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Southern Africa – Towards Inclusive Economic Development

REPORT

A proposed freight and passenger road-to-rail strategy for South Africa

J.H. Havenga, A. de Bod, Z.P. Simpson, S. Swarts, and I.E. Witthöft

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About the project

Southern Africa –Towards Inclusive Economic Development (SA-TIED)

SA-TIED is a unique collaboration between local and international research institutes and the government of South Africa. Its primary goal is to improve the interface between research and policy by producing cutting-edge research for inclusive growth and economic transformation in the southern African region. It is hoped that the SA-TIED programme will lead to greater institutional and individual capacities, improve database management and data analysis, and provide research outputs that assist in the formulation of evidence-based economic policy.

The collaboration is between the United Nations University World Institute for Development Economics Research (UNU-WIDER), the National Treasury of South Africa, the International Food Policy Research Institute (IFPRI), the Department of Monitoring, Planning, and Evaluation, the Department of Trade and Industry, South African Revenue Services, Trade and Industrial Policy Strategies, and other universities and institutes. It is funded by the National Treasury of South Africa, the Department of Trade and Industry of South Africa, the Delegation of the European Union to South Africa, IFPRI, and UNU-WIDER through the Institute's contributions from Finland, Sweden, and the United Kingdom to its research programme.

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REPORT

A proposed freight and passenger road-to-rail strategy for South Africa

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Abstract: A cornerstone of rail improvement in South Africa is the development of a road-to-rail strategy for both freight and passengers. The report proposes road-to-rail strategies for both freight and passengers to assist identifying key next steps to facilitate rail improvement. A succinct overview of major shifts since the 1980s in the structure of the state-owned entities involved in rail freight and passenger transport is provided for context. The report focuses on the development of proposed road-to-rail strategies, with a discussion on cross-cutting issues that need to be addressed by government to ensure successful implementation of the strategies. Many issues have been on the agenda for five decades — South Africa's government needs to act decisively to avoid the collapse of foundational economic infrastructure that will be extremely difficult and costly to repair beyond a tipping point of collapse.

Key words: rail transport, freight, state-owned entities, economic infrastructure, tipping point, South Africa

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List of acronyms

ANC	African National Congress
DC	Distribution Centre
EMI	External, market, internal
FDM™	South Africa's national Freight Demand Model™
FMCG	Fast-moving consumer goods
GDP	Gross domestic product
GFB	General freight business
LSP	Logistics service provider
MSA	Moving South Africa
MPT	Multi-purpose terminal
NATMAP	National Transport Master Plan
NFLS	National Freight Logistics Strategy
OD	Origin-destination
PRASA	Passenger Rail Agency of South Africa
RDP	Reconstruction and Development Programme
SAA	South African Airways
SANRAL	South African National Roads Agency Limited
SAR&H	South African Railway and Harbours Administration
SARCC	South African Rail Commuter Corporation
SATS	South African Transport Services
SOE	State-owned enterprise
USA	United States of America

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Executive summary

This report was prepared for the programme Southern Africa — Toward Inclusive Economic Development, UNU-WIDER. The programme aims to enhance economic research, capacity-building, and policy dialogue. One of the focus areas of the programme is performance improvement of the rail sector to accelerate South Africa's economic recovery. A cornerstone of rail improvement is the development of a road-to-rail strategy for both freight and passengers, which is the focus of this report.

A number of policy documents and reform initiatives for rail improvement in South Africa exists, albeit lacking coordination and a shared data-driven intelligence platform, however specific road-to-rail strategies for both freight and passengers are absent, which renders it impossible to develop targeted initiatives to facilitate modal shift. The purpose of this report is therefore to propose road-to-rail strategies for both freight and passengers which will assist in identifying the key next steps to facilitate rail improvement and modal shift for the long-term benefit of society. This will be enabled by a strong data-driven foundation, the key missing ingredient in recent attempts by the government to develop a road-to-rail strategy (this is discussed in more detail in the sections on freight and passenger transport).

At the outset, a succinct overview of the major shifts since the mid-1980s in the structure of the state-owned entities (SOEs) involved in rail freight and passenger transport is provided here for context. Prior to the deregulation of road freight transport, and the legal succession of Transnet and the South African Rail Commuter Corporation (SARCC) in 1990, both rail freight and rail passenger transport in South Africa were managed by the South African Transport Services (SATS) which was not a legal person but an agency of the state. The 1986 National Transport Policy White Paper proposed new principles for the creation of a more efficient transport system. This led to the Transport Deregulation Act of 1988 and the Road Traffic Act of 1989, abolishing economic regulation of road freight transport. The 1989 Legal Succession to the South African Transport Services Act created the mechanism to commercialise SATS and separate rail commuter services from rail freight and long-distance rail passenger services — the former resorting under the newly-formed SARCC, the latter resorting under Transnet (whose core focus was, and remains, freight rail, pipelines, and ports). The long-distance passenger service was moved out of Transnet in 2008 to the Department of Transport (DoT), who currently manages both long-distance and commuter passenger services in South Africa under the Passenger Rail Agency of South Africa (PRASA), with the exception of the Blue Train and Gautrain.

The report contains three main sections namely, the development of proposed road-to-rail strategies for freight and passenger transport, followed by concluding remarks that discuss cross-cutting issues that need to be addressed by government to ensure successful implementation of the strategies. The development of the road-to-rail strategy proposals are informed by a data-driven discussion of the history and status quo, which clearly highlight the core challenges and resulting strategies to redress these challenges.

It is important to note at this point that many of these issues have been on the agenda for more than five decades. The time is running out for government to act decisively against political interference and corruption, both in the transport sector and the broader environment, to avoid the collapse of foundational economic infrastructure that will be extremely difficult and costly to repair beyond a tipping point of collapse. It is not clear where that tipping point is, it might already have been reached in passenger transport.

PART 1: FREIGHT

1 Freight transport policy evolution and modal impact

In the mid-19th century, the connection of South African ports to the hinterland via the building of a new railway system was seen as 'immensely beneficial' and 'enterprising local merchants and speculators were pleading for a link to the interior' (South African Railways and Harbours 1960). Before rail's arrival in South Africa, the road and wagon trip to move a distance of the then around 1 000 miles from Cape Town to Klip Drift (now Barkly West) in the diamond fields on the Vaal River cost about 40 shillings per 100lb. and 65 days to complete (South Africa Railways and Harbours 1960). In today's terms this amounts to approximately R3,000 per tonne or between R100,000 and R120,000 for a truck or wagon load. However, despite the costs and challenges involved in making the road and wagon journey, the proposed new railway faced opposition almost immediately from existing industry players. The wagon-building industry would be impacted and the livelihoods of transport service providers threatened, with economic downturns already challenging the livelihoods of these industries. This however also brought the quest for more efficiency into focus (Pirie 1993). Despite opposition, the first railway trips started around 1860 and in the 1870s the then Cape and Natal railway systems became government property.

In 1910, the Union of South Africa was created and the South African Railway and Harbours Administration (SAR&H) established as an arm of government with differentiated tariff structures. Clause 127 of the Act of the Union of South Africa (1909) determined these principles:

> The railways, ports, and harbours of the Union shall be administered on business principles; due regard being given to agricultural and industrial development within the Union and promotion, by means of cheap transport, of the settlement of an agricultural and industrial population in the inland portions.

In order to enforce this, government placed legislative impediments on road freight transport. Through the Motor Carrier Transportation Act, the operational freedom of all road freight, except that used by farmers, local authorities, and government departments, was restricted. Permits for isolated categories such as perishable goods could be obtained, but the Act, enforced by railway police inspectors, ensured that most land-freight was rail-based. Despite this there was an upsurge in road haulage in the decade following World War Two to support South Africa's significant economic growth. Repeated exemptions as well as some relaxation of the regulations led to road haulage replacing rail as the dominant form of freight from the mid-1970s (Mitchell 2006).

The heavy transport industry regulation which existed for the most part of the 20th century had significant negative fallouts. The captured rail market negated the need for a long-term strategic vision (Havenga et al. 2011); successive Ministers of Transport based decisions on politics rather than sound commercial principles, including the allocation of capital which frequently favoured supporters of elected ministers (Frankel 1928).

In 1957 the then Minister of Transport instructed the DoT to conduct regular road freight surveys, although Smith reports in 1973 that this task was never properly implemented (Smith 1973). Jones (1999) confirms the lack of data on road freight transport, which was exacerbated by the deregulation of transport in 1989. The major shift to a fragmented road transport industry post deregulation made the determination of market demand and modal share much more challenging. During the period 1957 to 1985 sporadic surveys were undertaken, followed by annual surveys for a few years pre and post deregulation, the results of which are depicted in Table 1. (This data is

only available for tonnes, not tonne-km). The outsourced transport tonnes are obviously influenced by the large increase in low-value rail export of coal and iron ore with the establishment of the ore lines in 1976.

Table 1: Rail market share 1957–90

Million tonnes	Rail - actual	Road for reward	Road ancillary	Total	Rail market share of total, %	Rail market share of outsourced, %
Verburgh — 1957	75	67	113	255	29	53
Smith — 1971	100	245	279	624	16	29
Hamilton — 1985	170	263	241	674	25	39
Pretorius — 1985	182	272	414	868	21	40
Pretorius — 1986	178	251	470	899	20	41
Pretorius — 1987	188	227	498	913	21	45
Pretorius — 1988	187	192	472	851	22	49
Pretorius — 1989	179	153	435	767	23	54
Pretorius — 1990	184	149	402	735	25	55

Note: Pretorius' rail figures are replaced by more accurate known data; see Havenga and Pienaar (2012) for a detailed overview of this time series.

Source: authors' compliation based on time series data in Havenga and Pienaar (2012).

The most critical market distortion up to the deregulation of the freight transport market in South Africa was cross-subsidisation to provide cheap transport for remote farming and mining ventures from higher-than-cost charges for manufacturing and higher-value traffic. As the latter was more time-sensitive, it was also the first to migrate from rail to road due to better service offerings and typically lower rates offered by road. The railways found it increasingly difficult to compete against many transport permit applications, a requirement that disappeared with deregulation.

The most critical service development mistake of this era was the failure to develop an effective domestic intermodal solution to connect Johannesburg, Cape Town, and Durban. Between the birth of highways in 1950 and deregulation in 1989 the income from high-value traffic should have been invested in such a solution. Post deregulation an attempt at domestic intermodal was made by Transnet with the PX service, but it could never be launched on a major scale due to it not being regarded as a strategic service offering and therefore receiving insufficient management attention and investment focus.

1.1 Transnet response post-deregulation

Following legal succession in 1990 Transnet, a single legal entity, organised the business in 5 transport divisions, namely Spoornet, Portnet, Autonet, Petronet and South African Airways (SAA). The initial strategy of leveraging the different transport modes through an integrated structure, becoming more like a logistics service provider (LSP) with an intermodal rather than multimodal focus, did not gain traction. The integration of container divisions (CX and PX, standard and mini containers) with terminals (both rail and port) was initially proposed and a separate business unit, Viamax, was created to promote this integration. Viamax could not achieve this vision and eventually morphed into a fleet management solution.

This meant that Spoornet was left on its own to revitalise rail and early efforts were focussed on rationalising the railway on the one hand and increasing density through market share gains on the

other, the same recipe that USA Class 1 railroads followed post the Staggers Act in 1984 (Palley 2011). Increasing density would, however, require major network rationalisation (a move that allowed USA railways to return major benefits to densification, keep costs low and gain market share). By the end of the first decade post legal succession, Spoornet realised that there was no political appetite for network rationalisation in a newly established developmental state and the plan was abandoned. (A horizontal split between low- and high-density lines was attempted, but this also did not gain traction as truly separate business entities).

In order to gain, or at least defend, market share Spoornet formed industry-focused business units including Wood and Paper; Agriculture; Steel; Cement; Coal and other minerals; Automotive; and the separate container divisions CX and PX. The business units had a customer focus and some wagon fleet responsibilities, but integrated train operations were separate. A permanent combined working order between the business units and train operations determined a weekly, quarterly, and annual train plan. Eight regional divisions were rationalised and the business was organised by a Joint Operating Centre and 36 area managers that executed local train plans (wagon management and train building) and received daily customer orders. The export lines were eventually managed as separate businesses Coallink and Orex, giving rise to what is basically the current structure namely the dedicated export businesses and the GFB business, serviced by business unit managers.

A great deal of effort has been expended post-deregulation to make rail freight successful. However, the loss of density; the inability to leverage high-value freight corridors due to the absence of a domestic intermodal service offering; continued cross-subsidisation of general freight by the export lines and, within general freight, of low-value by higher-value freight; and the disastrous pilfering of resources over the decade leading up to 2021, claimed its toll — the railway is probably at the most critical cross-roads of its existence.

1.2 Department of Transport policy responses post deregulation

The first policy document of South Africa's current government in 1994, the Reconstruction and Development Programme (RDP), refers extensively to modal shift and emphasises the role that rail can play in reconstruction. Rail is prioritised over road for specific services and the importance of integration between the modes highlighted (ANC 1994).

