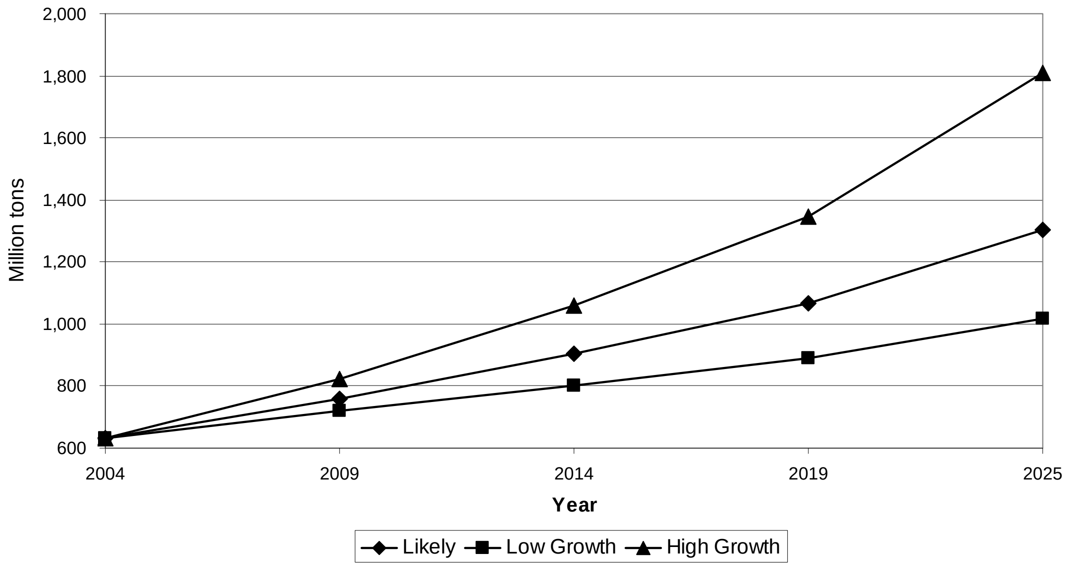

Figure 36: Expected future supply and demand in the South African economy

Supply and demand does not equal freight movements over the typologies as the same freight would sometimes utilise more than one typology or sub-typology. A link is therefore required between the future view of the economy by weight in tons and the number of times, on average, each ton would be observed on the typologies. The four measurements taken between the 1993 and 2004 (Table 46) suggest that this figure is growing inversely exponential and it looks like a flattening could occur at approximately 2.3 observations, but further research is necessary (Figure 37).

	Economy by weight (millions)	**Observed on typologies (millions)**	**Number of times observed on typologies**
1993	477	870	1.82
1997	506	1 053	2.08
2003	542	1 225	2.26
2004	575	1 307	2.27

Table 46: Number of times each ton produced is observed on typologies

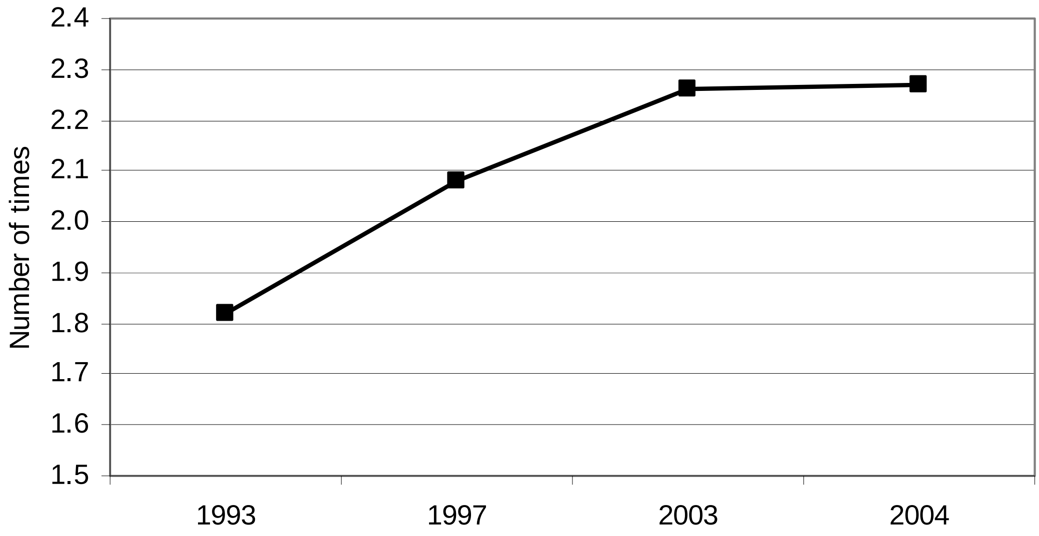

Figure 37: Flattening of number of times freight appears on typologies

It would seem that the number of observations over all typologies of each ton is increasing, but the growing granularity of the truck counts based on an increasing number of counting stations should be taken into account. The figure (observations of each ton over all typologies) grew by about 3.4% per annum between 1993 and 1997, 1.4% between 1997 and 2003 per annum and 0.5% between 2003 and 2004. A flattening of this increase is therefore observed that could flatten out completely at about 2.3 observations per ton, given the current trend. This would suggest that the current 1.3 billion tons observed on the typologies could grow to more than 4.1 billion tons in the next 20 years.

The previous Verburgh, Smith, Hamilton and Pretorius surveys indicated a reverse trend. A decoupling of the relationship between shipment volumes, average length of haul and GDP was reported by Raha and Williams for the United Kingdom since the early 1990s,[291] but in a recent study by Verny[292] the number of times that the transportable economy is transported for Europe shows an increasing trend (though still correlated), which agrees with the observations of this study (Figure 38).

[291] Raha and Williams, 2002, p. 47.
[292] Verny, 2007, p. 120.

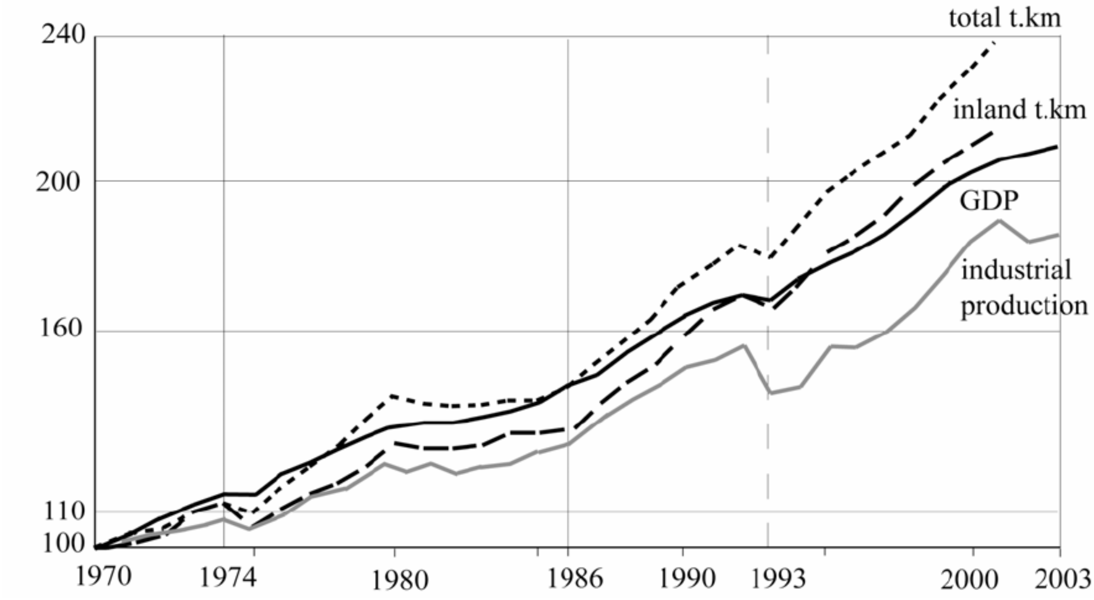

Figure 38: Verny's observation of freight transport statistics and GDP figures for Europe

It could be that this trend is related to economic maturity, but further observations would be necessary to clarify this point. It does seems as if Raha and Williams's further observation, i.e. that structural changes, caused by modal shift, caused the decoupling (they talk about modal shift causing improved road productivity and length of haul)[293] and if this is true it can be hypothesised that the figure for the number of times that the transportable GDP is transported will rise initially, but then stabilise as the structural effects of modal shift stabilise. This observation, if proved correct, will also correlate with the findings of this study.

It is at this point of the analysis that the commodity flow model begins to inform strategy in a real way, in that this growth cannot inform long-term infrastructure investment decisions without understanding where infrastructure would be needed, and the size and type of infrastructure that should be developed. These questions require a consideration of the types of commodities that will need transportation and the typologies on which the transportation needs per commodity will be required.

[293] Raha and Williams, 2002, p. 47.

9.3 Commodity growth

At a commodity level the growth in economic demand for the top 23 commodities by weight is shown in Figure 39 below.

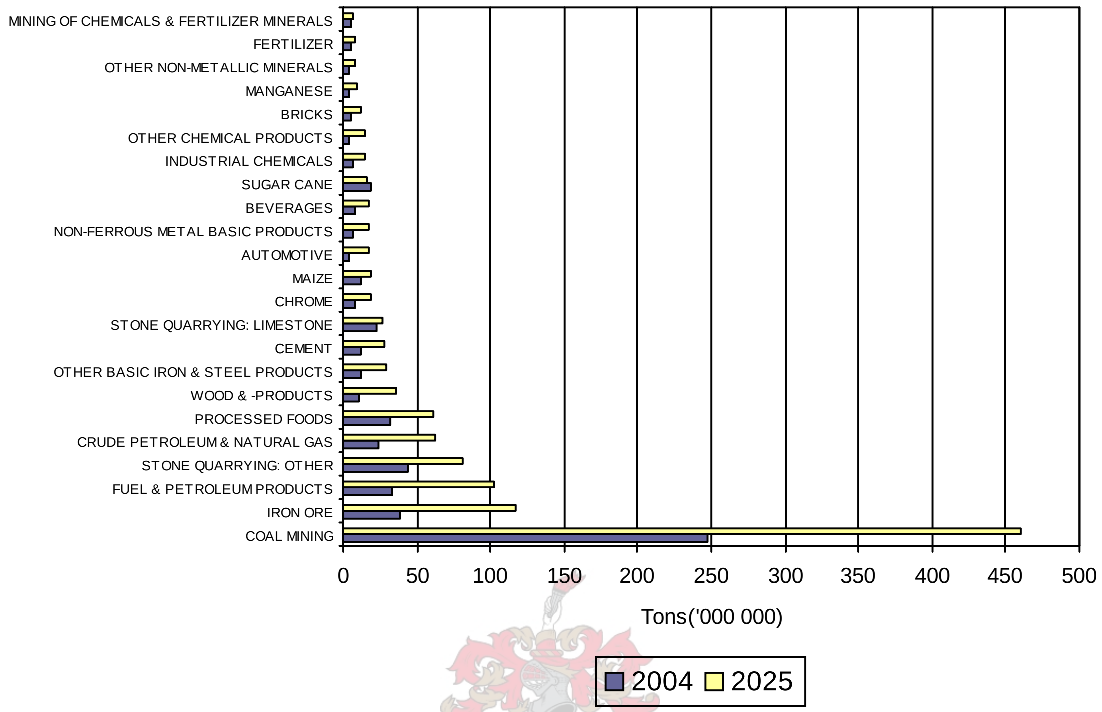

Figure 39: Growth in demand by weight of the top 23 commodities[294]

The demand for commodities can also be depicted by showing the growth in tons excluding coal (coal is the only commodity in South Africa that is often used by mine-mouthed industries, mostly electricity and conversion to fuel and other chemicals, therefore excluding 60% of the commodity from road and rail transport demand – a further 30% is transported on a ring-fenced export machine with defined and known needs). The results show that the economy will grow the fastest by weight in basic energy-related commodities, basic earthworks, and building-related and food commodities (Figure 40).

[294] The 2025 forecast that was originally used, were changed to 2019 for further analysis due to specific data constraints.