The 1996 White Paper on National Transport Policy (Department of Transport 1996) was the first transport policy document following the country's transition to democracy in 1994 and endeavoured to establish a transport vision that, for the first time, would serve all South Africa's inhabitants. The mission for the freight system as put forward in the White Paper is:

> To provide safe, reliable, effective, efficient, and fully integrated land freight transport operations and infrastructure which best meets the needs of customers at improving levels of service at an equitable cost in a fashion which supports government strategies for economic and social development while being environmentally and economically sustainable.

The White Paper also provided specific policy directives within which this mission must be accomplished. In 1998, the Moving South Africa (MSA) project was set up to produce a data-driven programme for strategic action that extends the short to medium-term *policy* formulation documented in the White Paper into a long-term *strategic* formulation embodying the sets of trade-offs and choices necessary to realise the vision as set out in the White Paper (Department of Transport 1998). MSA provided an extensive analysis of the reasons behind modal shift failure, relating specifically to rail service levels and service offerings, imploring for a concentrated effort

to make densified core lines work efficiently, while lamenting the lack of a data-driven programme for strategic action.

By 2005 the growth of freight traffic had however surpassed most of the 20-year growth forecasts made by MSA — at least 14 years before they were expected. MSA was followed by the National Freight Logistics Strategy (NFLS) in 2005 that promised the development of a master plan based on 'a range of freight demand scenarios' which in turn would be based on detailed modelling and data. The NFLS also placed a significant focus on institutional restructuring and economic regulation (Department of Transport 2005).

In 2009, the National Transport Master Plan (NATMAP) still referred to the lack of data: 'road freight origin and destination (OD) information is unavailable in South Africa …. The lack of information about road freight volumes, operators, commodities, and movements is a continual concern for planning authorities' (Department of Transport 2009a). The 2016 NATMAP Synopsis update (Department of Transport 2016) contains some data, mostly informed by secondary sources. Unfortunately, in 2021, 27 years after the RDP, 22 years after MSA, 16 years after the NFLS and 12 years after the start of NATMAP, the DoT has still failed to provide annual, reliable data for data-driven planning in the freight sector.

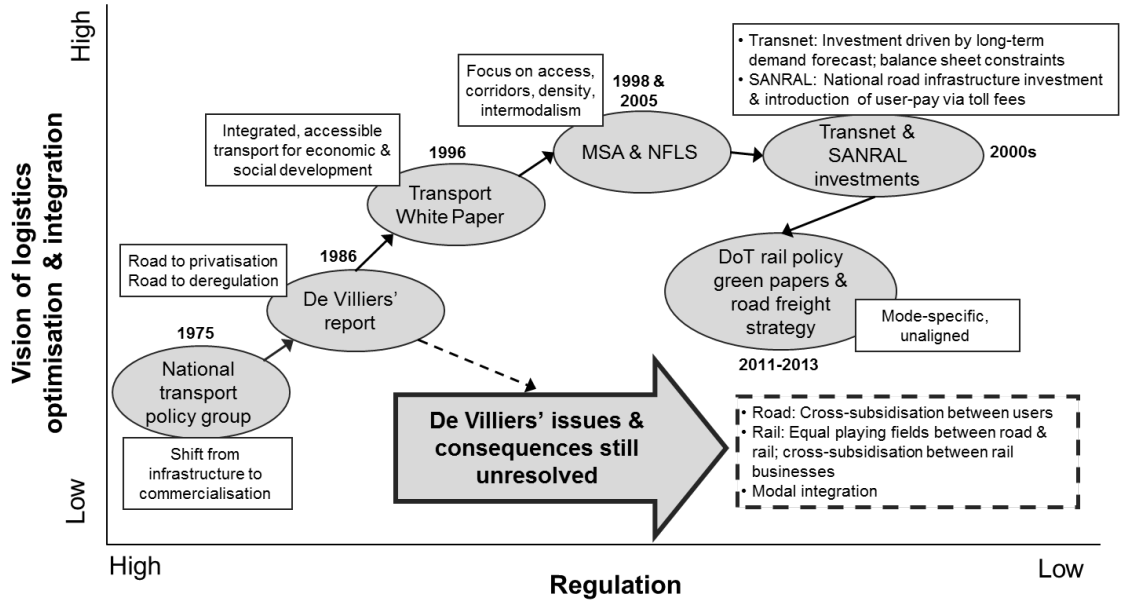
Post deregulation, the focus on mode-specific policies led to the DoT considering vertical separation as a possible solution with a strong rail regulation focus. The ensuing debate unfortunately detracted from the strategic issues within the freight sector, i.e., instead of determining and working towards an optimal rail system within the context of the broader logistics industry for the purpose of serving market demand and developmental state goals, the debate focused on the structure and regulation of rail in isolation. The most important policy statements relating to vertical separation was Transnet's own position (Mercer 2004) (which does not completely dismiss the idea, but states that the decision requires much more analysis and needs to consider 'commercial realities' to ensure that growth is achieved), as well as the DoT's position calling for vertical separation and rail regulation as a matter of urgency (Kuthele Projects 2007).

The DoT continued the position in the first draft of a 2009 rail policy Green Paper, which was largely dismissed (PalyreportSA 2015). The key ingredient, i.e., a demand-driven perspective for rail development (Havenga 2012), as advocated in the 1996 White Paper, MSA and the NFLS, was still absent. This was followed by a second edition of the Green Paper (Department of Transport 2015) that was better received, proposing the development of a rail master plan, investment strategy and asking questions about standard gauge, which, in the context of master planning and investment, could be considered. The only notable development following the Green Paper was the publication of a draft White Paper on rail policy (Department of Transport 2017a) and finally a revised White Paper on National Transport Policy that was approved by Cabinet in February of 2021 (South African Government 2021). The paper has not been gazetted yet, but it is purported that it still insufficiently addresses modal shift challenges and required policy interventions for an effective, short-term freight rail turnaround and long-term sustainability.

Havenga's (2011) stock-taking of South Africa's freight policy evolution is summarized in Figure 1. Unfortunately, a decade later the situation remains the same — government discourse is focused on unaligned, mode-specific strategies and regulation without a long-term vision and data-driven strategy based on the optimisation of the transport system with sufficient integration between modes. Transnet's balance sheet has deteriorated and service levels continue to decline amidst capacity challenges. This state of affairs has unfortunately been significantly exacerbated over the decade up to 2021 by inappropriate investments, maintenance failures, and misallocation of funds brought about by state capture. A new strategy at Transnet is developing since the replacement of the board by the Minister of Public Enterprises in 2018 and the subsequent replacement of

management by the board, but implementation with a challenged balance sheet will remain difficult.

Figure 1: Freight deregulation and policy development 1975–2011



Source: see Havenga (2011); copyright the author; reproduced here with permission.

Understanding the historical context is important to create a shared burning platform for change. In addition, it is important to understand what should be expected from the government to support this change. Similar to the strategic responsibility of a business' executive team, in the context of macrologistics the role of the government is, primarily, to facilitate the development of a long-term macrologistics strategy that optimally equilibrates the interaction between national freight transport demand and supply (Dollery and Wallis 1985). The first step in this process is an understanding of the status quo and the anticipation of future national demand characteristics per distinct freight market segment (Antonowicz 2011). A national road, rail and port infrastructure network design, and their intermodal connections, should flow from this, presupposing neutrality across modes by taking account of relevant social, environmental, economic, and land-use factors. This ensures that the contribution of each transport mode reflects their intrinsic efficiency, rather than government policies and regulations that could favour one mode over another. The strategy is subsequently enabled by a clearly defined freight policy, a single funding regime for the national network and the establishment of appropriate regulatory and institutional mechanisms to facilitate implementation (Australian Government Productivity Commission 2005). These steps echo the canonical management cycle of market intelligence, market segmentation, strategy development, business design, funding, and implementation. The fact that it is challenging to execute should not be a deterrent to at least attempt a strategic infrastructure view for a national economy.

These elements are all addressed in the lead-up to the proposed road-to-rail strategy in this paper, with a core focus on the missing element mentioned repeatedly in the introductory paragraphs, namely appropriate market intelligence. This refers to the creation of a data-driven backbone for national freight transport policy development, implementation, and tracking. The data-driven backbone has been diligently created by the private sector over the past 15 years, with data and financial support from Transnet, despite political apathy and an absence of support and inputs from the DoT notwithstanding numerous requests. A very high-level summary of the key steps in South Africa's freight demand model methodology is provided in the next section. (The approach

and outputs have been extensively peer-reviewed globally and more documentation can be provided on request). In addition, a succinct description of the other research components that informed the outputs of this paper is also provided in the next section.

2 Methodology for the development of the freight road-to-rail strategy

The core approach of this paper is a data-driven strategy development process based on three pillars:

1. Market intelligence (quantitative research inputs): The development of freight demand data, market segmentation to determine rail-friendly freight vs. actual freight on rail and benchmarking rail with international railways.
2. Stakeholder perceptions (qualitative research inputs): For an understanding of the current perceptions regarding the state of South Africa's freight road-to-rail strategy, and the challenges and limitations in its development and implementation, open-ended interviews were conducted with government (specifically the shareholder, the Department of Public Enterprises, and the regulator, the Department of Transport), as well as with large LSPs and freight owners.
3. A synthesis of these two pillars, i.e., a data-driven analysis of the gap between-rail friendly and actual rail freight, compared with government's response and the private sector's perceptions of the current and future state, should point the way to an appropriate road-to-rail strategy that will benefit the economy as a whole.

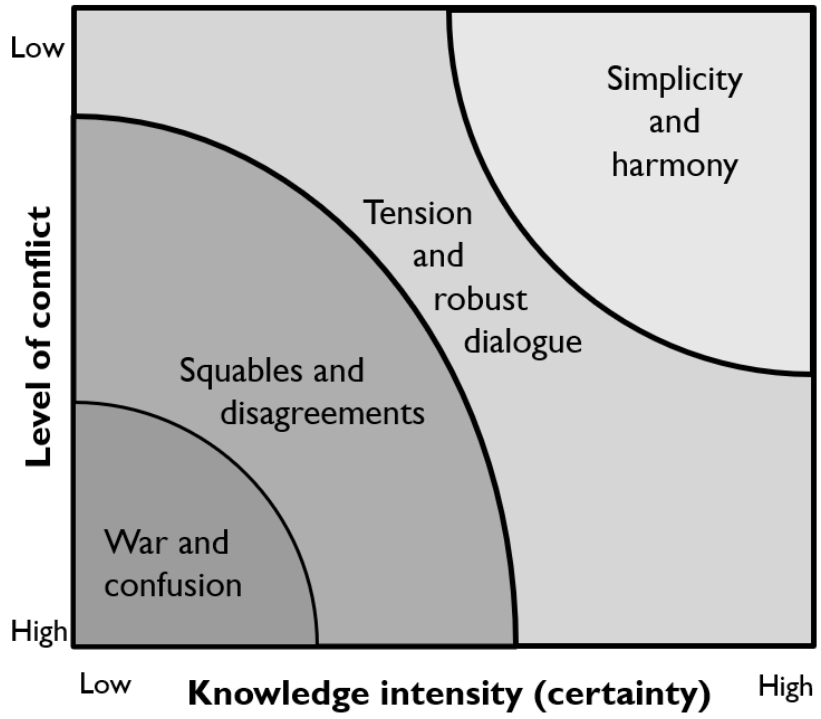
For freight demand determination the GAIN Freight Demand Model™ (FDM™) for South Africa is applied. The FDM™ estimates sectorally disaggregated supply (production and imports) and demand (intermediate domestic demand, final domestic demand and exports) of commodities in pre-defined geographical areas, the aggregate of which reflects total national supply and demand. There are 354 districts in South Africa, which are expanded to 369 geographical areas for this analysis by distinguishing the eight largest commercial border posts between South Africa and neighbouring countries, and South Africa's seven ports. The sectors are disaggregated into 20 agricultural commodities, 30 mining commodities and 33 manufacturing commodities. Subsequently, commodity-level freight flows, for which actual data cannot be sourced, are estimated utilising a gravity model. The gravity model assumes that bilateral trade flows are directly proportional to the disaggregated supply (origin) and demand (destination) volumes and inversely proportional to a measure of transport resistance. Transport resistance is a customised distance decay parameter informed by the nature of the commodity, known rail and port flows, industry interactions, and iterative applications of the gravity model. The FDM™ also develops a 30-year forecast at 5-year intervals (annually for the first 10 years) for three scenarios and has been applied annually since 2006 (Havenga and Simpson 2018). The outputs of this model are applied to determine rail-friendly freight according to a freight-flow segmentation approach (discussed in section 4) (for more on the freight-flow segmentation approach refer Havenga 2012).

For the gauging of government's response, five in-depth interviews were conducted with senior representatives of the Departments of Public Enterprises and Transport (including the Director General of Transport).

For gauging the private sector's perceptions, 17 interviews were conducted with LSPs, freight owners and agents, mostly from very large companies and at managing director or senior management level.

The synthesis is based on the principles of data-driven policy making (Havenga and Simpson 2018), where the policy debate is shifted from emotional and rhetorical arguments to a data-driven process as an antecedent to policy development. This impersonalises the policy development process and facilitates informed decision-making by reducing both complexity and uncertainty due to objective quantification which, in turn, facilitates agreement between stakeholders (Zimmerman and Hayday 1999; Ansell and Geyer 2017) (this process is summarised in Figure 2: Pulling power of data-driven policy making).

Figure 2: Pulling power of data-driven policy making



Source: authors' illustration.

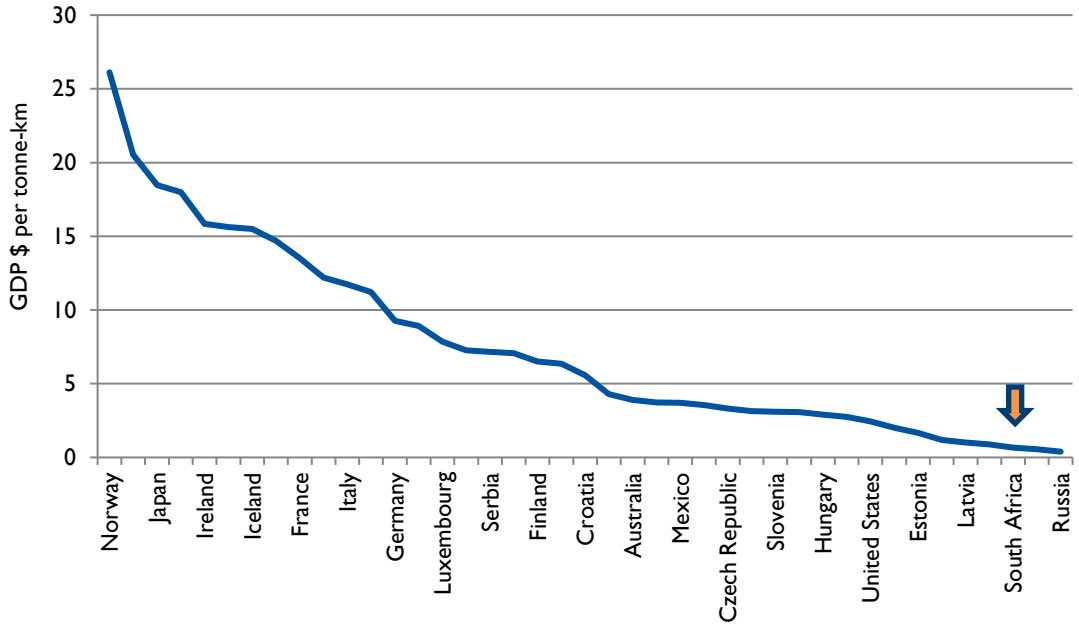
3 South Africa's aggregate freight demand position

The key consideration of a road-to-rail strategy for South Africa should be freight demand. In other words, it should be very clear how much of what needs to be moved from which origin to which destination now and in the long-term future.

The aggregate output of the FDM™ indicates that, in 2019, freight demand in South Africa amounted to 446 billion tonne-km (305 billion tonne-km line haul, 132 billion tonne-km last mile and 9 billion tonne-km in pipelines and on conveyor belts). This tonne-km demand is disproportionate to the size of the economy. Globally, approximately 40 trillion surface freight tonne-km (i.e., road and rail) were required in 2019 (International Transport Forum 2021) to generate US$87 trillion of GDP (World Bank 2021), i.e., approximately US$2.2 return for every tonne-km provided by road and rail. The South African GDP amounted to US$351 billion in 2019 (World Bank 2021), for the 446 billion surface freight tonne-km provided, i.e., the country's return is approximately US$0.79 for every tonne-km provided. The country's tonne-km demand is therefore almost three times less competitive than the world average; an extraordinary backlog from the outset. A country-level comparison is provided in Figure 3.

One of the reasons why South Africa is doing so poorly on this measure, compared to similarly large land masses such as Australia, is that South Africa's production centres are in the middle of the country and minerals are far away from the coast, making industrial and import/export corridor management a strategic priority for South Africa.

Figure 3: GDP per tonne-km — South African in comparison to a range of other countries



Source: authors' research and calculations.

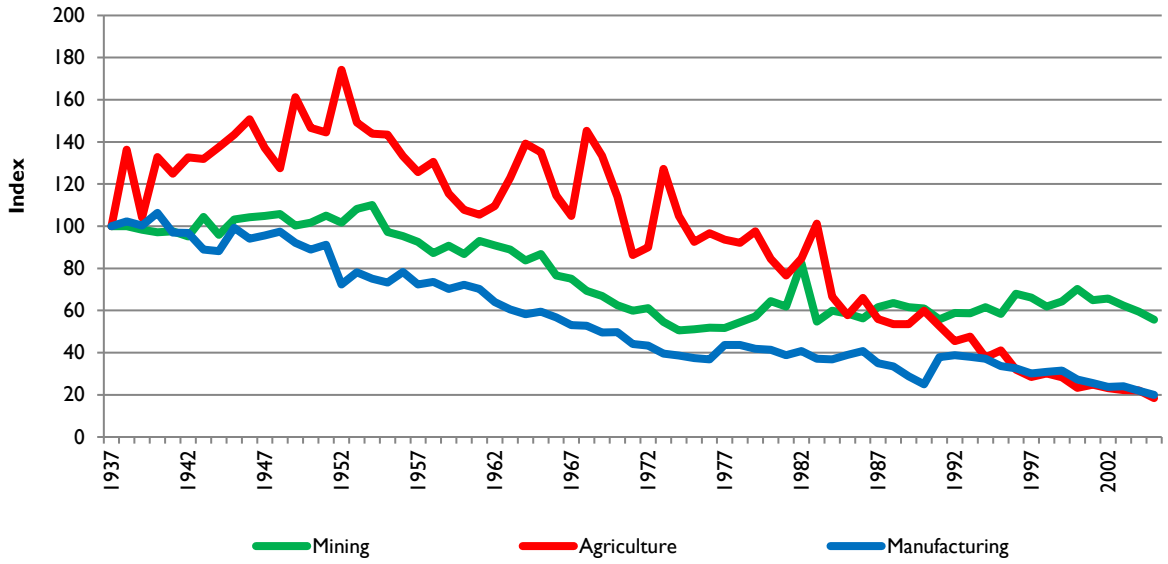
The question then is how to service this freight demand. As discussed, South Africa's tonne-km demand is high, it is therefore a strategic resource and transport supply should receive focussed macrologistics attention, a condition that has not yet been met in South Africa.

4 South Africa's aggregate freight supply position

South Africa's freight supply can be analysed historically in the modal context of Table 1 presented earlier but also, for freight rail specifically, as a relationship between GDP and rail freight (

Figure 4: Indexed correlation of the relationship between freight rail transport and physical production in the economy) (complete road freight volumetric data over such a long time series is not available as there has never been a formal process to create this metric). Over the six decades depicted, mining reduced by 40% and manufacturing and agriculture by 80%. The drive of the post-war years (up to 1952) to service commercial agriculture, and the impact of the coal and iron ore exports machines since 1976, are evident.

Figure 4: Indexed correlation of the relationship between freight rail transport and physical production in the economy

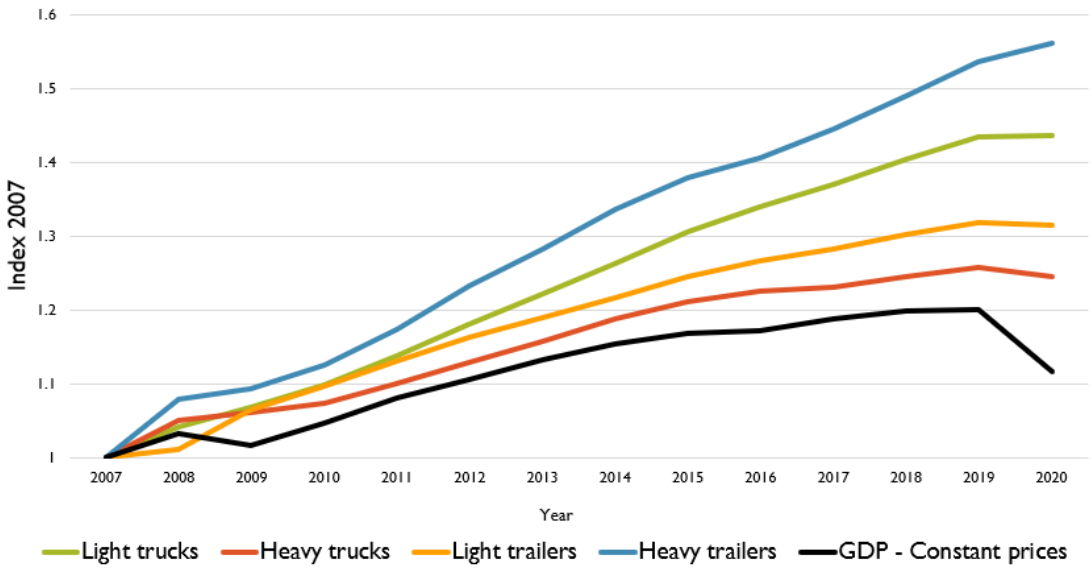


Note: transportable GDP.

Source: rail data from Transnet Freight Rail; GDP data from StatsSA.

Since the middle of the 2010s South Africa's truck fleet increased sharply (Figure 5). Not only did the heavy truck fleet grow faster than GDP, but extraordinary heavy trailer growth is also noticed. This is a result of an extreme efficiency drive. One of the major constraints on vehicle efficiency is depot turnaround time. By using more trailers, the industry is able to increase monetisation of expensive truck horses by preloading trailers, thereby eliminating horse empty legs.

Figure 5: Growth in South Africa's road truck fleet



Source: vehicle data from eNatis; GDP data from StatsSA.

From a modal supply perspective, the measurement and understanding of rail market share remains a challenge. The DoT's road freight strategy policy (Department of Transport 2017b) does produce rail market share targets, but with insufficient detail or context to highlight the challenges, opportunities, or targets adequately. Rail market share calculations can be complex as it can be defined from many different angles and should be clearly described when quoted.

The FDM™ outputs enable a detailed understanding of rail market share (see Table 2), which will assist in defining a road-to-rail strategy. South Africa's total freight demand expressed in tonnes supplied and demanded (where supply is production plus imports and demand is consumption plus exports) is 838 million tonnes. Of this 25% was moved by rail in 2011 with an unchanged figure for 2019. A portion of freight, especially higher value goods, is however shipped more than once in the supply chain between supply and demand. For example, manufactured foodstuffs can move from a remote production facility (e.g., in Malmesbury) to a distribution centre in the region (e.g., Brackenfell in Bellville), from there by long haul on road to a distribution centre (e.g., to Germiston in Gauteng), and from there do a last mile trip to a retailer (e.g., to Shoprite Checkers in Roodepoort). In this case the commodity was shipped three times. In this definition, total shipments in South Africa amounts to 1 587 million tonnes. Rail's market share of total tonnes shipped dropped from 23% in 2011 to 16% in 2019, primarily caused by its low market share in higher value cargo that is shipped more often.

Table 2: Various rail market share views

Calculation base	2019 Totals	2011 Rail market share, %	2019 Rail market share, %
Supply/demand of all products (million tonnes)	838	25	25
Tonnes shipped (million tonnes)	1 587	23	16
Tonne-km (billions)	384	35	37
Tonne-km excl. all export mining (billions)[1]	170	11	10
Outsourced income (Rand millions)	148 742	31	27
GFB corridor freight (million tonnes)	241	19	11
Palletised long-distance (million tonnes)	53	2	1

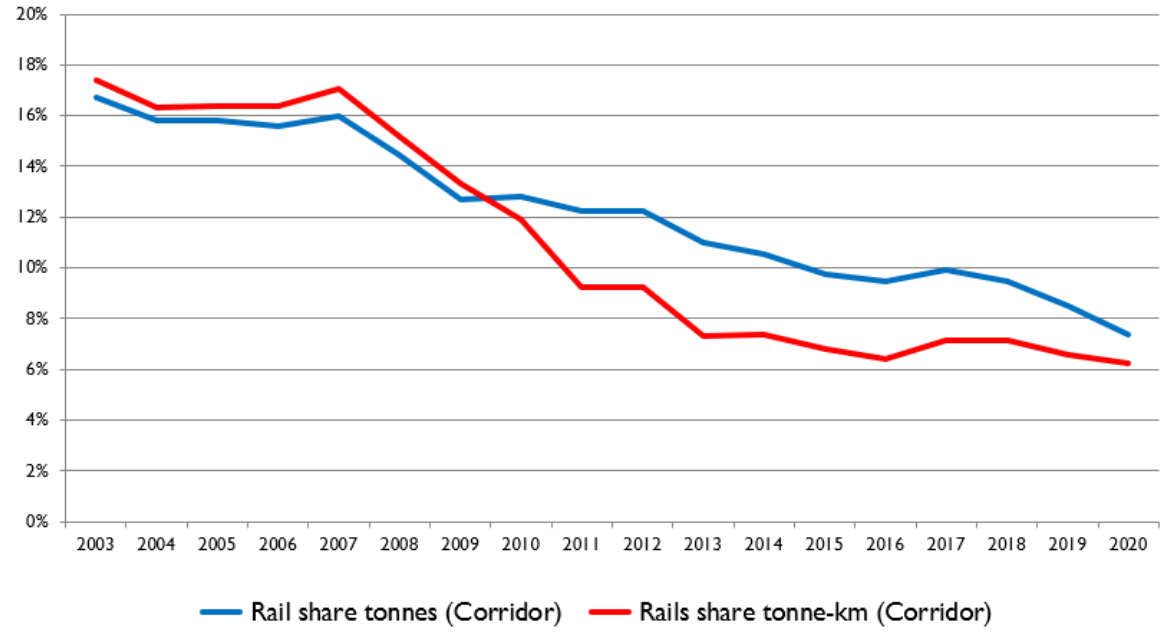
Source: outputs from the GAIN Freight Demand Model™.