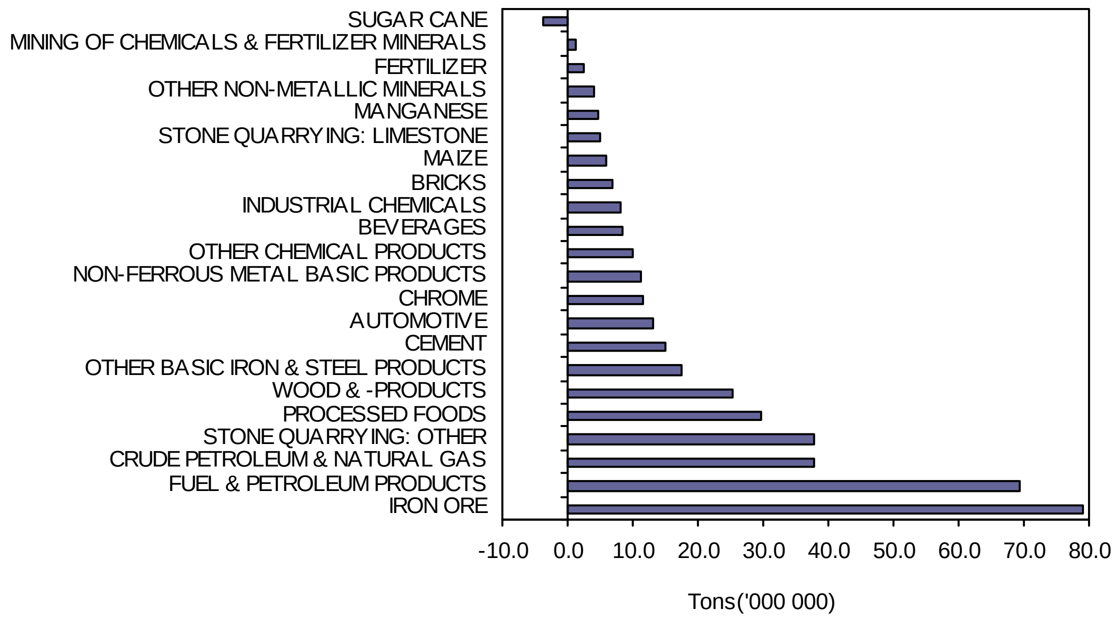

Figure 40: Growth in demand by weight for top 23 commodities (excluding coal)

When depicted as a percentage growth, however, it is apparent that growth in beneficiated products will be far greater than in unbeneficiated products (Figure 41).

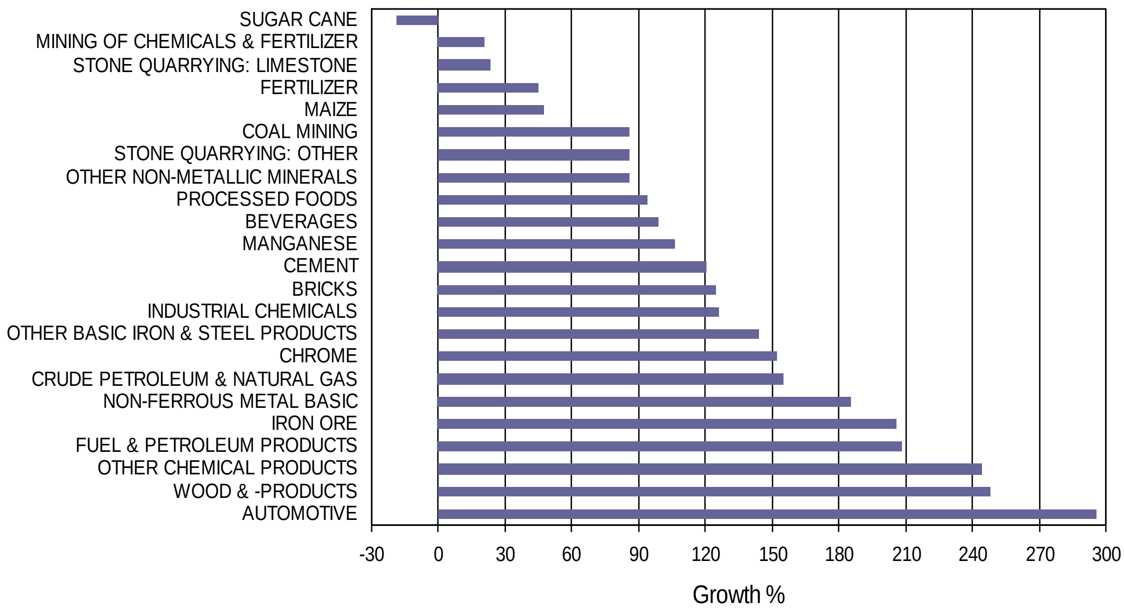

Figure 41: Percentage weight growth in commodities

This analysis indicates that it is not only apparent (as shown in the previous historical analysis) that the manufacturing sector is growing faster by weight, but also that some of the high-value elements of the manufacturing sector are growing faster than the lower-valued elements. The observation about the folly of previous investment decisions is therefore highlighted and it should be remembered that this view is not necessarily commonly known, as the sheer size and voice of the mining community by weight tended to overshadow the wisdom of other points of view.

The next step in the process is to answer the question of where these commodities will flow by applying the commodity flow model to the data. The data could potentially generate 354 by 354 by 23 distinct observations (i.e. close to three million observations, if 23 commodities are used) and it was therefore decided to concentrate on corridor flows for this analysis.

9.4 Corridor demand

In the calculation of corridor demand, a different approach was used to define corridors than the one used in the NFFM. This is because the model is an origin to destination-type model and not a model based on physical counts of truck movements. Furthermore, certain choices are involved in deciding to what extent certain origin to destination pairs are linked to a corridor or not. The final refinement of this approach would be to link the model to a geographic information system tool to inform this mapping more scientifically – a line of further research that is proposed in this dissertation and in which the candidate is already involved.

The definitions used were quite flexible in defining specific origin to destination pairs on corridors. This means that if an origin to destination pair was deemed to include the corridor infrastructure for more than 50% of the possible route, the traffic was included on that corridor. Clearly a geographic information system tool will inform this part of the model design better and should be applied.

On two corridors a close correlation was found between the models. The national freight flow model estimated the South Eastern corridors to carry 15.4 million tons of freight compared to the 14.7 million tons of the commodity flow model. The Gauteng-Durban corridor was estimated to carry 43.4 million tons by the national freight flow model and 42.2 million tons by the commodity flow model. It is believed that the same level of correlation could be possible if:

- The model run is repeated with less flexible corridor descriptions;
- A geographic information tool is used as a platform for both models.

The analysis shows that freight demand will continue to concentrate around the main freight corridors, if change in the current spatial structure of the economy is not engineered over the medium to long term. This is fortunate, since it allows for the construction of a high-density core network which will reduce unit transport costs and allow for the focusing of investment.

Figure 42 below shows the total growth in corridor freight on the eight biggest freight corridors in the country. The forecasted demand suggests that it will be practically impossible to provide the infrastructure that the economy will need in the same rail/road configuration than is currently the case. Even the doubling of current rail supply will mean that road volumes will have to increase by 60 percent on average to meet demand in 2019 and almost double by 2025. By 2025 this will make transport extremely expensive, even if the extrinsic costs of road transport supply are excluded. Finding a sustainable way to address the challenge of the growth in corridor freight is a strategic priority for the country.

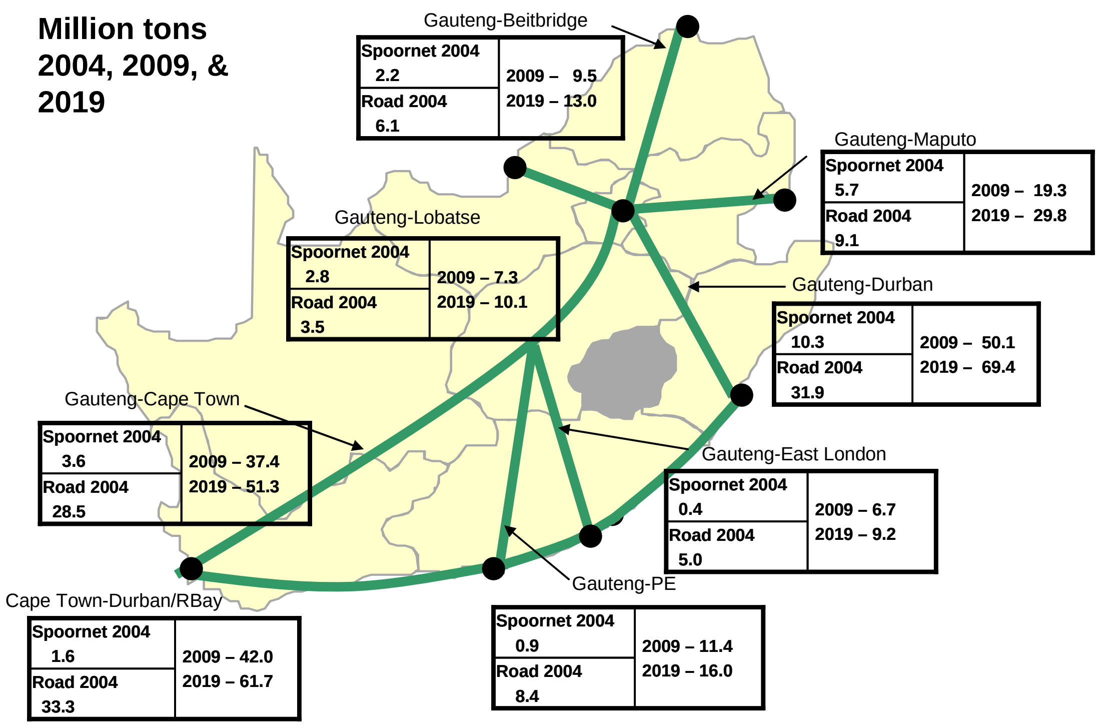

Figure 42: Expected growth in total traffic on corridors

Corridor freight can typically be categorised as dry bulk, break bulk and liquid bulk. Figure 43, Figure 44 and Figure 45 below show the projected corridor demand for these categories.

Dry bulk demand will grow, but not very rapidly. In percentage terms, the Gauteng-Maputo corridor is expected to display the largest growth in dry bulk freight as the Maputo corridor is developed, because Maputo is closer to Gauteng than the other coastal harbours. Steady growth is expected on the Gauteng-Durban and Gauteng-Cape Town corridors as well. Rail's under-supply of dry-bulk requirements (as evidenced by its low market share) is clear and unambiguous proof of under-investment in infrastructure. It also represents most of the traffic that is well understood by rail marketers and some of the first flows that should be targeted for a possible modal switch.

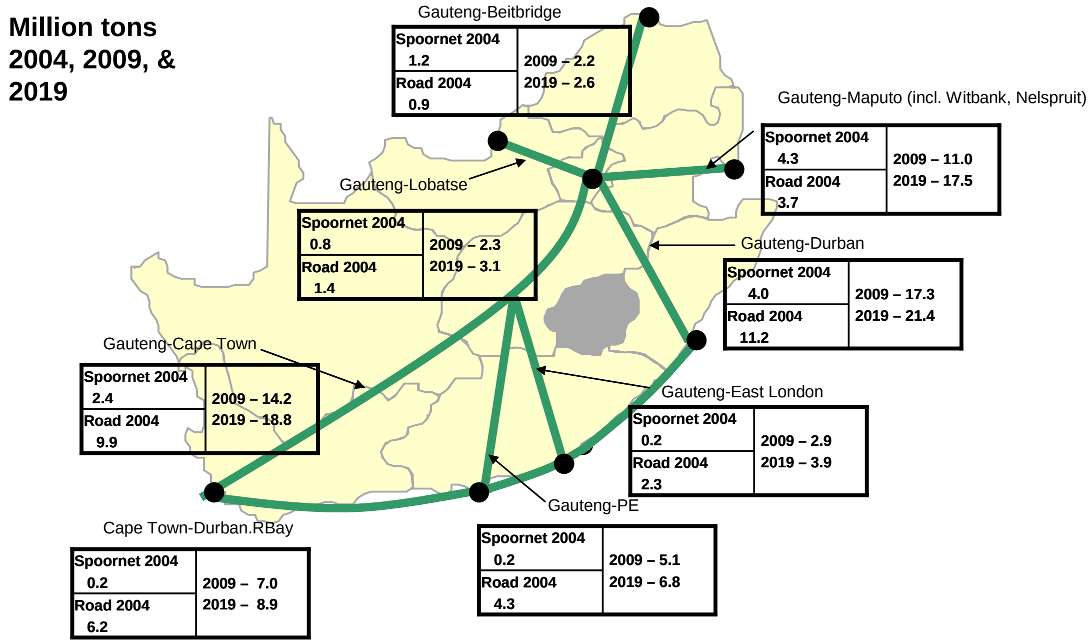

Figure 43: Dry bulk corridor demand

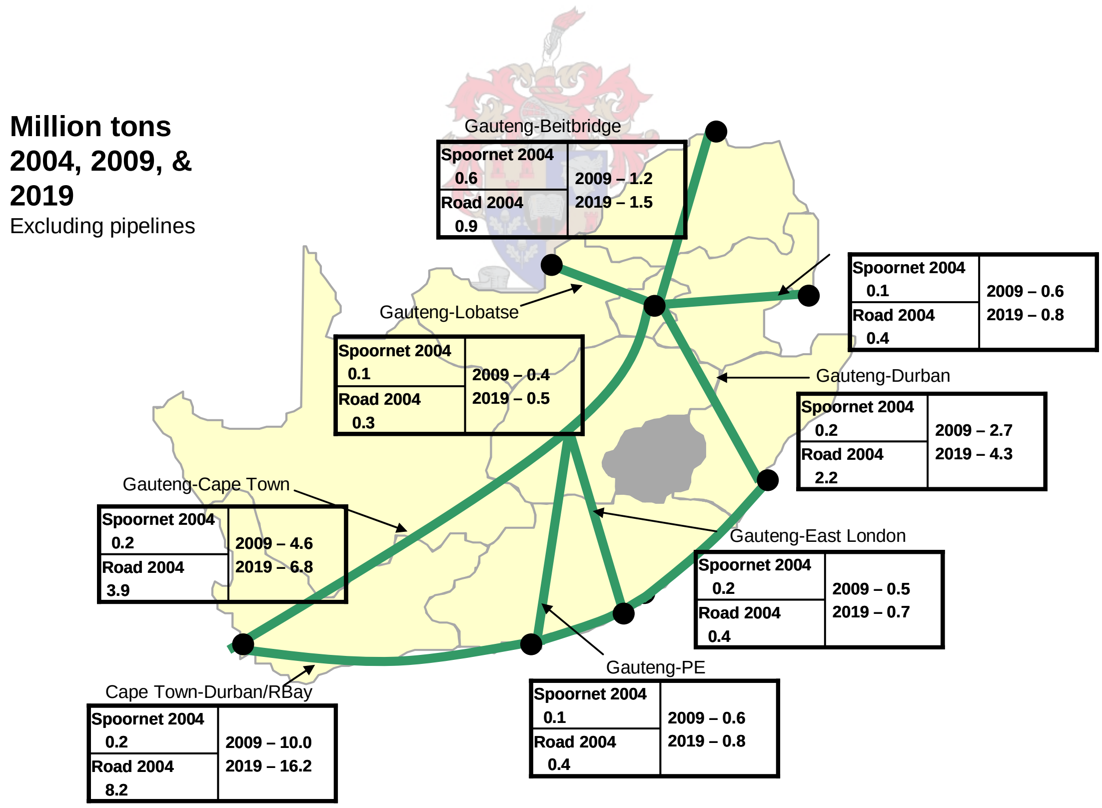

Figure 44: Liquid bulk demand on corridors (excluding pipelines)

Liquid bulk demand (excluding pipeline demand), on the other hand, is expected to show very little growth. It is anticipated that the bulk of new corridor demand will be accommodated by the pipeline network.