Tonne-km market share is based on the shipped tonnes. Rail's tonne-km market share increased slightly from 35% to 37% over the period, due to large increases in export manganese and export coal and iron ore over the dedicated ore lines. If all export mining commodities are removed from the equation rail tonne-km market share declined from 11% to 10%. One could also consider market share as a percentage of outsourced freight, i.e., freight not transported privately but for reward (about 50% of freight), in which case rail's share declined from 31% to 27%. In terms of general freight corridor tonnes, rail market share declined from 19% to 11%. One could even just consider palletised long-distance freight, which is a natural market space for rail, but is basically non-existent in South Africa.

[1] Export mining includes coal, manganese, export iron ore, chrome, magnetite, and other smaller mining exports

A return to density on corridors was a major and important focus of all the initial rail policy and strategy documents in South Africa, and the declining trends in rail corridor market share over the past two decades, depicted in Figure 6, can be regarded as a major policy failure.

Figure 6: Trends in rail corridor market share (tonnes and tonne-km)



Source: outputs from the GAIN Freight Demand Model™.

The aggregate demand and supply positions confirm that challenges exist within South Africa's national freight-flow space. The steps to develop a road-to-rail strategy in the context of the macrologistics strategy cycle (described towards the end of section 1 in the freight section, unfolds as follows in subsequent sections:

1. Market intelligence: Develop a view of total national demand, i.e., an understanding of all freight flows in the country (see sections 2 and 3).

2. Market segmentation: the classification of these freight flows into specific market segments based on freight characteristics and customer needs (section 4).

3. Strategic choice: Market segmentation enables a choice about where to compete. In the context of a road-to-rail strategy this refers to the identification of rail-friendly freight that will exploit the core rail economic principles, determining rail's current market share of this freight and how to bridge the gap (section 4).

4. Implementation is further informed by understanding how South Africa's railway compares to other railways globally (section 5), and customer perceptions regarding the status quo and future requirements.

5. This then enables the development of a high-level road-to-rail strategy, including infrastructure design, funding mechanisms and policy.

Prior to introducing the freight-flow segmentation methodology, it is prudent to highlight the importance of the above discussion on market share. Numerous market share figures are quoted in the press or in interactions between stakeholders; and it must be very clear which metric is being

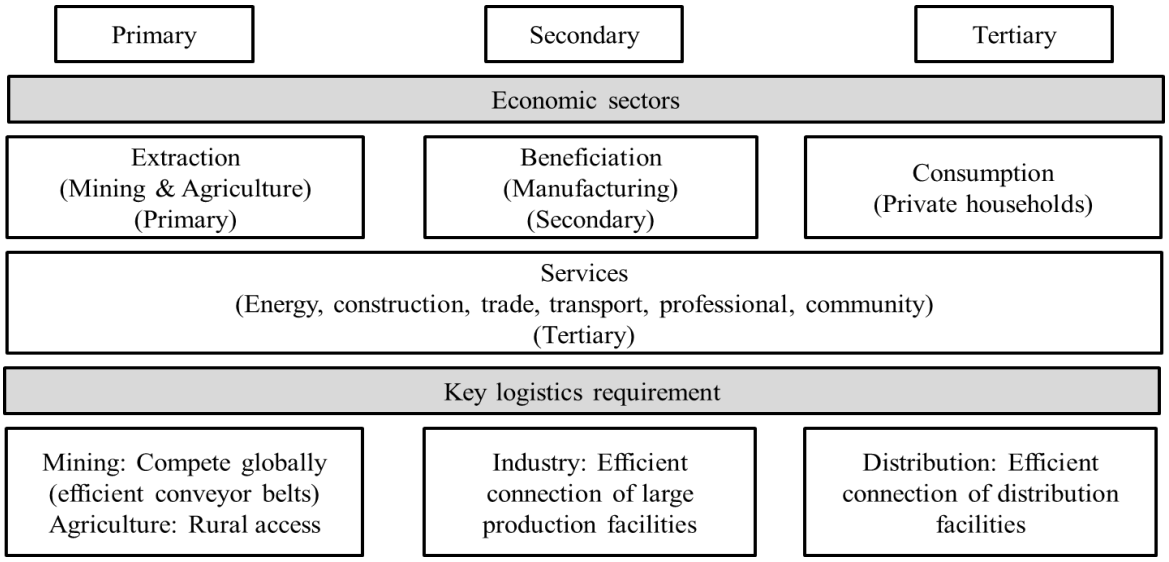
discussed, for which purpose, and what is contained in the data (which is mostly not obvious from quoted data). For the development of the freight strategy, the remainder of the freight section will focus on tonne-km as the key market share metric to inform the high-level strategy (density refers to tonne-km/route-km). For clarity, freight transport refers to the **total movement of goods using inland transport on a given network** — one tonne-km represents the transport of one tonne over one kilometre — the metric therefore takes into account the tonnes shipped as well as the distance shipped. It is therefore preferred to the use of tonnes. In addition, the freight segmentation approach taking into account the total freight transport market, discussed in the next section, ensures that rail objectives are understood in terms of the total market, as well as refined for specific market segments, and for rail-friendly freight within that market. As the strategy is fleshed out, additional metrics such as direct logistics costs and externality costs related to the individual flows will become important to direct priorities.

5 Freight-flow segmentation: rail-friendly freight

5.1 Definition of freight-flow market segments

In order to classify freight for the purposes of policy development, investment prioritisation and modal optimisation, freight-flow segments are defined. The assimilation of freight flows is derived from the economy's basic structure and its related logistics requirements, as illustrated in Figure 7: Basic economic structure and resultant logistics requirements.

Figure 7: Basic economic structure and resultant logistics requirements



Source: see Havenga (2012); copyright the author; reproduced here with permission.

Freight flows take place from the place of extraction or manufacture to the place of utilisation or consumption, resulting in key flow patterns. These flow patterns gave rise to five overarching freight-flow segments (numbering aligns with numbering in **Error! Reference source not found.**):

1. Large volume export mining flows: exports of coal, iron ore and manganese.

2. Domestic mining flows: movement of local minerals to domestic beneficiation centres.

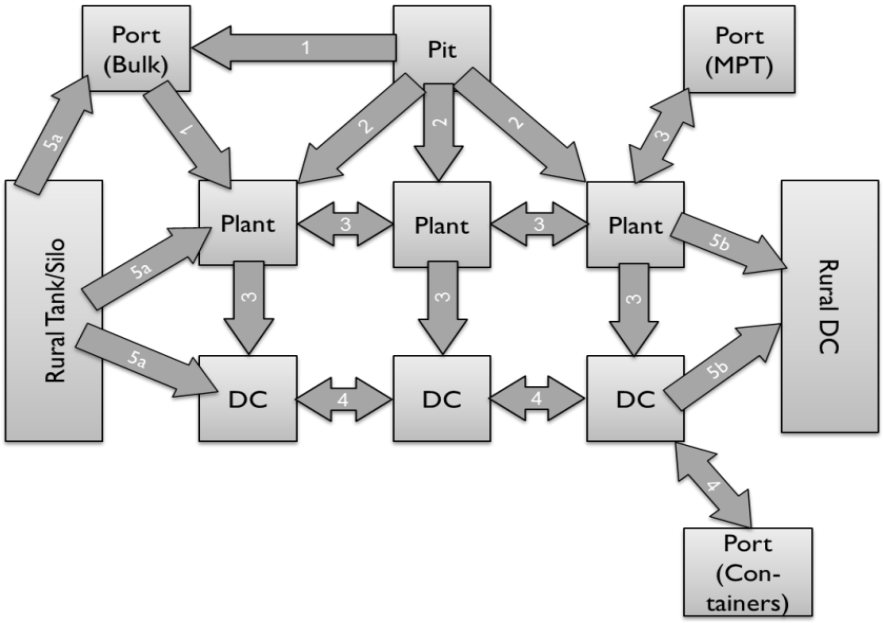
3. Intermediate manufacturing flows (siding to siding): flow of semi-beneficiated commodities between intermediate and final processing facilities.

4. Finished palletised goods: the flow of FMCG commodities of higher value between manufacturing facilities, distribution centres and retailers.

5. Rural extraction and delivery: the flow of agricultural bulk from rural areas (5a) and delivery of consumer goods to these areas (5b).

(Excluded from the segmentation is last mile freight that should always be on road and certain ring-fenced movements such as pipelines, conveyor belts and buoys for fuel movements in ports).

Figure 8: Freight-flow patterns derived from the basic economic structure



Source: see Havenga (2012); copyright the author; reproduced here with permission.

5.2 Rail economic principles for the determination of rail-friendly freight

Rail economic principles are determined by a few factors notably:

- Product/commodity uniformity: The standardisation of freight to facilitate handling and transport, such as bulk iron ore or containerised commodities. This requires large uniform fleets with focussed loading equipment such as evacuators and tipplers for ore; and cranes and ridge stackers for containers.

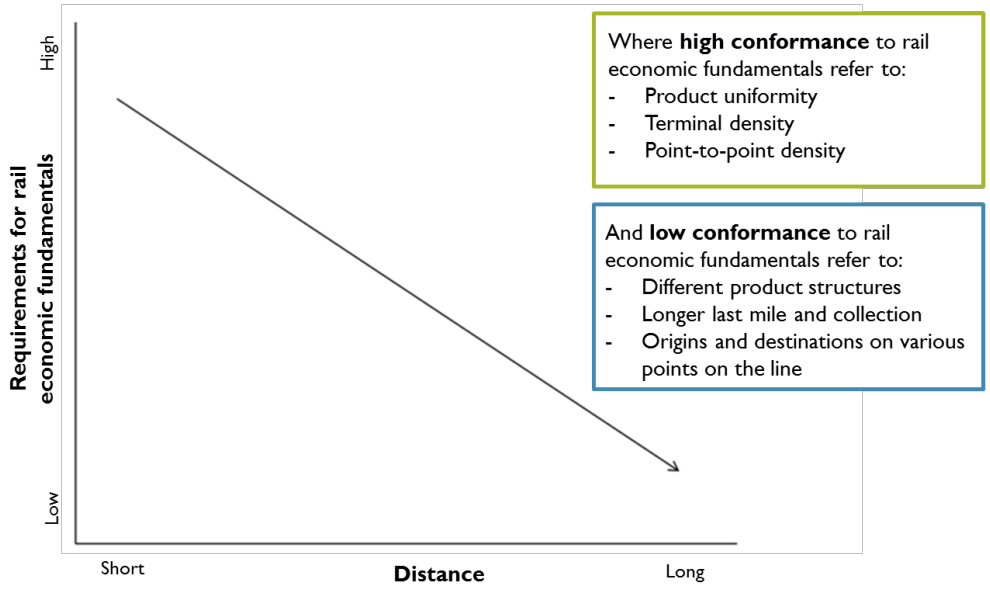
- Terminal density: The more freight is loaded and offloaded in the same district the more possible it becomes to create super terminals, logistics hubs and freight villages. These terminals create ideal opportunities for freight consolidation, intermodal and synchromodal operations.

- Line density: Consolidation of flows on the same route improves line density. High line density greatly favours rail; road trucks mostly pay for infrastructure variably as the road industry does not invest in road pavement directly (indirectly through the fuel levy and toll fees). Rail fixed infrastructure is 'really' fixed; it must be paid by rail even if not in use. In a scenario where rail

has low market share on rail-friendly routes, returns to density for rail can be phenomenal and large shifts can easily see new marginal freight only attract a fraction of the cost of the original load.

- Distance is another important consideration in the identification of rail-friendly freight because of the low distance sensitivity of rail transport versus road transport. There is however a trade-off between distance and all three of the above-mentioned factors (Figure 9). This observation is important, because distance is often perceived as a key determinant of rail friendliness of freight, but it is merely easier to deal with other unfavourable conditions provided that a minimum distance is achieved.

Figure 9: Returns to distance on rail



Source: authors' illustration.

- The last consideration is value, however value is also a trade-off with time. Inventory has an opportunity cost, but often high-value freight has a relatively low daily opportunity cost. Freight, for instance, valued at R50,000 per tonne and attracting an opportunity cost of 12% per annum (i.e., the cost of carrying that inventory) will carry a R17 per tonne per day opportunity cost charge, meaning that everything else being equal a R20 per tonne discount on total cost if rail is inserted in the value chain will be favourable for rail if the delay is one day or less.