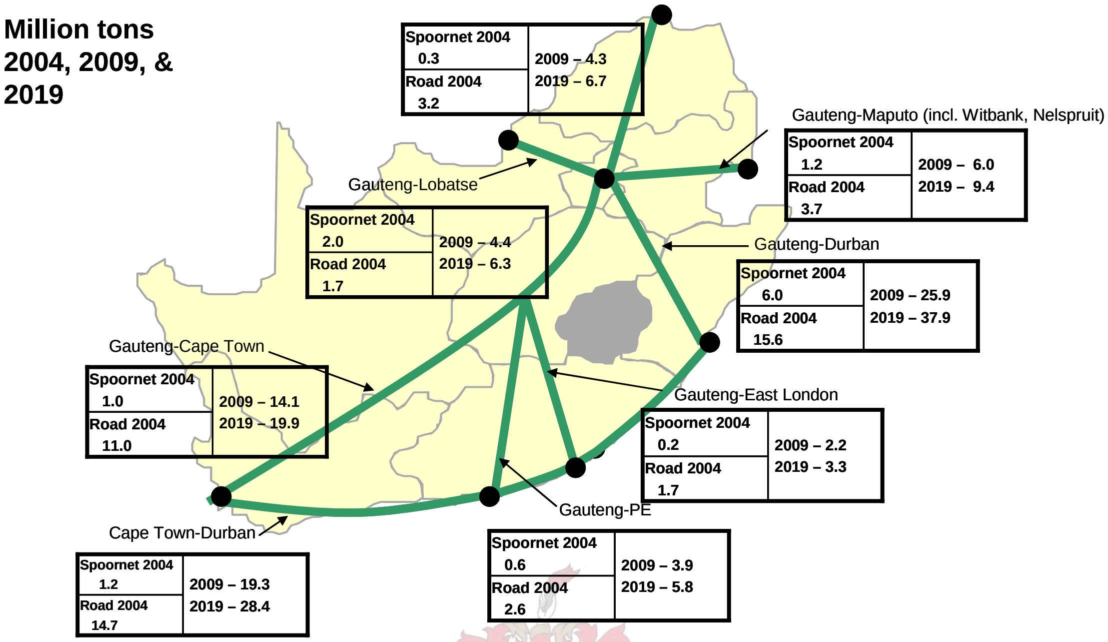

Figure 45: Break bulk corridor demand

It is estimated that about 80% of non-bulk dry and liquid cargo worldwide moves in containers (Figure 46).

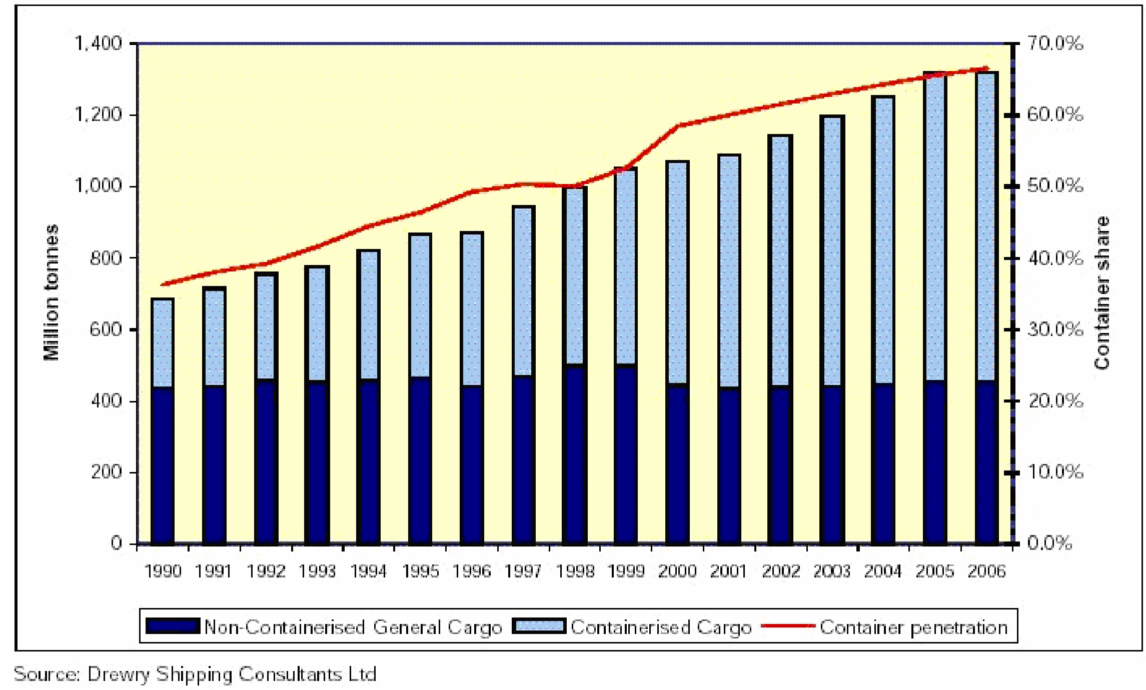

Figure 46: Containerisation propensity[295]

As international trade volumes continue to grow, developed countries in particular are driving the further containerisation of break bulk freight. The propensity to containerise will increase over the next 20 years, which will lead to an even faster growth in traffic that could easily use intermodal facilities.

This situation clearly points the way towards an intermodal strategy and the availability of intermodal facilities where break bulk reaches critical densities. This level is deemed to be four million tons of break bulk on any corridor longer than 500 kilometers, based on Harris's work, which will be explained further in the next chapter.[296]

In order to understand this situation an analysis was done to determine how much freight will be connected by intermodal facilities through a network of connections as each new node in the network is commissioned. (The analysis was based on terminal density in Gauteng – i.e. it was done in

[295] Container penetration refers to the degree to which all cargo that could be containerised actually is containerised.
[296] Harris, 1977, p. 563.

declining order of the weight of freight arriving and departing from Gauteng for each node by weight). (Table 47)

Tons added to Gauteng as node as each connection in terms of total and break bulk is added						
	Tons 2004		Tons 2009		Tons 2019	
	Total	Break bulk	Total	Break bulk	Total	Break bulk
Durban	42	22	50	26	69	38 (c)
+ Cape Town	74	38	92	45	130	66
+ Maputo	89	43	111	51	160	75
+ Port Elizabeth	98	46	122	55	176	81
+ Lobatse	104	50	129	59	186	87
+ Beitbridge	113	54	139	63	199	94
+ East London	118	54	146	65	208 (a)	99 (b)

Table 47: Impact of a cumulative set of intermodal facilities

This means that, if all freight is containerised by 2019, total freight between Gauteng and the other seven nodes will amount to 208 million tons, with 99 million tons of break bulk translating into about nine million loaded containers (TEUs) in Gauteng (see (a) and (b) in Table 47). It also means that 38% [(c) as a percentage of (b)] of the potential domestic break bulk intermodal solutions could be achieved in 2019 by a solution connecting Durban and Gauteng. This figure will increase to 67% by adding Cape Town, 76% by adding Maputo, 82% by adding Port Elizabeth, and so forth. For the first time in South Africa's history a planning hierarchy, based on actual commodity flow data, can be developed.

9.5 The indirect advantages of commodity flow views

Some indirect advantages of a commodity flow view were also identified. Of these the most important was the settling of the harbour-hinterland debate. In the absence of actual data, major corridors are often seen as feeder routes to and from ports. This approach means that the corridors are often expected to be "geared" to function as such and that major interventions, like the movement of terminals from one port to another or the development of new infrastructure at one port rather than another, are expected to have a major effect on corridor density.

This situation is especially true for South Africa's major general cargo port, i.e. Durban, and its major hinterland feeding route, i.e. the N3 from Durban to Gauteng. Of the 22 million tons of imports and exports handled by the harbour in 2004, it would have been difficult to estimate what tonnage would be used on the corridor, but all documents, plans and approaches for the corridor usually assume that this number is high. A simple population density assumption (which says that 50% of total tonnage is for local and direct hinterland consumption and 50% for consumption around the corridor hinterland) would mean that 11 million tons of the 42 million tons would be classified as port traffic on the corridor. With commodity matching (i.e. now having data with a finer granularity) and even with the most negative assumptions around the calculation – i.e. allowing for a two-thirds consumption of harbour imports at the end of the corridor per commodity and allowing for two-thirds exports for commodities coming from the Gauteng end of the corridor, it is difficult to identify more than 10% of traffic on the corridor that relates to the port – the figure is probably lower. (This calculation means, for example, that if the quantity of rice imported through Durban harbour is known – and it has usually been known up to now, though not always – and if the amount of rice that flows north on the corridor is known, a limiting factor for rice emerges. If more rice is on the corridor than the quantity imported, the rest must be domestic traffic, plus at least some of the rice that is imported must be for consumption in Durban. By repeating this sum per commodity and also doing the sum the other way around for exports, clarity can be achieved on the maximum of freight on the corridor that relates to harbour activities – and this volume is much lower than what is often expected). The case for information clearly emerges from this case study.

- In many reports today the corridor is still classified as a major contributory feeder to the harbour and its raison d'etre described as such.
- An analysis of traffic flows on corridors indicates that at least 75% of the traffic on the corridor is unrelated to the harbour.

- An analysis of commodities on the corridor shows that at least 90% of the traffic on the corridor is unrelated to the harbour.

It is true that the corridor is important for the port, but not necessarily the other way round. If this insight can be confirmed, the case for domestic intermodal traffic could have been made earlier and the problem of spatial organisation (or rather disorganisation) identified earlier.

The spatial challenges are not only an issue for South Africa's densest corridor, but also for the second biggest corridor, i.e. Gauteng to Cape Town. In the 1970s Gauteng industries consolidated and mining experienced exponential growth. This situation changed around as many large companies moved their headquarters to Cape Town, professionals relocated there and the deregulation of agricultural industries encouraged market entry. These aspects stimulated growth in the Western Cape (Figure 47) and increased the bidirectional food traffic between Gauteng and Cape Town. This situation went by "unnoticed" by freight and logistics planners, as no flow model existed to inform planning. The corridor grew faster over the 11-year period between 1993 and 2004 than the Gauteng to Durban corridor (135% vs. 26%) and the expected growth in bidirectional processed foods creates specific opportunities for national efficiencies to serve spatially disabled markets, as discussed below.

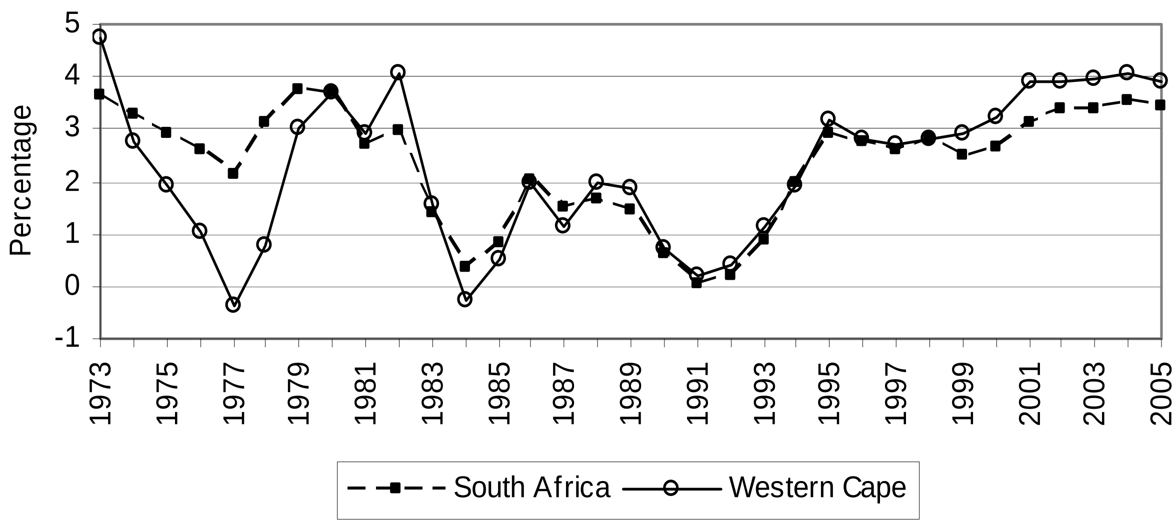

Figure 47: Western Cape vs. South African GDP growth

9.6 Understanding break bulk commodities – the case of processed foods

Processed foods is an important commodity that is transported between the three major nodes of Gauteng, Durban and Cape Town, amounting to 12.3 million tons in 2004 and forecasted to be 19.6 million tons by 2019.

About 50% of the break bulk commodities between Gauteng and Cape Town is processed foods and this position will not change by 2019. This figure is about 30% for the corridor between Gauteng and Durban and will not change relative to other commodities over the medium term. The model indicates that 2.8 million tons of processed foods flowed from Gauteng to Cape Town, and 3.2 million tons in the opposite direction from Cape Town to Gauteng. It further predicts that this distribution should be close to perfect balance in 2019, with 4.6 million tons of processed foods flowing in both directions. Between Durban and Gauteng 4.2. million tons of processed foods flow from Durban and 2.1. million tons in the opposite direction. This distribution should remain more or less the same by 2019, when 7.0 million tons is predicted from Durban and 3.4 million tons towards Durban.

This densification of a single commodity group (all perishables and liquids were excluded from this comparison) on two corridors with a combined length of more than 2 000 kilometers and a near perfect bidirectional flow, connected at a single congested node, i.e. Gauteng, is a clear and unambiguous indication of intermodal solutions. Never before has this case been stated in such stark and incontestable relief.

This case, as a specific opportunity within the break bulk flows, will be analysed further in the next chapter, once costs can be added to the analysis.

9.7 Conclusion

The commodity flow model described for the first time specific demand conditions for freight and logistics infrastructure now and in the future. It also highlighted errors in certain assumptions about freight types in South Africa and specific opportunities that had never before been identified.

The commodity flow model is now ready for an update and will be updated on an annual basis (should funding be available) in the quest for finding solutions to South Africa’s spatial challenges. The final element in macro-economic understanding of transport and logistics in South Africa is an understanding of costs.

Chapter 10 - Logistics cost perspectives

10.1 Introduction

During the course of the research to determine modal market share the need arose also to develop an understanding of logistics costs in South Africa. It has been hypothesised already that surface freight transport is a big challenge in South Africa, probably more than in most other countries because of this country's spatial challenges. The rest of the world has, however, moved on to a holistic logistics view, of which transport is seen as but a subcomponent.

It should be remembered that transport is:

- The largest cost factor in South Africa;
- The most noticeable administered cost;
- The most visible in terms of modal competition or coopetition.

Transport also requires the most investment for combined domestic as well as international freight movements.

A view of total logistics cost in South Africa would therefore:

- Make the picture more complete and enable planners to understand transport in its total context, understand the various relationships of logistics stack elements and provide a complete view of logistics infrastructure requirements in South Africa;
- Close the loop to determine performance of macro-logistics, also for transport.

During the period in which the models in this dissertation were applied (between 2005 and 2007), the initial aim was to determine logistics costs and therefore the state of logistics in South Africa, but the scope of the dissertation was changed to concentrate on the finer details of the transport dimension of logistics, such as modal market share, freight flows and commodity flows. Whilst the candidate concentrated on this research and the spatial challenges presented by transport, he initiated and obtained funding for a task team of researchers at the Logistics Department at the University of Stellenbosch to develop a logistics cost model of the South African economy. The challenge was to incorporate the findings of such a model into the findings of the candidate's own research.

10.2 The development of the model

Botes et al.[297] refer to current methodologies on logistics costs measurements and Delaney's popularisation of the concept. Delaney applies a transportation cost component using Smith's methodology and an inventory carrying cost component using the Alford-Bangs formula.[298] The accuracy, difficulty of compilation and unsuitability of the methodology for logistics cost calculation are well described by the researchers (Botes et al.), but the historical context is of interest and is described below.

As mentioned in Chapter 2, it is clear that the Delaney study still applies the Alford-Bangs formula,[299] which is usually quoted from Alford and Bangs's work of 1955 (probably because when Delaney himself sets out his approach, he quotes the 1955 version[300]). The original work, published in 1944, almost certainly contained the formula, but the candidate could locate only the 1946 edition. In the 1946 edition the formula is described[301] and the authors initially estimated an inventory carrying charge of between 10% and 20%.[302] 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.[303] 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

[297] Botes et al., 2006, p. 3.
[298] Botes et al., 2006, p. 5.
[299] MacroSys Research and Technology, 2005, p. 6.
[300] Delaney, 1987, p. 6.
[301] Alford and Bangs, 1946, pp. 396-397.
[302] Alford and Bangs, 1946, p. 396.
[303] Alford, 1941.

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[304].)

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. Researchers who insist on the finest detail of absolute correctness will struggle in the macro-economic and macro-logistics field. An initial point of departure would be to at least improve on the very coarse granularity of Delaney's and Wilson's work.

10.3 The global state of logistics

The most publicised global research that has been conducted on logistics cost is that of Delaney, continued by Rosalyn Wilson after Delaney passed away. The 18th report indicates that in the United States a steady upswing of logistics costs as a percentage of GDP has been noticed in the last three years (Figure 48). Wilson reported that transportation costs rose slower than expected, but costs in total were driven up by higher fuel prices, inventory and interest rates and warehousing costs. Transportation costs were still at record highs.[305]

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[304] Wilson, 2007.
[305] Wilson, 2007, p. 12-14.

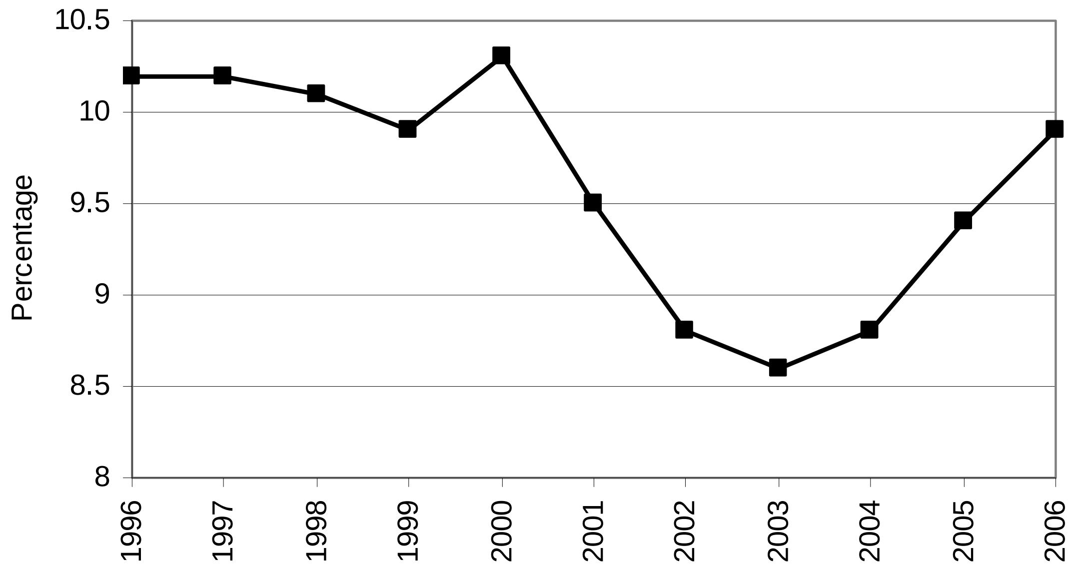

Figure 48: US logistics costs as a percentage of GDP[306]

Rodrigues et al.[307] developed an artificial neural network approach[308] to compare global logistics costs by country. They use 24 countries representing 75% of the global GDP in 2002 (37 859 billion USD – countries included in the study - of 48 771 USD – total world GDP for 2002) for their approach[309] and a combination of Wilson and Bowersox, Calantone, Closs and Stank's approaches and estimations.[310]

The findings of Rodrigues et al. are worrying for developing nations as they report that logistics costs of the countries used in their study rose from 13.4% in 1997 to 13.8% in 2002. They also summarise their results based on the income of countries in the study, as depicted in Figure 49.

[306] Wilson, 2007, p. 4.
[307] Rodrigues, 2005, p. 1.
[308] Rodrigues, 2005, p. 3.
[309] Rodrigues, 2005, p. 5.
[310] Rodrigues, 2005, pp. 4-5.

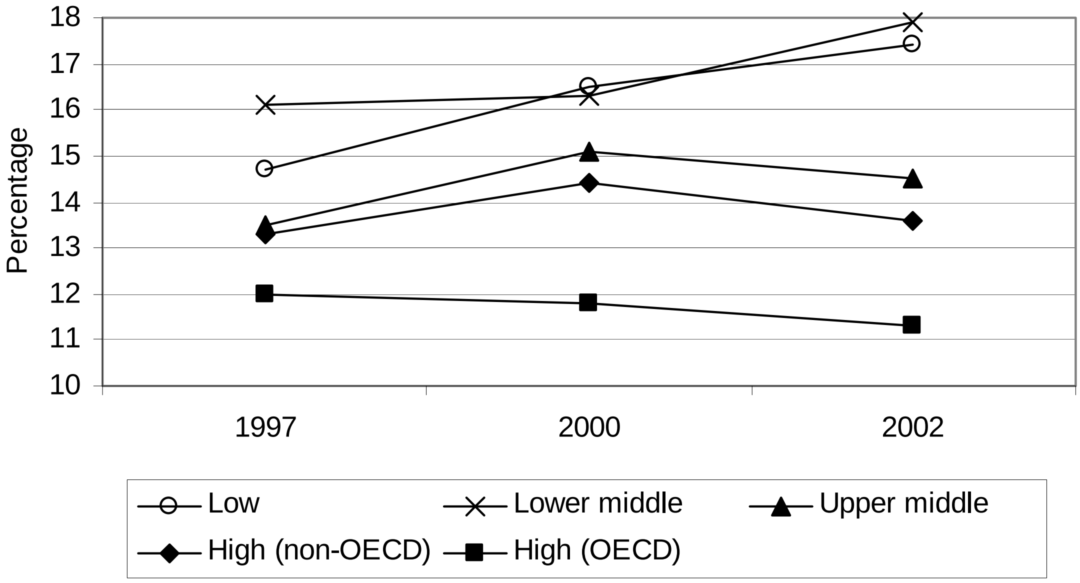

Figure 49: World logistics costs according to income groups[311]

For the period of their research logistics costs decreased for all nations, except for the nations with lower incomes, and it is also higher for nations with lower incomes. Rodrigues et al. hypothesise that this could be caused by operational pressures in the first world and density considerations.[312] Both of these observations are of importance for the situation in South Africa today where, as was illustrated, the development potential of the second economy has not yet been achieved and the full potential cost savings on densified first economy corridors have not yet been exploited.

10.4 Results for South Africa

The article by Botes et al. includes figures for 2003 indicating the results of their model's first application to South African data. The model, together with the national freight flow model, is now repeated annually and it is possible to discuss their results for 2005. The results are published in the CSIR's state of logistics survey, which the candidate co-authors on an annual basis. It estimates logistics costs for 2005 at R223 billion (R141 billion for transport), or

[311] Rodrigues, 2005, p. 9.
[312] Rodrigues, 2005, p. 13.

14.5% of GDP, slightly down from 14.8% in 2003 and 14.6% in 2004. If the data provided are analysed in a different fashion from what the researchers provided in the state of logistics report, however, an interesting picture appears.

Transport and profits (including management and administration) account for the major contribution in cost increases. The timeframes are short, but it could be worrying as South Africa's transport costs as a percentage of logistics costs are 63.1%, compared to the lower than 40% in the rest of the world (Figure 50).