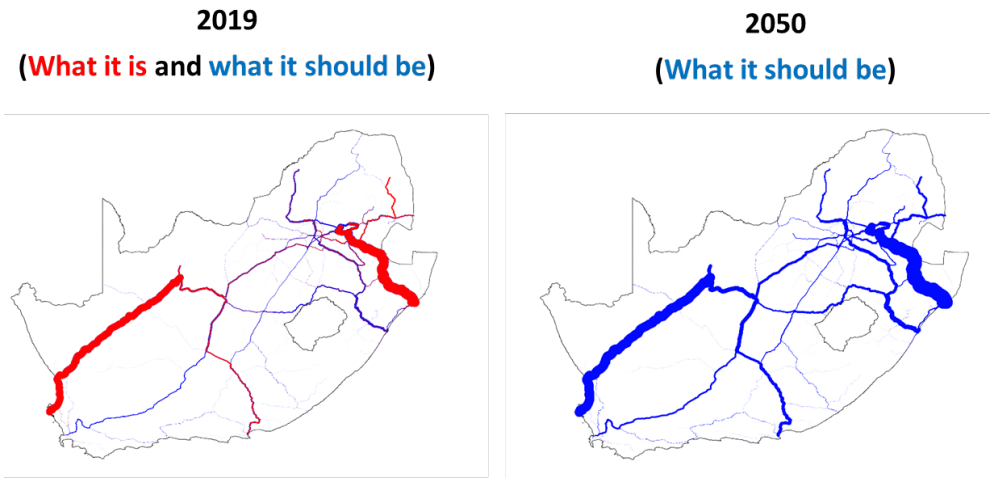
For each of the freight-flow segments identified in section 0, a rail target market share can be determined based on these rail economic principles and rail's current performance against the target measured. This is described in the next section.

5.3 Rail's current and target market share of rail-friendly freight

In 2019 total rail-friendly freight was estimated at 181 billion tonne-km of which approximately 141 billion tonne-km was on rail. This figure is expected to increase to 276 billion tonne-km by 2050 (Figure 10). The 2019 rail market share of 78% of rail-friendly tonne-km (65% of rail-friendly tonnes shipped) reflects the gap in rail-friendly freight that should be on rail as indicated by rail economic principles. In other words, 22% of tonne-km that can best be served by rail, and 35%

of tonnes, was served by road, adding significant direct logistics costs and externality costs to the economy. This view is overpowered by the iron ore and coal export lines where 134 billion tonne-km of freight is expected to be on rail and only 11 billion tonne-km not achieved. This gap is mostly manganese on road and should be redressed with immediacy.

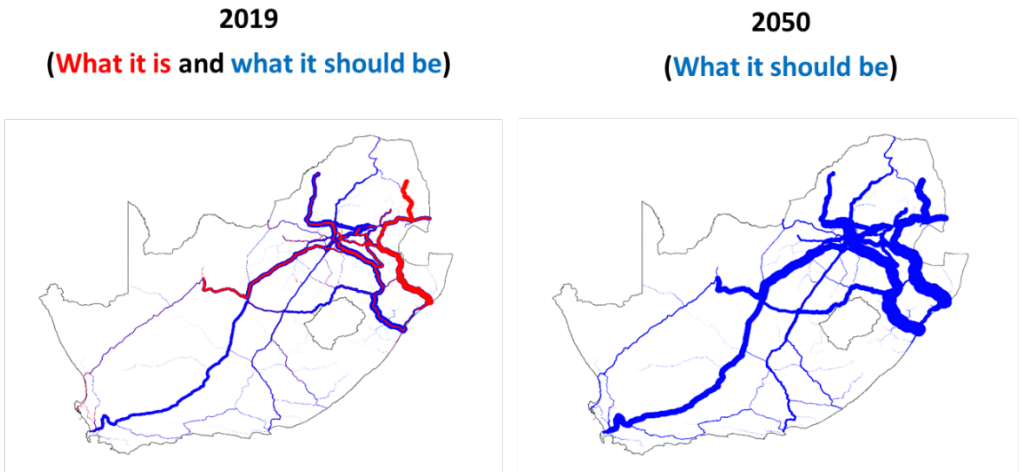
Figure 10: The total rail task and fulfilment of the task



Source: outputs from the GAIN Freight Demand Model™.

With regards to the total general freight market, rail should have delivered 47 billion tonne-km in 2019, but delivered only 18 billion tonne-km, therefore a gap of 30 billion tonne-km (Figure 11). This task is expected to grow to 77 billion tonne-km by 2050, meaning that modal shift success will require the general freight railway to more than quadruple from its current size.

Figure 11: The general freight rail task and fulfilment of this task

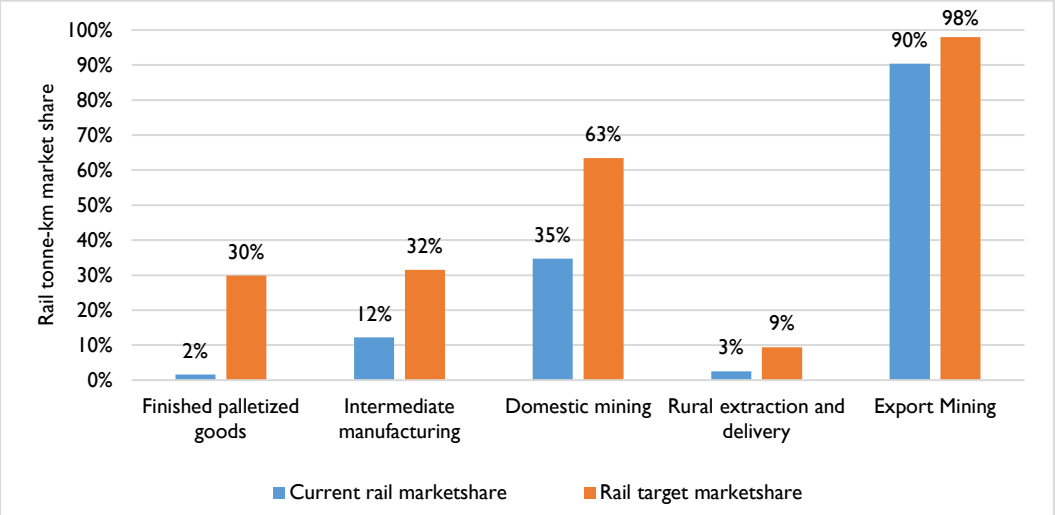


Source: outputs from the GAIN Freight Demand Model™.

Rail's current performance and gap (or opportunity) is depicted per market segment in

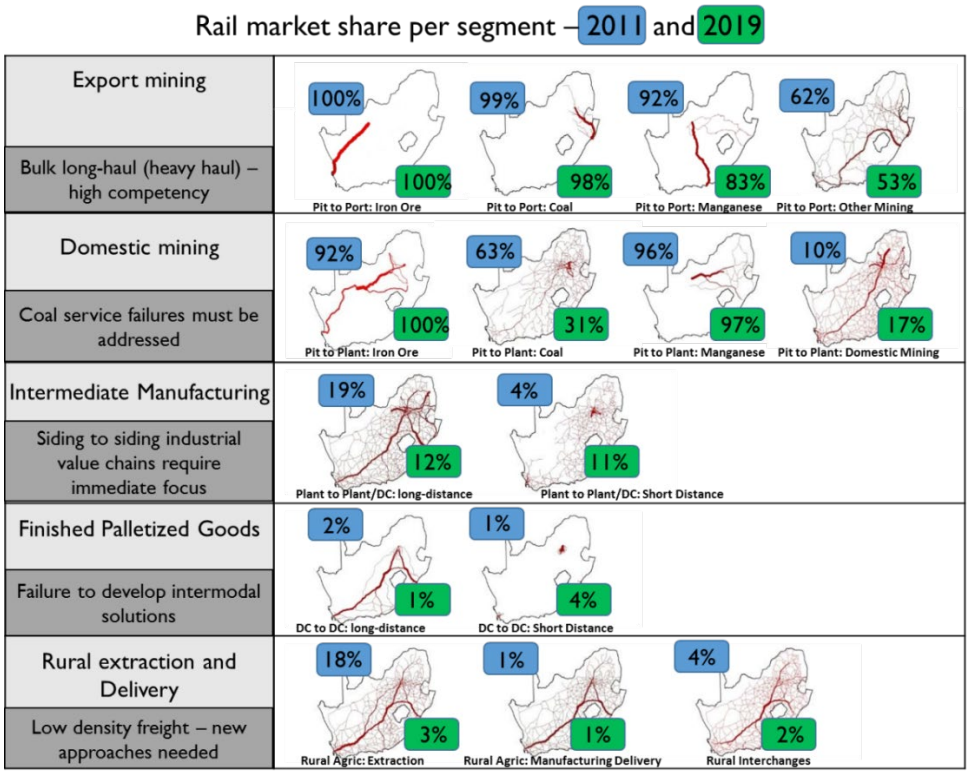
Figure 12. The biggest undeveloped rail service opportunity is in the palletised long-distance freight segment, whilst the biggest gap relative to existing competencies is in domestic minerals. The shift in market share in freight-flow sub-segments can also be tracked over the last decade (Figure 13). The loss of coal market share has been quite visible due to the investment and service challenges at Transnet already discussed. The reduction in rail market share in industrial value chains (long-distance intermediate manufacturing), is nothing short of tragic.

Figure 12: Rail's current and target tonne-km market share for each segmentation type



Source: 2019 data, outputs from the GAIN Freight Demand Model™.

Figure 13: Rail tonne-km market share development over the last decade



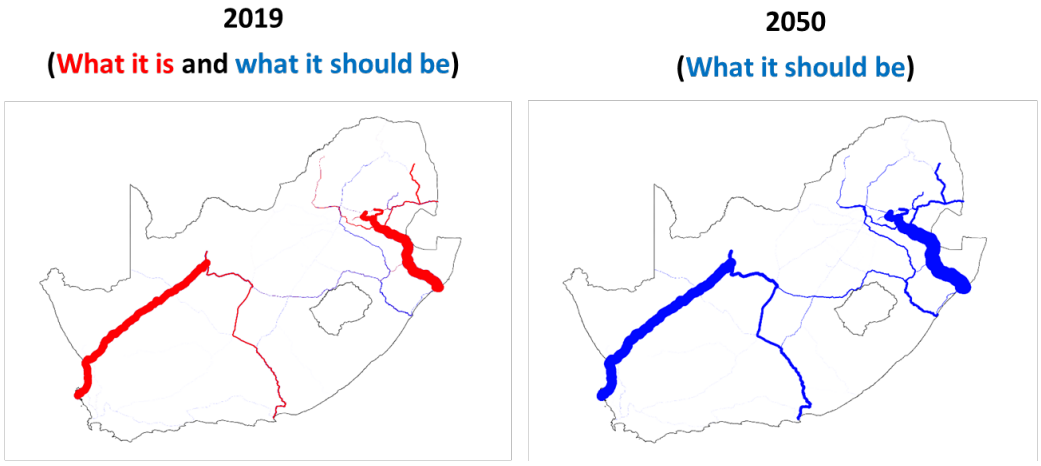
Source: outputs from the GAIN Freight Demand Model™.

Rail's performance, opportunities and challenges in each market segment are discussed in more detail in the next section and, importantly, a view on the target market for 2050 is provided, which will form an important component of the strategy as the rail infrastructure and services need to be able to deliver against this target.

Rail's performance in each freight-flow market segment

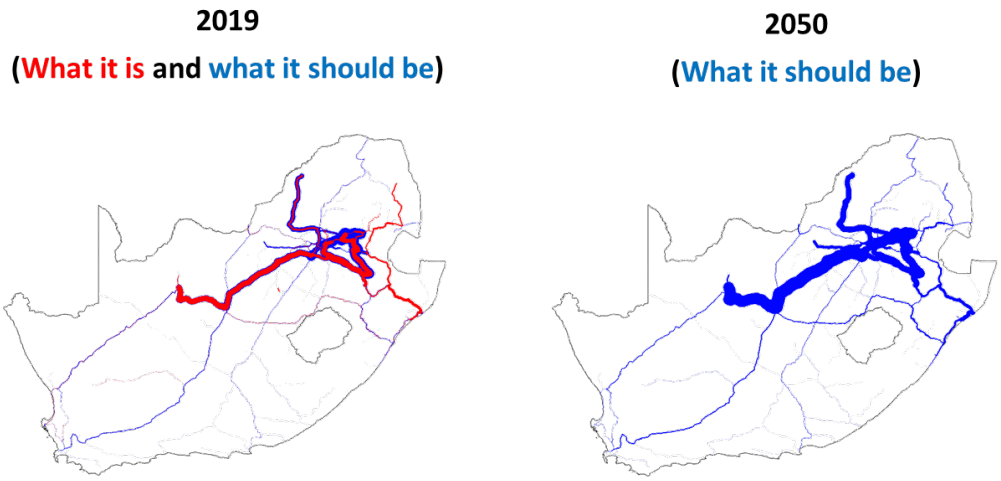
Rail's competency in **large volume export mining** flows is known, and especially the coal and iron ore export lines are regarded as world class. It was more difficult to develop manganese export growth due to rail capacity challenges and, during the last decade's favourable market conditions and due to South Africa's world-leading deposits, manganese could shift to road when required. However, manganese on rail has grown exponentially in this time. Despite this it is estimated that an additional 9% of tonne-km could have been delivered given sufficient capacity (Figure 14).

Figure 14: Large volume export mining gap



Source: outputs from the GAIN Freight Demand Model™.