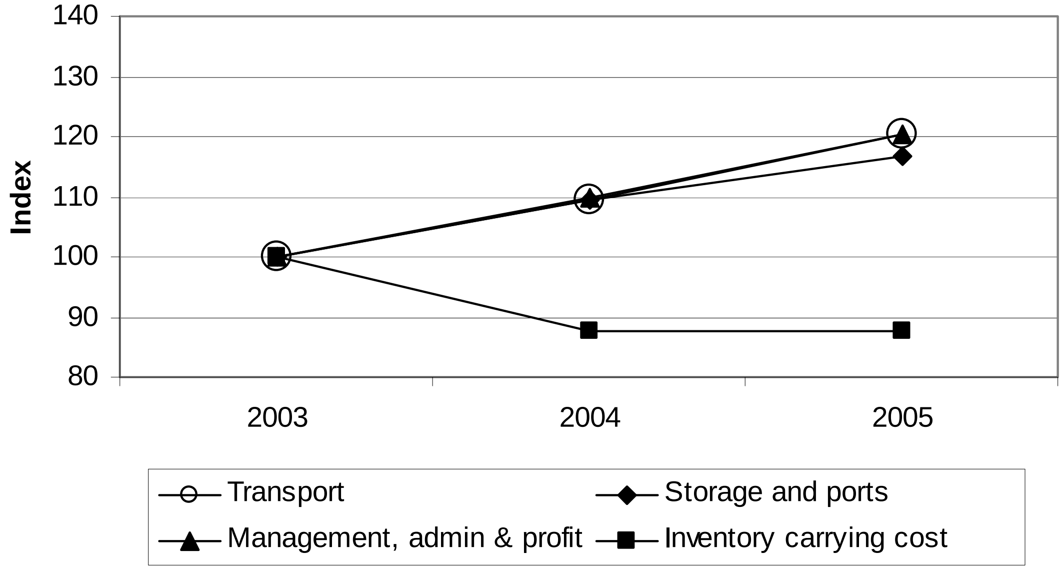

Figure 50: Trends in logistics cost components (2003 % contribution indexed, 2003=100)

Another interesting perspective is to measure the conversion factor of logistics spending (Table 48).

	Conversion of logistics rand into GDP rand	**Conversion of tons handled into GDP rand**
Primary	3.3	140
Secondary	1.4	500

Table 48: Conversion factors of logistics

The conversion factor indicates that the primary sector consumes logistics in an efficient manner. It only generates R140 of GDP for every ton handled (and of this, mining generates around R90 per ton handled and agriculture R250), but it converts every R1 spent on logistics into R3.30 of GDP. The conversion rate for the manufacturing sector is very low. It is obvious that the manufacturing sector would require more logistics complexity in solutions, but what is not so obvious is why few stakeholders acknowledge that South Africa is spatially challenged and that the manufacturing sector's logistics should behave more like that of the primary sector, and especially mining, to be more efficient.

It is here that the typologies point towards a solution, i.e. part of the manufacturing sector's freight on corridors does behave like mining commodities, being the freight between convergence points as depicted in Chapter 7. In fact, even more efficient solutions can be developed as this freight is bidirectional, which mining commodities are not. The case study that the candidate aims to propose in the next paragraph therefore poses the question that, if 44% of the freight on corridors is break bulk (as shown in Chapter 7) and if this tonnage is enough for efficient mining type solutions when transported between intermodal hubs or convergence points by rail,[313] should a large saving not be possible for about 11% (break bulk freight on corridors forms around 11% of all freight in South Africa - Figure 51) of all freight in South Africa, i.e. of R141 billion of logistics costs. Surely if 11% of total costs can be handled more efficiently, the logistics system deals with nearly R15 billion of costs systemically? This is once again an example where macro-economic data point the way towards specific areas of inquiry.

[313] As a crude rule of thumb it could be assumed that local delivery is paid for by what is saved on bidirectional traffic – refer Chapter 6.

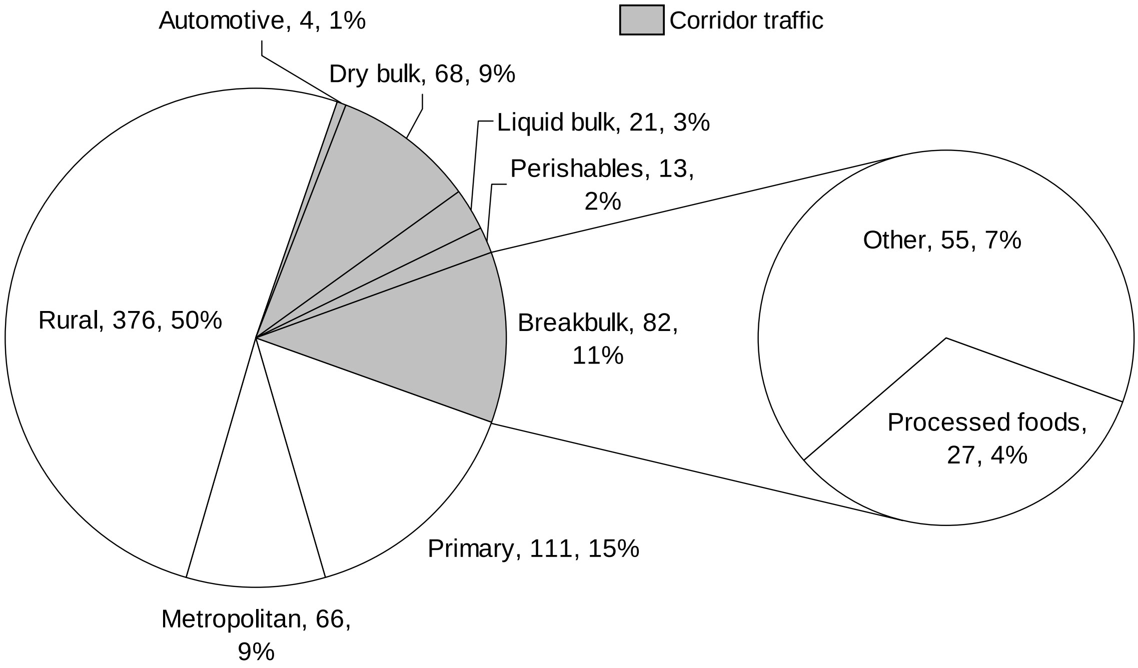

Figure 51: Break bulk corridor traffic in the context of total traffic (million tons 2004)

10.5 A cost case study for South Africa – taking macro-logistics cost measurement to the next level

The following case study was developed to show how the argument, as set out in the previous section, could be developed further with the data now available. It is also used to determine whether at least a pre-feasibility study on certain solutions should have been developed earlier.

Erero and Van Heerden (2005) analyse the role of freight rates in South Africa in depth and come to some interesting conclusions:

- More study is necessary to determine the real costs, especially in terms of road vehicles and in terms of externalities;
- Road vehicles are often over-cropped (leading to lower prices);
- High traffic densities on rail are only possible on a few routes;
- Future trends should be towards containerised rail transport between dense metropolitan hubs;

- Road tariffs are hard to find.[314]

Further research in this regard is necessary but, now that densities are known, a pre-feasibility case study is developed based on 2004 data.

10.5.1 Finding tariffs

A major impediment in comparative research is usually road tariffs (and recently often also rail), which are deemed to be secret and unavailable. In terms of the macro-economic nature of the case study, a rough rule of thumb indication of costs would probably be sufficient, but it was decided to do a reasonably accurate calculation based on the state of logistics survey, and also to poll hauliers and/or freight owners for actual tariffs on the two main corridors.

The logistics cost model pegs total surface transport costs in South Africa at R140.5 billion, of which rail earns R14.1 billion, leaving R126.4 billion for road, for which it delivers 223 billion ton-kilometers, i.e. at 57c per ton-kilometer. This figure is obviously different for freight movements over the various typologies, i.e. metropolitan, rural and corridor freight. Using rail distribution of tariffs, which are known, as a training case, the road cost per ton-kilometer could be distributed between the typologies with the same weights (Table 49):

	Rail cent per ton-km	**Road cent per ton-km**
Corridor	23	38
Metro	70	114
Rural	24	39

Table 49: Comparable typology costs in cent per ton-kilometer[315]

The rail training case suggested that metropolitan tariffs would be three times higher than corridor tariffs. Polling hauliers and freight owners indicated a tariff

[314] Erero and Van Heerden, 2005.
[315] Based on logistics costs survey and rail cost distribution as training data.

of between 34c and 40c per ton-kilometer for corridor distances between 500 kilometers and 1 000 kilometers (mostly for Gauteng to Durban traffic), and between 22c and 28c for longer distances (mostly for Gauteng to Cape Town traffic). It would therefore seem that an average bidirectional rate of 37c for the Gauteng to Durban corridor and 26c for the Gauteng to Cape Town corridor could be accepted. It should be remembered that this rate is bidirectional and, if an assumed 15% empty haul is included, a very close match between the logistics cost model figure and the polled figure from hauliers is achieved.

Rail tariffs also differ for the different corridors and for the ring-fenced heavy-haul export machines (which are based on one-directional traffic). These tariffs are 23.5c per ton-kilometer for the Gauteng to Cape Town corridor and 32.6c for the Gauteng to Durban corridor. Once again, if the rail tariffs were taken as a training set and applied to the road tariff in order to determine the corridor split, the answer would have been exactly the same (i.e. the Gauteng to Durban corridor's tariff is more or less 40% times higher than the Gauteng to Cape Town corridor tariffs).

The 577 kilometer average transport distance coal export machine conveys around 65 million tons of coal at 8.3c per ton-kilometer and the iron ore export machine conveys 25 million tons at 3.9c per ton-kilometer. In the rail proof of concept case[316] the 8.3c per ton-kilometer will be used for the Gauteng to Durban corridor and the 3.9c per ton-kilometer for the Gauteng to Cape Town corridor.

Rail pick-up and delivery tariffs are well known. Even if Goosen maintains that all terminal costs are comparatively low in terms of total freight movement,[317] it should still be included. Erero and Van Heerden[318] quote R328 for a 12-meter container (with a maximum carrying capacity of 27 ton) over a

[316] "Proof of concept" refers to a system's proven ability to deliver on a specific solution within specified parameters. The term is used here to describe rail's proven ability to perform at specified low cost levels on dedicated export lines – given adequate densities
[317] Goosen, 1979, p. 7.
[318] Erero and Van Heerden, 2005.

maximum distance of 40 kilometers for Spoornet cartage rates. That will be R12.15 per ton for a maximum of 40 kilometers.

10.5.2 Developing a model for a possible macro saving

1. $N_s = W_s - R_s$
   a. Ns = Nett result for scenario
   b. Ws = Road cost for scenario
   c. Rs = Rail cost for scenario
2. $W_s = T_{tc} \times V_s \times D$
   a. T_{tc} = Road tariff for case
   b. V_s = Volume for scenario
   c. D = Distance
3. $Rs = T_{rc} \times V_s \times D + (2P \times V_s)$
   a. T_{rc} = Rail tariff for case
   b. V_s = Volume for scenario
   c. P = Pick-up and delivery for rail
4. Scenarios, $_{s(pf,25\%,50\% \text{ or } 75\%)}$:
   a. Primary commodity (processed foods) on corridor total switch = $_{s(pf)}$
   b. 25% of road break bulk to rail switch = $_{s(25\%)}$
   c. 50% of road break bulk to rail switch = $_{s(50\%)}$
   d. 75% of road break bulk to rail switch = $_{s(75\%)}$
5. Cases, $_{c(tc,rbc,rpoc,rs)}$
   a. $_{c}$ = Base case
   b. $_{poc}$ = Prove of concept case (Rail)
   c. $_{s}$ = Stretch case (Rail)

Volumes and tariff cases for the two corridors are depicted in Table 50.

		Gauteng – Cape Town	Gauteng – Durban
Volume (in million ton)	**Processed Foods**	6.0	6.3
	Break bulk	11.9	21.6
Tariffs (in cent per ton-km)	**Road**	37c	26c
	Rail base case	32.6c	23.5c
	Rail proof of concept	8.3c	3.9c
	Rail stretch[319]	4.2c	1.9c

Table 50: Volume and tariff cases for case study

The tariff cases are based on the following assumptions:

- The base cases are the current tariffs (for which rail is not profitable and road may be over-cropped);
- The proof of concept case is the current rail export machine tariff. The export machines are engineered for few origin-destination pairs, heavy haul and are profitable. The exact same heavy haul design is therefore necessary between corridor convergence points, and pickup charges will be added;
- The stretch case is the proof of concept case, but for bidirectional traffic.

Some of the tariff cases might seem extreme, but since the volumes are now known, the question should rather be asked under what conditions these tariffs could be achieved? The export machines' engineering provides some indication:

- No shunting (break up) of trains;
- Longer unit trains;
- Even tempo;
- Large volumes.

The export machines were also designed for heavy haul in terms of gradients, movable frogs and loops. The extent to which this engineering would be required will depend on density. In the following scenarios densities such as

[319] The rail "stretch" case refers to what could be achieved if export line efficiency were possible

those achieved on the coal export machine will probably still not be necessary.

It should be remembered that both export machines were built from scratch 30 years ago, both are profitable and became profitable at volumes around 10 million tons per annum. The case study therefore proposes a change from thinking that these conditions could only exist for the export machines to asking why specifically these conditions couldn't exist for high-volume corridor transport between convergence points.

One of the reasons why the export machines are successful is also the singularity of commodity. For this reason processed foods (excluding liquids and perishables), which are nearly always transported palletised in South Africa, were specifically included as a ring-fenced option in the model. Food production power is also highly concentrated in South Africa (mostly in the hands of only three companies), which could facilitate design discussions.

10.5.3 Applying the model

Applying the model results in the following answers for the two corridors (Table 51 and Table 52).

			Switching scenario		
			s=25%	**s=50%**	**s=75%**
Current volume & cost for road	**Processed foods (million tons)**	6.3	5.4	10.8	16.2
	Road base	1 399	1 199	2 398	3 596
Cost to economy	**Rail base**	1 390	1 191	2 382	3 574
	Rail proof of concept	471	404	808	1 212
	Rail stretch	316	271	542	813
Savings	**Rail base**	9	8	15	23
	Rail proof of concept	927	795	1 590	2 385
	Rail stretch	1 082	928	1 855	2 783

Table 51: Gauteng to Durban model result (rand millions, except first data row)

			s=25%	s=50%	s=75%
Current volume & cost for road	Processed foods (million tons)	6.0	3.0	6.0	8.9
	Road base	2 184	1 083	2 166	3 249
Cost to economy	Rail base	2 124	1 053	2 106	3 159
	Rail proof of concept	478	237	474	710
	Rail stretch	310	154	307	461
Savings	Rail base	60	30	60	89
	Rail proof of concept	1 706	846	1 692	2 538
	Rail stretch	1 874	929	1 859	2 788

Table 52: Gauteng to Cape Town model result (rand millions, except first data row))

The cost saving for the two corridors combined at the 75% switch scenario would therefore be R4 921 million for the proof of concept scenario and R5 571 million for the stretch scenario.

The question is sometimes asked whether the export machines are really profitable and if this is feasible. The model was therefore repeated to generate, for an indicative summarised figure, just these 75% switch scenario totals for the two corridors for the poc and stretch case. The results are summarised in Table 53.

Percentage price increase	Rail poc cost saving (Rm)	Rail stretch cost saving (Rm)
None	4 923	5 571
10	4 794	5 507
20	4 664	5 442
30	4 535	5 378
40	4 405	5 313
50	4 276	5 249
60	4 146	5 184
70	4 017	5 119
80	3 888	5 055
90	3 758	4 990
100	3629	4 926

Table 53: Cost saving for 75% switch scenario with price increase options

Even if double the current export machine tariffs could be charged by Spoornet and all other efficiencies can be equalled, Spoornet will become highly profitable and the country (in the poc case) could save 4% of its total freight bill.

The model delivers a few interesting results:

- It proves that rail, in its current form, could not survive (a view shared by Van der Meulen);
- It shows that, even with a one-directional proof of concept case, the switching solution would be worthwhile;
- It shows that if the same conditions as with the export machines could be achieved:
    - The switching solution would pay for itself;
    - The solution would save the country (for just these two corridors) 6.6% of the nation’s freight bill;

- The saving would be equal in return to the country as if Spoornet in its current form lowered its rates by 60% for all traffic and turned profitable.

It is true that some of the assumptions might be contestable, but the indicated return is so vast that further research is imperative. The case study also confirms the value of macro data to indicate possible avenues for exploration.

A few salient points should be remembered in this regard:

- The tariffs are not strictly tariffs in the normal sense of the word. They are, however, in the case of rail the exact average that was applied in each typology, and in the case of road the exact average that was calculated on a macro level and quoted on a micro level (no large difference was noticed).
- Tariffs are known more generally than is usually assumed.
- The export machines were developed and paid for through own funding – no government subsidy was required.
- If a systemic development could be achieved, as in this case study, further advantages could develop:
    - Logistics hubs around the convergence points could develop with distribution centres – such as for major food manufacturers and retailers in the processed foods case that was specifically highlighted;
    - Placing the hubs at convergence points will alleviate congestion by taking one of the two trips (being from long haul to distribution centre and distribution centre to retailer) out of the congested metropole;
    - As carbon emission issues grow, only a single power source (the source that drive the trains) will have to change, but even with coal-based electricity generation for rail, it would still emit less carbon per ton.

The most important and salient feature of the argument is a density argument. A benchmark study by Harris researched the economies of density carefully for various rail operators in the United States. Harris never comes to a specific conclusion, except that he maintains that it is important and that railways should be allowed to increase low-density rural rates and decrease high-density corridor rates.[320] This observation was sorely needed in South Africa between 1950 and 1990. Harris does, however, plot the negative exponential nature of his results and, interestingly, an inflection point of the curves can be read from his plot, i.e. at around 4 million tons for a 500-kilometer length of railway. Anselm studied the German railway and came to the same conclusion; he indicated that wherever the slots are available to double volume, the costs and tariffs should decrease by 40%.[321] This is a major, and often forgotten, factor in cases where capacity utilisation is below 50% and traffic is available. This case is often not considered in rail business planning in South Africa, especially since it requires a step-function thinking approach rather than a gradual ramp-up, something which rail planners are often unwilling to do.

As Kennedy indicated before deregulation and when the deregulation debate became widespread, a specific role for rail was expected with deregulation. This role was bulk long haul of low-value commodities, and "movement of containers in special trains…to provide excellent door to door service for many commodities between major centres."[322] The question should be asked why Kennedy's prediction did not materialise? It is true that Spoornet probably failed in service delivery and the required competitive posture, but other reasons could also be proposed.

10.6 Conclusion

The last step in the process of a macro-economic view of logistics, and specifically transport, in South Africa was the understanding of costs. Through this, the loop from modal flows over typologies, by specific commodities, forecasted into the future and with a view on costs to the economy and possibilities for improvement, was closed.

[320] Harris, 1977, p. 563.
[321] Anselm, 2002, p. 11.
[322] Kennedy, 1982, p. 26.

Through these data, and the annual repeat of the process, infrastructure planning and opportunities for improvement could be better informed and performance could be measured.

Chapter 11- The contribution of this research and future challenges

11.1 Introduction

History has shown that man’s transport ability plays a core, even fundamental, role in development. The development of the wheel was a foundation on which more or less all further growth in society was founded. Without the ability to move people and produce, no specialisation would be possible with no complex economies, no complex manufacturing, no international trade and no globalisation. Yet, man would measure all other things on a macro scale and assume that transport would merely be “there”, automatically available and invisible. Like the sun that rises in the morning, the weather or the tides, transport would be available when needed.

The unwillingness to measure the transport function on a macro scale has an interesting explanation and even more interesting side effects. It has to be assumed that transport is such a fundamental pre-condition to everything else that it has to be in place before anything else can happen. If it takes a team of people with oxen sixty-five days to move a few tons between Cape Town and Gauteng at a cost of R15 000 per ton in today’s terms, nothing much would move. On the other hand, if a railway is built and the journey can be completed in two days and at a fraction of the cost, it can be assumed that it is not really an issue any longer.

The interesting implication of this explanation is that the same could be said of all basic resources in the world. Once the mere flick of a switch can provide power and lights, the turning of a valve can provide water, a single movement of the hand can dispose of sewerage and refuges, and the pressing of a button can provide communication, one could assume that these issues do not require much further thinking. Yet most of these normal daily functions are usually carefully managed, measured and planned. And all of these functions are suddenly heading for a critical point of depletion in their current form for the first time in the world's history.[323] In addition, the damage caused by these functions will for the first time, within the next three decades, become untenable for man and will have to change. Where does this leave transport in South Africa? This is the case of double jeopardy in its worst form.

The management of the South Africa's transport infrastructure is behind developed nations (industrialised countries) in terms of depth and performance measurement.

- Transport as such is often managed more poorly than other infrastructure functions.
- All infrastructure functions are currently challenged and often believed to be inadequate for current development challenges.
- Very little work has been done around considering sustainability issues in infrastructure development, especially in South Africa.
- Of all the measures that would be required to manage sustainability, those that relate to transport (for instance CO_2 emission tons per ton-kilometer) are the furthest behind for transport – especially in South Africa.

Smits[324] analyses the reasons for poor performance in Sub-Saharan economies (Figure 52) and proposes three, i.e. geographical and resultant spatial factors, colonial legacies and institutional environment, which he explains as a lack of "equal access".

[323] Martin, 2007, pp. 7-9.
[324] Smits, 2006, pp. 2-3.

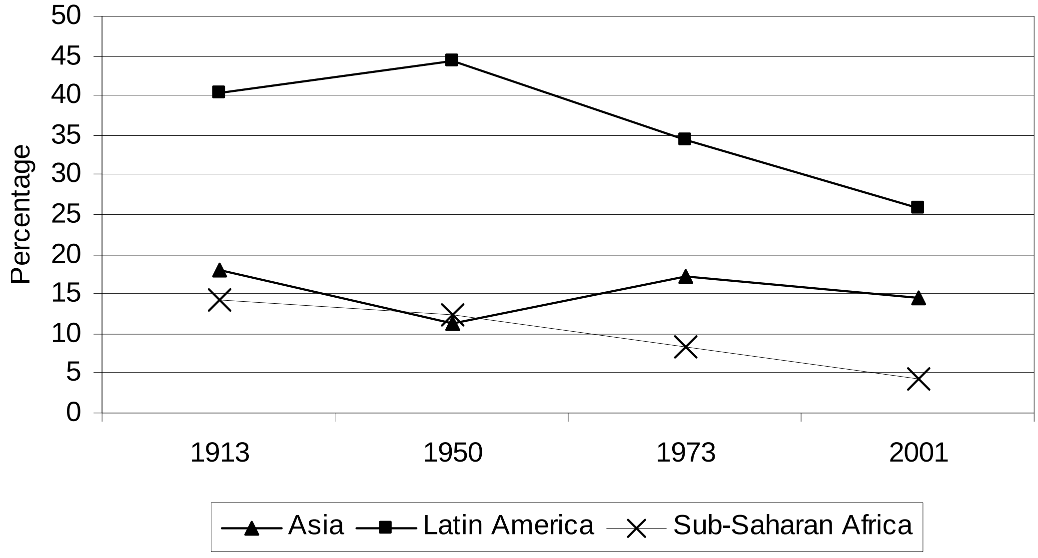

Figure 52: Regional GDP per capita as % of GDP per capita of the Western world[325]

All three of his core fundamentals relate to transport, i.e. spatial factors could lead to high transport costs, the colonial legacy was to pump mining commodities out of the country (rather than beneficiate these at the point of origin) and thereby create centres far from the sea and access challenges, especially for the second economy, including transport deficiencies.

11.2 The contribution of this research

This research proposed a macro-economic dimension and in its outcomes improved the understanding of the South African economy in total. It was illustrated how limited this understanding used to be and how little attention transport infrastructure development planning and economic management on a macro-level used to be (and in many respects still is until the communication cycle that follows from this research is fully developed.) By quantifying flow and size as well as market share and future demand, sensible planning and management is possible and the current bottlenecks could be eradicated and its future manifestations minimised.

[325] Compiled from Smits, 2006, p. 8.

The research uncovered the volume and modal market share of all freight flows in South Africa. The methodology made historical comparisons possible and therefore highlighted problem areas for improvement. It provided the first comprehensive data set to allow for network segmentation and the understanding and quantification of the freight transport typologies in South Africa. The management of these typologies as both separate, but also integrated constructs is now possible. Corridors' efficiency requirements, primary traffic's global competitiveness requirements, rural traffic's developmental requirements and metropolitan traffic's congestion alleviating requirements can now receive the necessary individual and administrative focus as well as integrated funding and policy-making focus. Before this research many hypotheses about segmentation and network typologies were proposed, but the absence of quantification led to confusion as far as propositions about what was needed are concerned.

The characterisation of these freight flows, within all these typologies on a quantitative commodity level, now and forecasted into the future, not only allows for better infrastructure planning requirements identification, but also for an improvement in modal balancing. By understanding the nature of freight on a quantitative level, specific modal balancing case studies can be researched. If the economic regulator and modal competitor understand the exact nature of what is required, the most efficient solutions can be sought, the underlying policies developed and management structures installed to improve freight transport in South Africa.

The contextualisation of these freight flows in a logistics costs framework allows for the utilisation of the systemic trade-off characteristics of logistics within the total national context. It is now possible to measure the overall performance of the current system, and propose and measure possible solutions.

Through this work the overall management of macro freight transport can be improved and the national economy benefited.

National economies in the world have unique challenges, but one of South Africa's own unique problems is of a spatial nature. No other comparable economy exhibits the quantum of South Africa's spatial problem (as the 63% of logistics spend on transport compared to the less than 40% for the world illustrates), which means that the transport sector should be especially well-managed, which is often not the case. By proposing, developing and proving a unique and working modelling system a ground-breaking management tool becomes available.

This is necessary, because not only is the comparable problem smaller in the first world, the first world is also moving forward to address new future challenges. These challenges should be defined and the usefulness of this research to contribute to these challenges illustrated. This should be done to also understand what future directions follow-up research should take.

11.3 Development and growth objective of the economy – how to implement change

One of the major impediments to growth is often the focus on individual advantage versus the common good construct. This focus on individual advantage could be direct, such as the migration of each extra ton from rail to road (to gain an individual speed or service advantage) up to the point that a large migration carries huge costs for the economy that has to be carried by the freight owners. This huge cost that is then occurred can also be indirect where the resultant damage of this action must be borne by a total economy.