Figure 15: Domestic mining gap

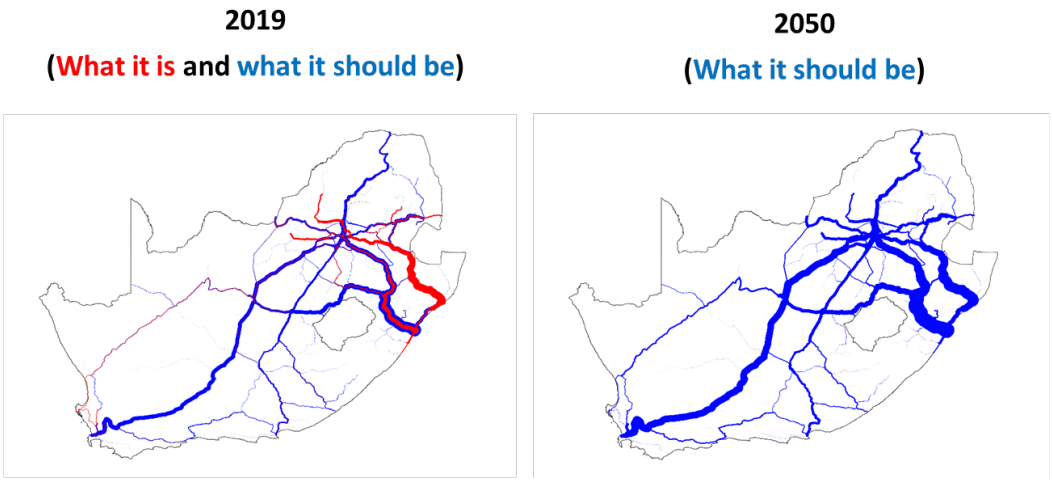


Source: outputs from the GAIN Freight Demand Model™.

Rail's competency in the movement of **domestic mining commodities** to beneficiation centres is well-established. The challenge is that these flows do not follow typical freight corridors, but often rural routes, e.g., iron ore from Sishen to New Castle, manganese from Kuruman to VanderBijl, or coal from coal mines to power stations. This freight is not only clearly rail economical (uniform products, dense flows, and large terminals — refer earlier discussion) it is difficult for road infrastructure in rural areas to entertain a large number of heavy road vehicles. Rail capacity failures in this regard are therefore highly visible and unsettling. The gap in the

transport of domestic mining is mostly around the coal fields, although there are also sizeable amounts of coal on the N1 and some manganese flows that require attention (Figure 15). Manganese is a high-value commodity, therefore less cost-sensitive than coal and iron ore and shifts to road during rail capacity challenges. The flow of some domestic iron ore on road is however also a challenge.

Figure 16: Intermediate manufacturing gap



Source: outputs from the GAIN Freight Demand Model™.

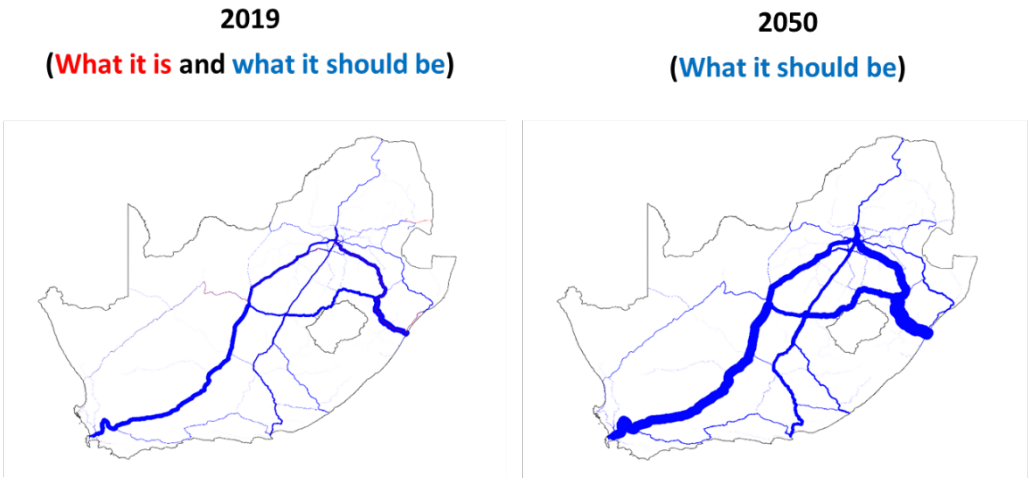
Intermediate manufacturing flows refer to large industrial value chains where an intermediate step is required before a final product is manufactured, e.g., the manufacturing of steel coils at Mittal Steel Vanderbijl that is subsequently shipped to Volkswagen for car manufacturing. Usually the two centra (in this case Mittal and Volkswagen) should have rail sidings and can easily be connected by a rail service. When it is large consignments (as is often the case) block trains or at least rakes can economically be used, if smaller wagon loads these wagons have to be collected from sidings in an area, taken to a shunting yard, built into a train and follow the same process on the other side, which is obviously less economical. However, once again large volumes of the same commodities over long distances can here be defined as rail-friendly. The intermediate manufacturing gap is especially prominent in the south west of the country. This freight flows over long distances and could easily be on rail (Figure 16: Intermediate manufacturing gap). A revitalisation of industrial sidings, and the re-insertion of rail in industrial value chains, is a critical component of any road-to-rail strategy.

Once large volumes of **finished palletised commodities** are manufactured (in South Africa mostly packaged food with some textiles, toiletries, pharmaceuticals, and beverages) these are moved between distribution centres on a core network connecting three predominant centra, Gauteng, Cape Town and Durban, and several other large peripheral centra such as Port Elizabeth, East London, Bloemfontein, Kimberly and Nelspruit. This freight is higher in value, follows main commercial corridors such as the N1 and N3, and is often transported over long distances on road, frequently in a pallet-friendly curtain-side interlink.

As far as palletised long-distance freight is concerned rail's low market share is not so much a gap as a completely non-existent service (Figure 17). This freight complies with all the aspects of rail economics i.e., it is unitised onto pallets and can be easily unitised into pallet-friendly containers making the resulting 'commodity' uniform; it follows highly densified routes; and has dense origin and destination points. In the developed world this type of freight is often transported via rail between distribution centres, with the last mile on road. A rail solution must be developed for this

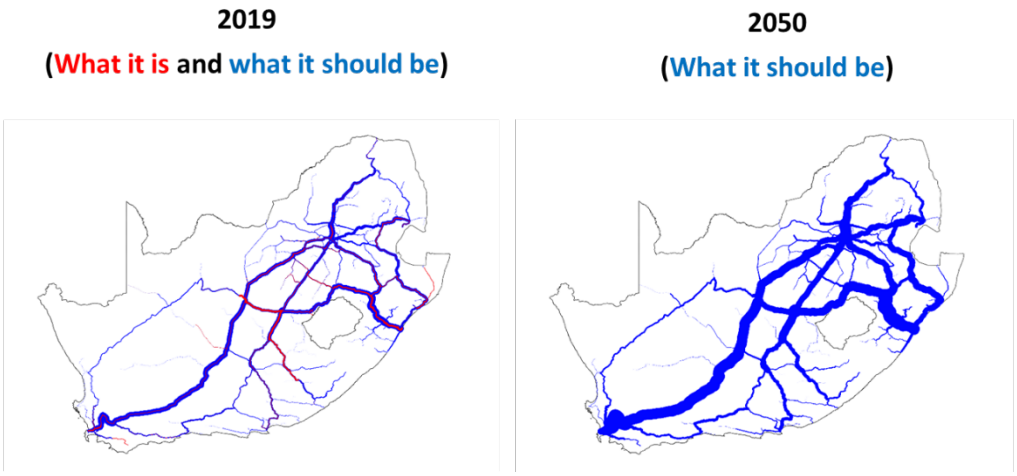
freight in South Africa — typically rail for long, dense flows, with road providing feeder services at both ends.

Figure 17: The palletised long-distance gap



Source: outputs from the GAIN Freight Demand Model™.

Figure 18: The rural gap



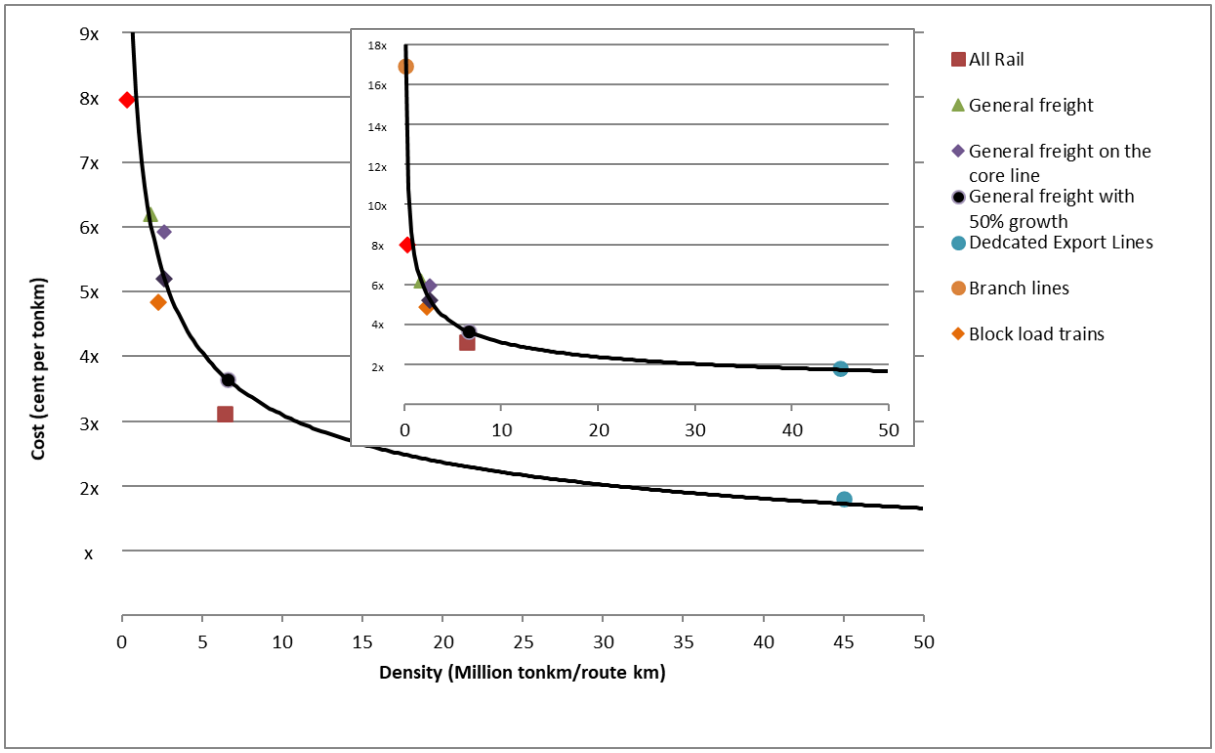
Source: outputs from the GAIN Freight Demand Model™.

Agricultural or rural freight typically exhibit low-density flows and dispersed collection points, making rail economics more challenging. However, once consolidated at e.g., silos, and provided there are sufficient volumes, the same approach as with domestic minerals can be followed. Rail-friendly characteristics are also improved if the cargo has to be moved over long distances to production centres and begin to follow corridors. A sizeable portion of this freight can therefore be classified as rail-friendly (Figure 18: The rural gap). There have been major losses of this freight over the past decade (see Figure 13) and the road-to-rail strategy must also consider service offerings here to support the development of rural economies.

6 Benchmarking rail

One of the most important objectives of a railway is densification. In South Africa's case the export lines are naturally dense, and the general freight corridors that have developed also exhibit high-density (see previous section) — these corridors serve siding-to-siding traffic, domestic intermodal traffic between major centra, and some rural traffic when it connects with far-off centra. Harris (1977) described densification as a major increase in tonne-km per route kilometre, having a dramatic effect on lowering rail unit fixed cost (given the large fixed cost component of rail). A new interpretation of Harris' original research into many different railways is shown in Figure 19: Harris' density curve adapted for South Africa, which is specifically adapted for South Africa.

Figure 19: Harris' density curve adapted for South Africa

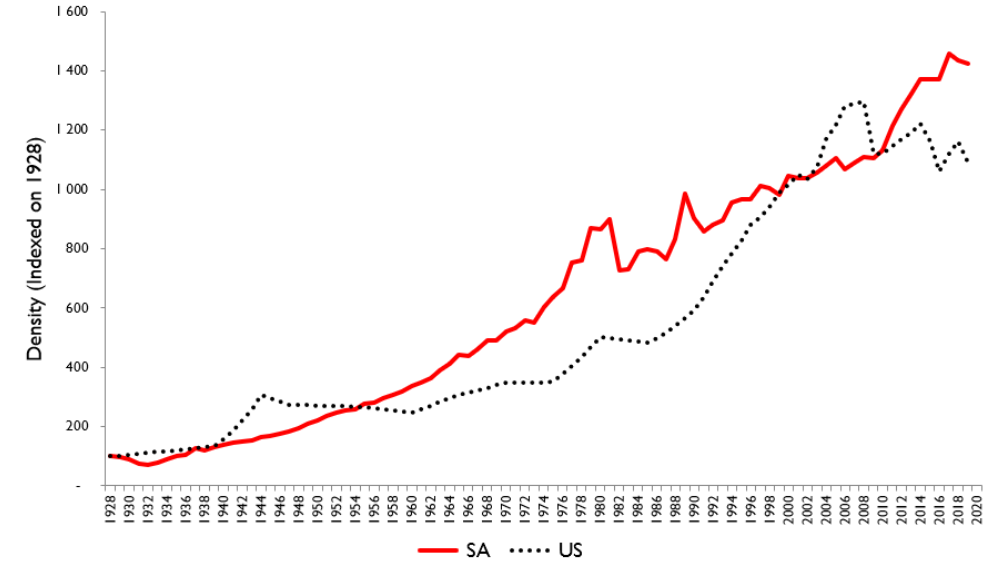


Source: authors' illustration adapted from Harris (1977).

The Staggers Act of 1984 provided USA Class 1 Railways with a unique opportunity to densify using two important levers, i.e., (1) an increase in tonne-km through market principles in a deregulated environment and (2) network rationalisation (the abandonment of low-density lines). The growth in the USA's densification index since 1984 is noticeable in Figure 20. What is obviously initially surprising is South Africa's outperformance of the USA, but this is where freight-flow segmentation plays a role.

Trends in density development can be split between rail's bulk export lines and general freight (Figure 21). It is quite clear why South Africa's export lines are seen as world class and also why the general rail freight business is in great peril. The density comparison for general freight with USA Class 1 Railways is extremely poor (Figure 22). This creates a stark picture of the cross-subsidisation within the freight rail business. The low and declining density in general freight is not viable (see the Harris curve, Source: authors' illustration adapted from above). It is critical to improve this and, in the short term, it simply requires the decision and dedication to make more slots available, and potentially more filled slots over a shorter network.

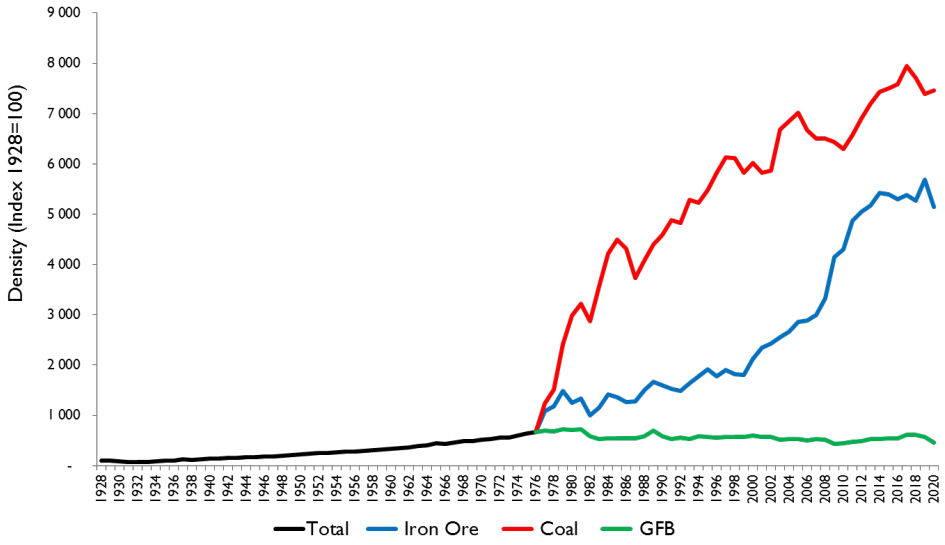
Figure 20: USA and South African rail density index



Note: density = tonne-km/route km.

Source: USA data from International Union of Railways (UIC); South African data from Transnet Freight Rail.

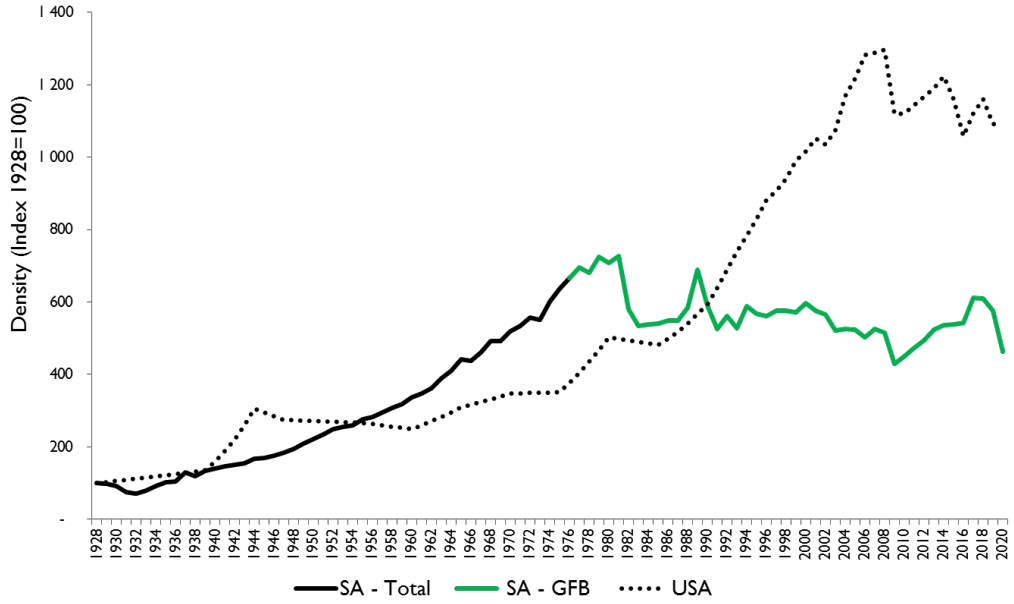
Figure 21: South Africa's rail density development since 1928



Source: data from Transnet Freight Rail.

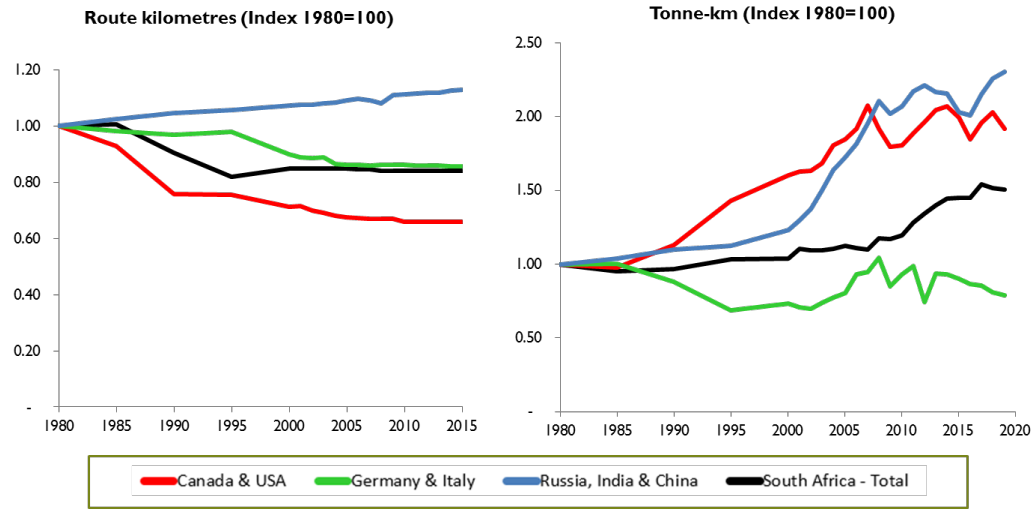
Comparisons with other railways are also possible and for this comparison seven countries were selected that, combined, represent more than 90% of global rail tonne-km. The comparison of density between these railway systems are depicted in Figure 23 — showing route-km and tonne-km trends separately.

Figure 22: USA and South Africa GFB density index



Source: global data from International Union of Railways (UIC); South African data from Transnet Freight Rail.

Figure 23: Tonne-km and route kilometre development of selected rail systems



Source: global data from International Union of Railways (UIC); South African data from Transnet Freight Rail.

Up to 2010 so-called capitalistic railways (USA and Canada) achieved major densification through route rationalisation, lower cost and 'buying' market share (i.e., selling below profit-maximising price) to increase tonne-km. Developmental state railways (Russia, India, China) expanded route-km (a developmental state phenomena) but with a growth objective, and the gradual increase in tonne-km can be seen over the past decade. European railways are sustainability orientated and because of poor rail economic fundamentals, especially shorter distances, focus on railway development to reduce congestion and emissions. These policies are having a minimal growth impact.

South Africa's split position is quite apparent. The coal and iron ore export lines are standalone entities and world-class in their own right. The general freight railway has neither developmental state nor capitalistic properties. The requirement to split high- and low-density lines is abundantly

clear and a business model for the absence of this specific horizontal separation has been a major shortcoming in the development of a sustainable general freight rail business — this refers to both a separation between the export lines and general freight, as well as a separation between low- and high-density lines within the general freight business itself. The absence of this strategic focus increases cost, challenges service levels and hampers filled-slot development over a shorter network.

7 Feedback from the private sector

As mentioned in the methodology section, 17 open-ended interviews were conducted with the private sector around rail modal shift. Here a basic qualitative interpretation of the interviews is provided to support the development of the strategy.

Some key challenges are identified. From an overarching perspective there is an obvious degree of despondency. The determination of the potential for freight rail demand that has been shared in this paper was confirmed by interviews, but rail has been unable to fulfil that demand. There is an understanding of extraneous factors such as infrastructure destruction due to theft, yet most respondents feel the most that could be expected from government is to protect rail assets. There is no expectation that any involvement from the Department of Transport in the policy space will make a difference to rail service delivery. It is, in fact, political involvement that is often perceived as the problem and the general belief is that the issues with rail freight should be solved between Transnet and the private sector. This points to significant stewardship issues. There is also concern that, especially within Transnet, personnel are replaced or moved around too often, making it impossible to build long-term relationships, which are important for collaborative success.

However, despite these challenges, many companies still have a stated intent to shift freight to rail and, in some cases, would do so even given current service level shortcomings. A portion would require more competitive tariffs, but a shift even at current tariffs would have been possible if capacity was made available. Many LSPs also have a stated intent to collaborate with the railway and are keen to get involved in intermodal solutions. Wholesaling to LSP's would be entirely possible where rail provides hook-and-haul services between privately-owned terminals, and even of privately owned wagons. Provided there is assurance of service levels, these arrangements have wide-spread support.

The next section contains a summary narrative of the historical events and missed opportunities that gave rise to the current crisis in freight rail transport in South Africa, with the intent to establish a shared burning platform.

8 Summary narrative of current crisis

With country and rail unification around the turn of the 19th century, the railway was correctly identified as an important tool for the developmental state. However, very early on, the strategic development of the railway was superseded by political interference. As is always the case, political interference challenged sustainability, and the railway was protected through regulation. This enabled the cross-subsidisation of mining and commercial farming interests by captured high-value traffic. The railway fought a continuous battle against freight owners and road service providers to allow the unimpeded shift of higher-value freight from rail to road (due to *inter alia* improved

service levels and more transparent tariffs). Deregulation of freight transport finally took place in 1989.

An important component of deregulation should have been road quality control and user- pay principles; this was however never really achieved. In the run-up to deregulation, and given the continued loss of high-value freight to road, two critical mistakes were made by the railway. Firstly, the export lines' impressive successes were used to conceal general freight challenges. Operational issues, losses in density, poor returns and system lethargy were not visible because of this cross-subsidisation. Secondly, there were service delivery failure in GFB: the failure to create heavy intermodal freight haul on dense corridors, as well as the failure to provide a better-organised block train system to serve large industrial customers. These failures left a large and gaping hole in any defence of rail market share.

With legal succession and deregulation came rationalisation of people and fleet but not of the network. The inability to densify, driven by the lack of political appetite for splitting the rail network in a high- and low-density business, made competition difficult as investment into new services and service excellence were continuously challenged. The initial reorganisation path, followed from 1990–98 (see section 0), was valid but could not be executed in the then political climate (the same challenges remain). The intended focus on predictable slot provision by a market- and customer-focussed organisation, on a rationalised, profitable network could have worked in a capitalistic environment but not in a developmental state. At the turn of the century, at the same time that this realisation of the inescapabilty of a dual role (profit and developmental state) became clear, government replaced the management of the railway without proper continuity to pursue this strategic discussion. Unfortunately, this strategic discussion is still not resolved two decades later, due to continued political interference, loss of core skills, continuous management changes and restructuring, and the tragic financial impact of state capture over the past decade.

9 Proposed freight road-to-rail strategy

The proposed freight road-to-rail strategy is described in relation to the key strategic objectives, network design (i.e., lines, nodes, and terminals), service design, overarching structure, funding mechanisms and policy.

9.1 Key strategic objectives

The **first, short-term strategic objective** is to create capacity for and shift the identified 11 billion tonne-km of rail-friendly export minerals and 30 billion tonne-km of rail-friendly general freight currently on road to rail in the next two years. (It is important to comment specifically on the bulk export iron ore and coal lines. The iron ore line is a viable stand-alone business that should be horizontally separated from GFB, and treated as a ring-fenced, vertically integrated system. It could be operated by TFR, sold as a single business to another company or investor, or to the mines. The coal line carries a sizeable portion of general freight and could be treated similar to GFB corridors. Terminals are already privately owned, the wagons could be sold to Richards Bay Coal Terminal (RBCT), and Transnet can continue to do hook-and-haul on the line.)

The **second, longer term strategic objective** is to ensure that the reform and investment path will facilitate the quadrupling of the general freight railway by 2050. This second strategic objective especially creates a significant opportunity over time for many other players to become involved.

A back-of-the-envelope business case calculation for the short-term strategic objective highlights the potential size of the opportunity.