Hardin maintains that "the population problem has no technical solution; it requires a fundamental extension in morality".[326] Hardin's excellent exposition of problems associated with micro-management results in an interesting proposal which he calls "mutual coercion mutually agreed upon" based on rational thought.[327] He asks for careful measurement, then comparisons and then agreement on the necessity for change. He specifically warns that

[326] Hardin, 1968, p. 1243.
[327] Hardin, 1968, pp. 1247-1248.

systems will not change if a “perfect” alternative cannot be found, even though the less than perfect alternative might be better than the status quo. The only way for advancement in this situation (which is more or less the position in all cases when change is necessary) is to rationally measure the two alternatives (status quo and alternative for change), decide on a course of action rationally and then implement it. Hardin calls this a “moral” approach, not technical, and through this description elevates rational planning and the implementation of this planning to the highest social order possible.

This work solves the measurement problem, and therefore enables society to engineer alternatives that move away from the status quo. On the other hand, some of the underlying issues that Hardin’s work uncover refers back to human nature itself. Future work should therefore look at the macro change management requirements for the implementation of the planning which this work enables.

11.4 Distribution of wealth objective of the community – the national development application of this work

Demkes and Tavasszy discuss the difference between macro- and micro-level indicators in depth and find the problem in the meso area (Figure 53), because “the macro indicators focusing on welfare maximisation are mostly decomposed into meso level indicators focusing on welfare optimisation, under the condition of subsidiarity, for sectors or regions, and not on supply chains”.[328] They therefore blame both macro-economics and the regulatory side for not having a supply chain view and the supply chain side for not connecting with macro objectives.

[328] Demkes and Tavasszy, 2000, pp. 15-16.

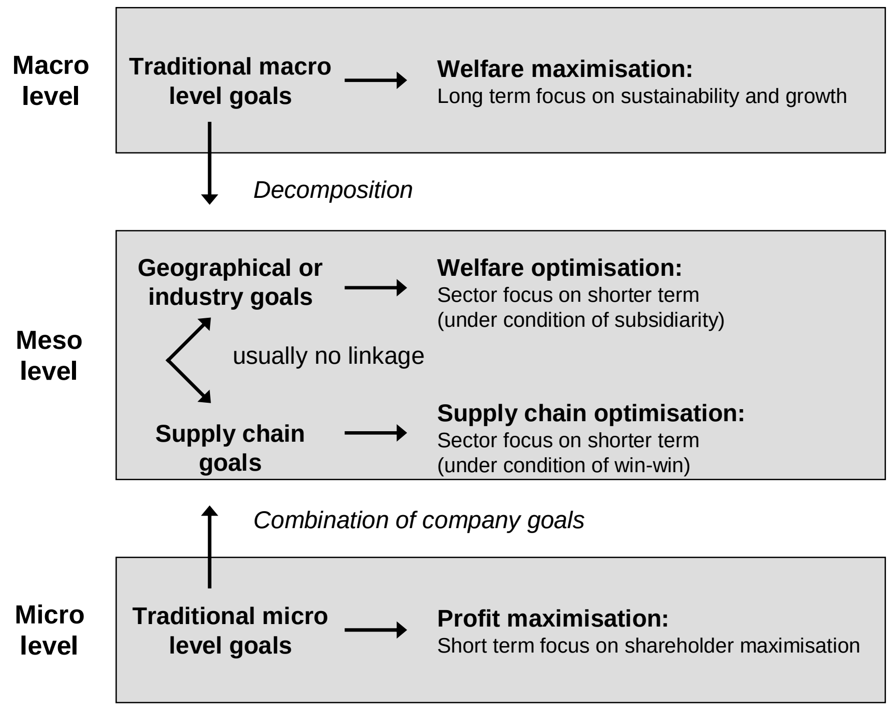

Figure 53: Demkes and Tavasszy's description of micro, meso and macro indicators

They continue to say that:

> It appears that traditional micro indicators are useful for internal and external measurements of single companies' logistic performance, but inadequate for the whole, interrelated, supply chain. A similar statement can be made for traditional logistics performance indicators on a macro level. They are useful for comparative analyses among different nations, but they are inadequate for comparing different supply chains. Moreover, there is very little information on regional differences i.e. intra-European differences and the effectiveness of policy measures in the area of logistics and telematics facilities. Supply chain indicators could be seen as a combination of aggregated micro indicators, disintegrated macro indicators and meso indicators. Yet, the macro indicators focusing on welfare maximisation are mostly decomposed into meso level indicators focusing on welfare optimisation, under the condition of subsidiarity, for sectors or regions, and not on supply chains.[329]

[329] Demkes and Tavasszy, 2000, p. 16.

As given in Figure 53, policy-makers should seek the linkage between on the one hand the macro and meso level indicators and on the other the supply chain indicators, aimed to create a win-win situation.[330]

Demkes and Tavasszy add a new and interesting perspective to the issue. They claim, by definition, that macro-level measurement of logistics performance is not only important as lead and lag indicators for macro-management of logistics and infrastructure development, but for all societal development (the welfare imperative in their definition) and that meso welfare objectives and measurement should be decomposed into supply chain goals.

People in South Africa might think that the issues of the second economy are important, but hidden to the rest of the world. It seems that this might not be the case and that the differences between rural and corridor transport and its effects are highly visible and as such could become a global issue. The World Trade Report of 2004 gives various transport costs, of which some of the salient examples are summarised in Table 54.

Route	US Dollar per kilometer
Johannesburg to Maputo	1.40
Durban to Lusaka	1.56
Durban to Maseru	2.16

Table 54: Transport costs for a ton of containerised cargo[331]

The more rural the transport becomes, the more expensive it often is – with the obvious negative community effects associated with it. One of the specific outcomes of this work was the enablement, of a much more specific quantification of the wealth distribution challenges as it pertains to access of the second economy and tailor-made solutions are now possible.

[330] Demkes and Tavasszy, 2000, p. 16.
[331] Panitchpakdi, 2004, p. 118.

11.5 Sustainability of the environment

Whitelegg[332] measures various environmental impacts, such as CO_2 emissions (Figure 54) per ton-kilometer, compares modes and illustrates improvements over time.

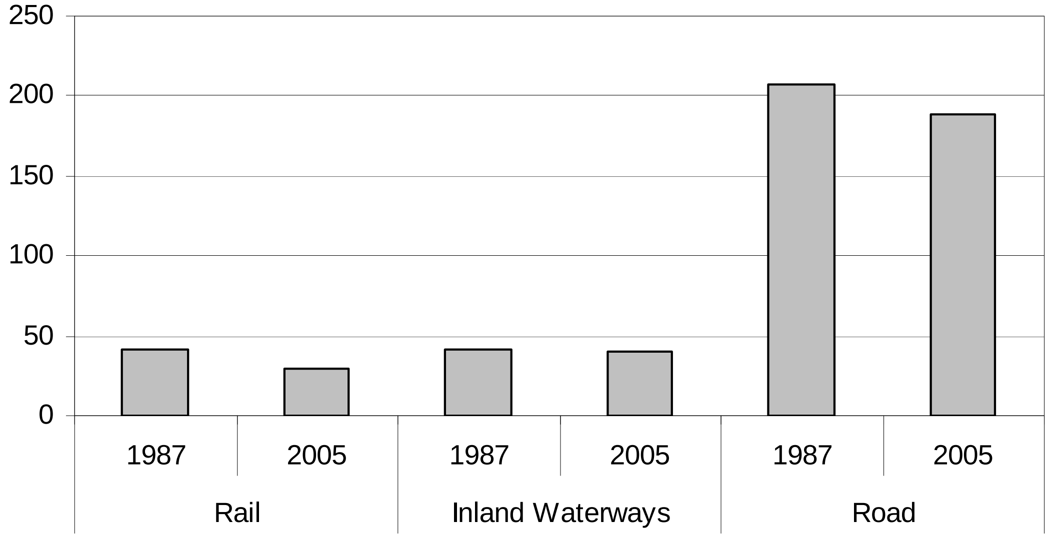

Figure 54: CO^2 emissions - gram per ton-kilometer

His comprehensive study includes other obnoxious emissions as well (Figure 55) and illustrates the poor position of road freight in terms of future sustainability issues.

[332] Whitelegg, 1994, p. 6.

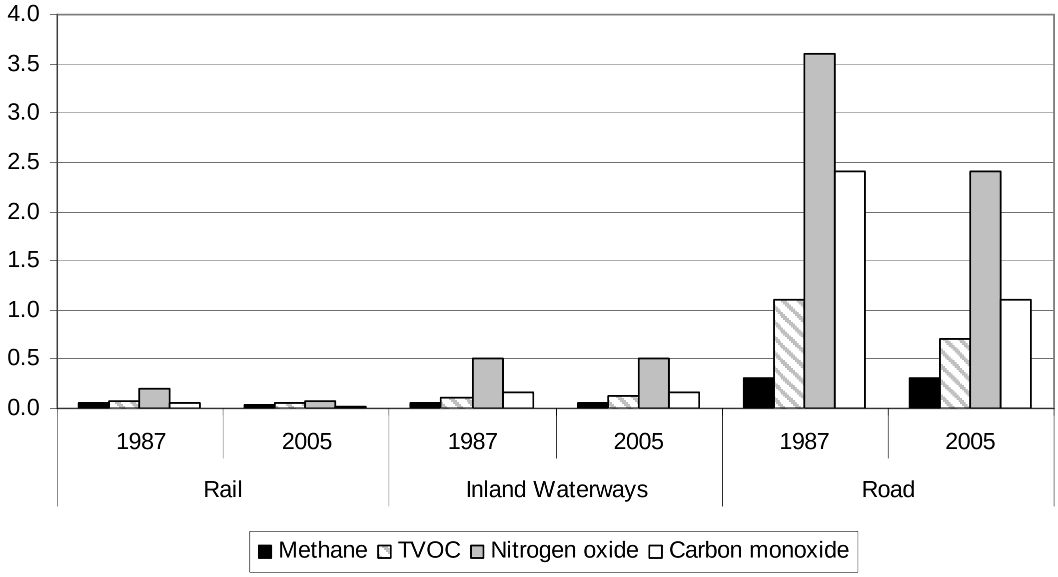

Figure 55: Obnoxious gas emissions - grams per ton-kilometer

It is, however, not the specifics and various arguments and counter arguments of the road vs. rail debate and the need for intermodal solutions that are important here, but rather the fact that measuring is taking place and certain shifts will be managed. From the time that Whitelegg has written his article the debate around these issues has heated up considerably. Many conventions in the first world are arising and it is becoming increasingly certain that Kyoto will finally be implemented and even strengthened with more stringent world protocols. It is difficult to imagine how this situation will be managed by a society that can't even perform the simplest of measures, i.e. count ton-kilometer per mode.

The World Business Council for Sustainable Development is taking this issue further by predicting the contribution of various modes to transport supply (Figure 56).

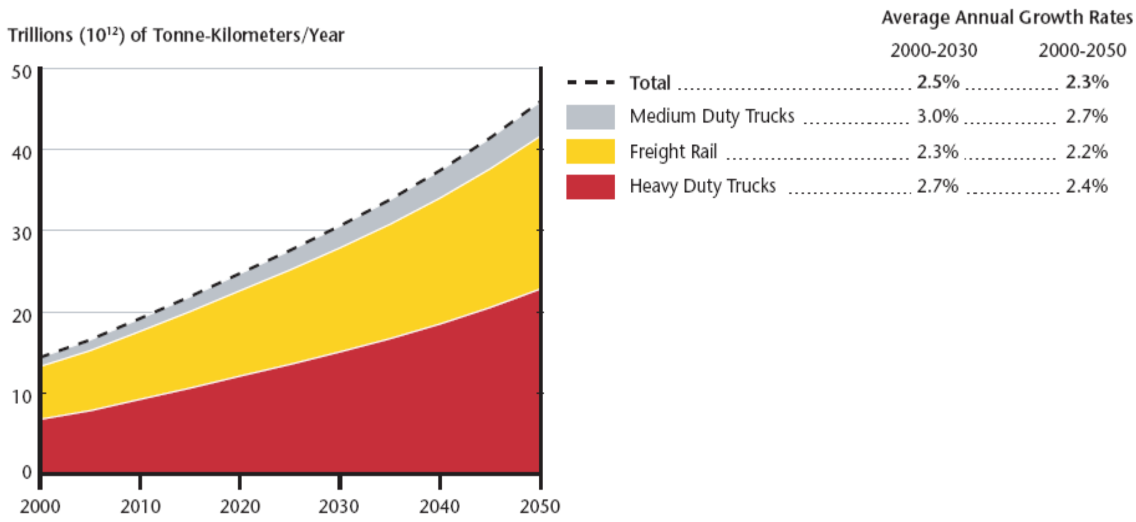

Figure 56: Future freight transport by mode[333]

The growth prediction from the 15,000 billion ton-kilometers at the turn of the century to close to 50 000 billion ton-kilometers by the middle of the century is staggering in terms of the potential damage to society. Freight transport consumes 43% of all transport fuel and causes the most damage in terms of environmental impact.[334] The specific impacts of various transport vehicles are also predicted and depicted in Figure 57.

333 Stigson, 2004, p. 32
334 Massachusetts Institute of Technology, 2001, p. 6-2

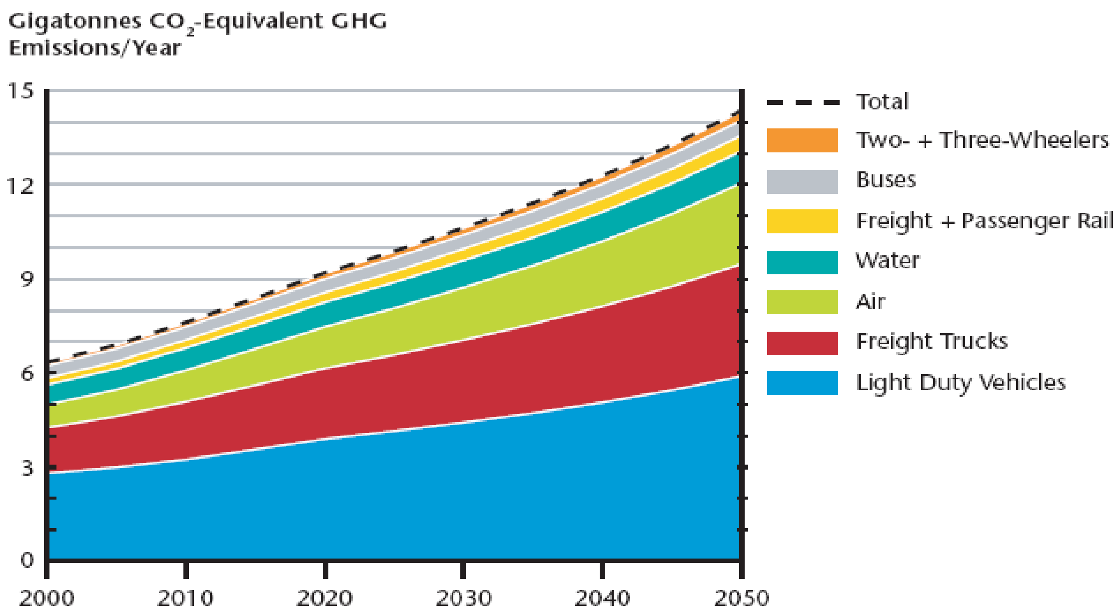

Figure 57: Future freight transport contribution to CO^2 emissions[335]

Once again the specifics of the debate are not what is important here, but the foundation on which the debate and resultant decisions will be based, especially in the absence of measurement from an economy that contributes 2% to this problem (but has far less than 1% of the world's population and relative economic size).

Through this work this challenge can be addressed in the future and South Africa can prepare itself for a more environmental friendly transport system. The country would be able to report the relationships between underlying transport options for freight and how these constructs impact on the environment. It will eventually be able to join the first world in a more pro-active stance towards environmental control.

[335] Stigson, 2004, p. 37

11.6 Measurement for future direction – a new model for sustainable measurement

McKinnon illustrates measurement in terms of sustainability quite clearly by outlining proposed policy measures and the reasons for these measures. These include:

- Provision of additional infrastructure capacity (because of data that suggested that congestion-related delays cost the United Kingdom economy £1.2 billion);
- Restraint on freight movement growth (because data suggested that ton-kilometers rose 146% in 39 years);
- Modal shift (because of a rail modal market share drop from 30% to 7%);
- Further support for improving back-haul (because empty-haul has dropped from 33% to 27% and could go further);
- Improved energy efficiency (because freight transport accounted for 5-6% of all CO_2 emissions);
- And the reduction of externalities (also all dimensions measurement based).[336]

The unavoidable fact is that measurement will be required to identify and measure these matters.

Demkes and Tavasszy[337] discuss the role of performance indicators for companies, industries and governments, and identify four goals:

- To establish a holistic system view;
- Feedback to improve the measured system;
- Clarification of aim and goal (essentially alignment);
- Development measurement for policy direction.

All of the issues summarised above could be modelled back to the United Nations' pillars for sustainable development, summarised in Chapter 2 (Figure 1) and relating it back to South Africa's future.

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[336] McKinnon, 2003, pp. 133-149.
[337] Demkes and Tavasszy, 2000, pp. 4-5.

The three pillars are ubiquitous for all nations and have recently been enhanced by Verny's definition of sustainable development Figure 58.

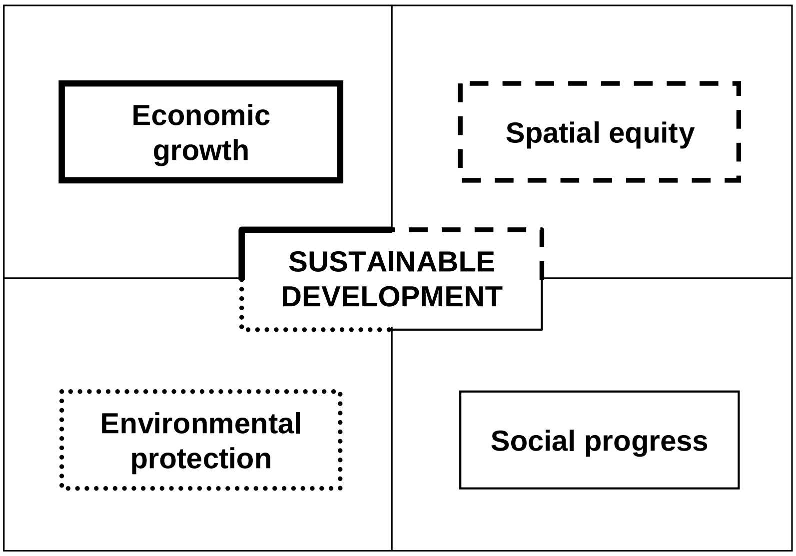

Figure 58: Verny's definition of sustainable development[338]

Verny adds a spatial dimension to the mix and this is an essential improvement on the definition. He argues that:

> Distance is the heart of the problem. Stakes consist of preserving the quality of transport services and economic growth. The aim is to carry shorter distances or to carry differently. So our hypothesis supposes a link between productive logics, spatial organization and supply chain.[339]

Logisticians should consider a spatial dimension and therefore a new model for sustainable development is proposed that depends on spatial physicality and community welfare (Figure 59).

[338] Verny, 2007, p. 115.
[339] Verny, 2007, p. 115

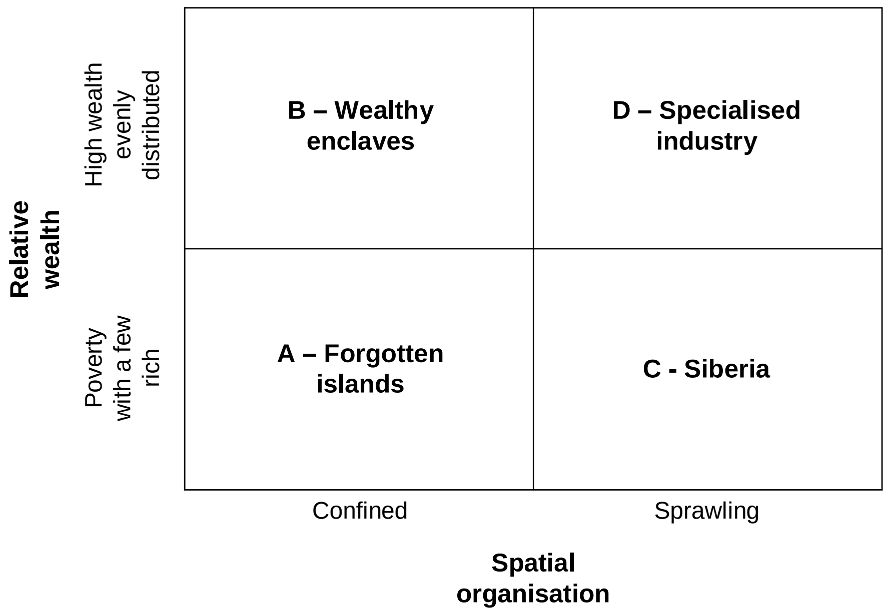

Figure 59: Wealth and spatial organisation factors of sustainable development

The groups are described as follows:

- The A group could be described in terms of the forgotten Christmas Islanders on the Polynesian islands who lost touch with the global community and starved once this connection was lost;
- The B group, such as rich enclaves in the West that live behind high walls or on islands, such as Japan, which need precious connections to the world, but have their own successful individualised cultures;
- The C group, such as South Africa, with some wealth, but in the hands of a few, with widespread poverty over large geographical areas, but not on an island, in fact with porous borders, where more poverty is imported, but trade is also possible;
- The D group, such as Europe with specialised and smooth flowing interchanges between nations.

From this model the challenges in terms of the United Nations definition can be summarised (Figure 60).

Type	Growth of the economy	Distribution of growth	Environmental protection
A	Aid	Population control	External agencies
B	Manage security of supply	Fine tune social systems	Manage natural resources carefully
C	Competitiveness of first economy	Education, wealth distribution through job creation, stimulation of second economy	Create environmental management systems and prepare for future management
D	Steady monetary and fiscal management and exchange agreements	Social fine tuning, growing aged population burden	Global protection agreement frameworks

Figure 60: Sustainability challenges in terms of spatial and community position

Transport, logistics and performance-management priorities can now be deduced from this. In A types food and aid must reach impoverished communities over poor infrastructure. In B types communities must develop their own effective transport systems to ensure security, often requiring a strong maritime culture with effective ports. In C types communities must stimulate growth nodes to make them globally competitive, but provide access to the “unconnected”. In the D types communities must manage the environmental damage of transport systems carefully. All the types require measurement and all of these will require management, from different perspectives and with different emphases, but eventually performance and planning measures will improve all systems and (as depicted in Figure 61) these measurements and measurement objectives will become more complex as new perspectives are added.

Type	Measurement	Objective
A	Understand basic measures of modal market share, transport efficiency and hinterland corridor blockages. Measure infrastructure development	To measure Lead and lag for infrastructure development
B	Add port efficiencies and cargo transfer specifics	To ensure effective linkages for security of supply
C	Add network typologies, intermodality	To minimise transport costs in spatially challenged environments
D	Add sustainable measures	To manage environmental charges

Figure 61: Measurement systems and objectives

This research makes it possible to manage these priorities and quantify the objectives, irrespective of where a country is on the spatial and community position matrix.

11.7 Final thoughts on the macro perspective

Davies contemplates reductionism in science and he refers to the "rampant reductionism" that was "the main thrust of Western scientific thinking over the last three centuries". He expands on this viewpoint by adding:

> But of course some problems (such as jigsaws) are only solved by putting them together – they are synthetic or 'holistic' in nature. The picture on a jigsaw, like the speckled newspaper image of a face, can only be perceived at a higher level of structure than the individual pieces – the whole is greater than the sum of its parts.[340]

Davies continues to discuss the apparent paradox in the creation of order by comparing it to the second law of thermodynamics. It appears as if the creation of order reverses entropy, but it does not. The overall "entropy balance sheet", as he calls it, remains balanced and the order is paid for in

[340] Davies, 1990, p. 61.

the external environment of the open system.[341] (Entropy in a closed system cannot be avoided, according to the second law). This is a ubiquitous fact and in all sciences it means that in the race for order, in the final reckoning, there will be winners and losers. In the specific field of this study a country like South Africa can either win or lose in the field of global competitiveness (with global competitiveness supplied inter alia by the transport system), it could renew natural resources or deplete these resources (through incorrect energy allocations – also inter alia through transport and spatial design) and it could uplift society or destroy the societal fabric of the country (through denying access to the second economy). These issues are issues of order that must, by definition, be measured and managed.

The "order" decisions that South Africa make will be the culmination of the national will translated into policy and implementation. This research can provide inputs into the understanding of the freight transport dimension's capability to improve this order.

11.8 Conclusion

In this research the macro-economic imperatives of logistics and the resultant burden of measurement for macro-logistics were highlighted. An in-depth analysis of the history of measurement confirmed that the problems associated with poor information was often understood, but never really addressed. A few attempts were made, with varying degrees of success, but with no permanent solution. Three interactive models were proposed and the success of these models for measurement on a continuous basis and examples of contribution to lead and lag policy and infrastructure management systems were illustrated.

It is possible to use these models to begin to answer the questions of not only the past, but also the future, i.e. what would South Africa need in terms of infrastructure, how will the performance of this infrastructure be measured for

[341] Davies, 1990, p. 65.

renewed planning and how will policy makers ensure that future growth, and societal and sustainability objectives are met.

The interaction amongst communities, as described in Chapter 2, in the emerging new world order will place immense new pressures on the management of South Africa's transport system, which is not even on the agenda yet. Eventually countries will be graded on the performance of their domestic transport system (that will have to be measured) and an inability to demonstrate performance against specific sustainability criteria might jeopardise the country's foreign trade system in many respects. This study proposes immediate action to rectify this situation.

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