At current income levels, and given the specific commodities involved, shifting the rail-friendly export minerals currently on road to rail (the 11 billion tonne-km) could add R3 billion to the rail income statement. The figure for the rail-friendly general freight gap (the 30 billion tonne-km) is R18 billion, but given the result of the private sector interviews, around half of the additional general freight will probably have to be sold initially at a 20% discount. That would therefore amount to R16 billion additional general freight rail income. This adds up to an additional R19 billion rail income in total.

A calculation of income statement cost to deliver this service and capacity is interesting. Even assuming a 20% loss on general freight at current densities, a 70% saving due to returns to density (see the Harris curve, Figure 19: Harris' density curve adapted for South AfricaSource: authors' illustration adapted from) (that is without additional railway lines and without route rationalisation) means that additional cost should be no more than R7 billion.

This leads to a positive case of R12 billion on the income statement and, in the event of route rationalisation, even more for a high-density business (income of which could be initially used to subsidise the low-density business until a better solution can be found).

This business case is overpoweringly positive, but difficult to achieve because it will require investment (which will be challenging with Transnet's current balance sheet), a significant improvement in asset utilisation (creating more predictable and serviced slots with the current infrastructure), improved service levels and committed stewardship. The success of this business case is therefore predicated on a major paradigm shift that, while challenging, is of critical immediate importance before system collapse.

In summary, more slots on the same infrastructure, predictably delivered, effectively serviced, and sold into the market could create investment opportunities. Once a saturation point, given the current theoretical maximum installed infrastructure, has been reached, new technology will be required to increase capacity further. It seems, however, as if quite a large volume of slots can be unlocked with the current assets, given proper asset utilisation.

Table 3: The EMI model

External	The area that ***qualifies*** and controls the system *(the contextual environment - the rules of the game)*
Market	The area where the system as a whole ***competes*** for positioning and survival *(the transactional environment - playing the game)*
Internal	The aspects that are under the system's ***control*** *(the business system - enabling the team)*

Source: see Havenga and Hobbs (2004).

An important caveat or emphasis is the immediacy of this approach. Government and the private sector must assist and Transnet as a business itself focus to achieve this one simple objective on the very short term — slot provision, servicing and selling.

Utilising a systems thinking tool such as the EMI approach (external-market-internal, Table 3) can facilitate the development of such a specific short-term strategy, and point to considerations for the longer-term implementation horizon.

Internal includes the aspects that the railway has direct and immediate control over. Serviced slots per line segment need to be increased as a matter of urgency, achieved by both continuous and breakthrough improvement. Slots can be released through better maintenance, improved signalling, adding loops, scheduling improvements, and improving productivity (especially driver productivity). A strategy to achieve this is urgent, because of the fixed cost nature of the business — the wastage of not deploying and servicing more slots is significant. In order to facilitate performance measurement and activity-based cost accounting, separation between slot availability and train operations is possible and should be installed immediately. The focus should however be on capacity first; and cost, income and return allocation second. Internal streamlining to a focussed point of delivering sold and operational slots (i.e., improved asset utilisation) is the singular initial point of departure.

Market refers to immediate steps around service design and execution. Market strategies should follow the segmentation proposed, or some semblance of this segmentation that could for instance highlight critical commodities or industries in the segments based on market needs. Examples of a separate strategic focus include (1) an intermodal segment which can comprise a domestic and export/import dimension focused on the core loading unit, i.e., containers (although containers should not be the ultimate focus but rather how the service is inserted in industrial and consumer value chains); (2) strategic finished goods such as processed foods and automotive; (3) within export and domestic minerals a focus on the four major commodities i.e., coal, iron ore, manganese and chrome ore will be necessary; and (4) 'ring-fenced commodities' energy commodities such as fuel and gas as there are large and complex relationships with other modes and facilities such as pipelines, buoys and ports.

The wagon fleet and terminals are the customer-facing infrastructure of the railway and, together with service design, must ensure that available slots are filled with revenue-generating traffic. In the short term (during rescue) it is less important if the revenue is seen as a direct return to the railway or indirectly through the payment of a slot charge to an infrastructure provider. Service design must fill the specific gaps immediately, such as the revival of sidings and domestic intermodal services. Apart from the operational requirements to achieve the singular objective, the railway is operating in real-time in a market with an important requirement on focus. In the short term, the market can be supported by merely deploying as much of the service that the market is already asking for. Over the medium term, market focus means segment strategies, customer orientation and relationships. New more involved service designs would then be possible and also cooperative agreements where customers or other service providers own wagon fleets, or own and operate wagon fleets.

External refers to aspects that can attract investors, allow for external involvement in the system, policy and external (board) governance. Externally issues of investment partners and policy require careful attention. In the immediate short term, the current focus to dispatch more trains must be supported. The external environment, community and government can assist by protection of railway assets, clearing the permanent way and removing other institutional bottlenecks and barriers. In the medium term, network redesign must focus on horizontal separation and public private partnerships. Investments can be enabled by the horizontal separation of equipment, as well as with cooperative agreements between the railway, freight owners and LSPs.

Succinctly, the short-term objective will be delivered against:

- internal: more operational slots
- market: more filled slots

- external: more protected slots.

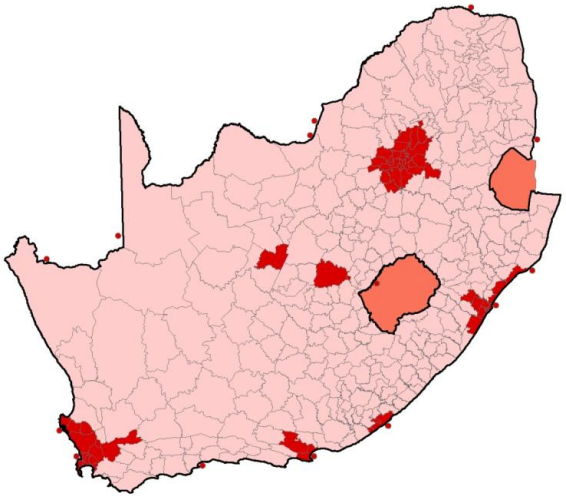
9.2 Network design

The strategic objectives inform the proposed network- and service design. The network design comprises of line design, node design and terminal design.

Line design

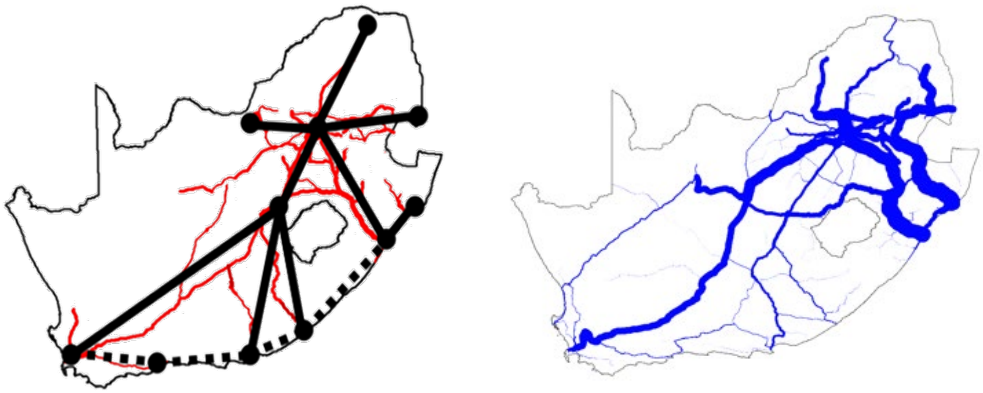
The railway must be horizontally separated into a low-density and high-density business. Given the data-driven analysis presented in this paper, the design of the high-density business is quite clear and broadly informed by the rail economics principles of terminal and line density. Dense origin and destination districts for general freight in South Africa are depicted in Figure 24. These districts are also connected by dense rail-friendly freight flows as depicted in Figure 25.

Figure 24: Dense origin and destination districts for general freight in South Africa



Source: 2019 data, outputs from the GAIN Freight Demand Model™

Figure 25: Core theoretical high-volume network (left) and required 2050 GFB network (right)



Source: outputs from the GAIN Freight Demand Model™.

This results in an 8,700 kilometre theoretical high-volume network which will service the industrial and domestic intermodal service portions of rail. It will also be the backbone of rail-friendly, but rurally localised, mining minerals and agricultural products that use portions of this core network. These rural minerals and agricultural products can arrive at the core and use it:

- as densified non-core lines, i.e., although the lines are single-purpose and do not have an industrial corridor effect, the lines will have sufficient volumes to remain part of the high-volume network;

- from low-density lines with transition points between the low-density and high-density networks; and

- by road.

The volumes on this core network are depicted in the right of figure 24 as the target for 2050. The major focus of the high-density network would be to dispatch the maximum number of trains, enabled by slot availability. The low-density lines' focus would be low-cost feeder services to the high-density lines.

Node/terminal design

Nodes (or terminals) will play a major role in modal shift success and must be designed to facilitate freight concentration and consolidation, shortening supply- and demand distances, enabling intermodal transfers and logistics support services with multi- and intermodal access. These are designed where terminal density is high, as well as at ports and border crossings. Terminals develop in complexity and with each layer of complexity provide new opportunities for improved freight management. These options need to be considered in the design and are depicted in Table 4.

Rail sidings or depots are usually dedicated to single users and, in the most optimal design, a single-commodity terminal allowing for efficient loading and offloading. Some freight owners in the same area can share a **dedicated commodity terminal** such as with coal and chrome terminals between mines and silos. Depots with sidings provide obvious modal shift opportunities and a modal shift strategy would require attention to sidings and dedicated commodity terminals.

Table 4: Terminal options (developed by authors)

Facility description	Use
Rail siding or depot	Dedicated to a single user
Dedicated commodity terminal	Single focus transshipment
Multi-purpose terminal (MPT)	Multi-purpose transshipment
Logistics park	MPTs and warehouse combination
Logistics service centre	Logistics parks providing ancillary logistics services
Freight village	Logistics service centres with light manufacturing

Source: authors' compiliation.

Multi-purpose terminals (MPTs) service many discrete freight owners and commodity types and are, in rail terms, comparable to large rail stations of the past that had goods, parcels and passenger elements. Clusters of factories, production facilities or distribution centres in industrial areas form virtual MPTs. Rail insertion would require a shared and easily accessible siding with

multiple freight-handling options amongst the production facilities. In the case of DCs that could be focussed on palletised unitisation into containers.

When warehousing is added to the MPTs, **logistics parks** develop, leading to more rail opportunities with natural freight consolidation and easier options to fill block trains. These opportunities increase if shared logistics services are added for freight forwarding, logistics management companies and intermodal operators which will all benefit rail. By adding light industrial beneficiation to a terminal itself it turns into a **freight village** with a typical design depicted in Figure 26.

Europe has 200 of these freight villages that provide excellent opportunities for modal shift with the concentration of supply and demand, logistics focus and natural consolidation, making dedicated rail use much easier. The concept can be extended to ports and border posts with most of the freight village functions included, but with other special requirements (Table 5: Requirements of border terminals).

Table 5: Requirements of border terminals

Ports	Efficient maritime transshipment connection in the supply chain
Dry ports	Effective port extended gate
Border posts	Efficient free-flow facilitation

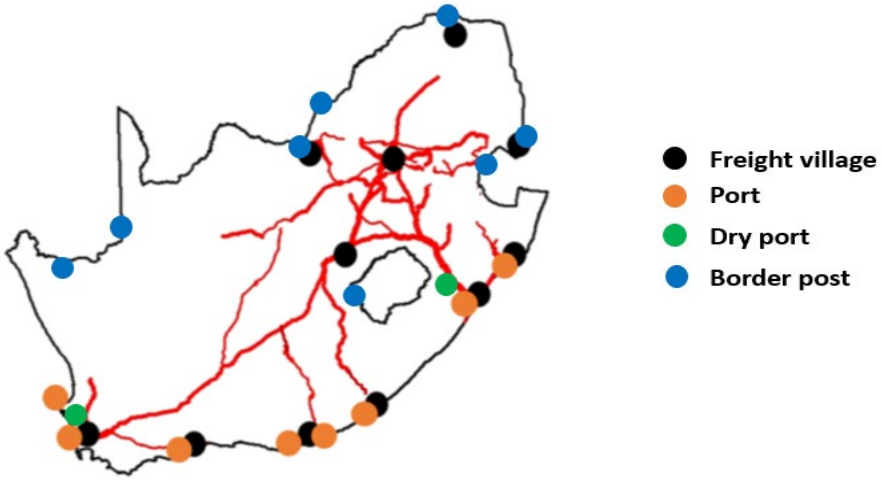
Source: authors' illustration.

Figure 26: Bologna freight village

Source: Interporto Bologna SpA (2020); reproduced here with permission.

Figure 27 is an example of a potential nodal design. As a first step this design should be completed based on meticulous planning, the basic terminal structures added (such as sidings and multipurpose terminals) and special economic zones superimposed.
The ownership of these terminals is immaterial relative to the importance of their establishment. It could be owned by a railway that operates like a well-established LSP, other LSPs, freight owners or even other entities. It is the functions that are important. In the South African context a large freight village could be owned by a municipality or private landlord with various logistics facilities. It could contain dedicated commodity terminals, for instance chrome ore, which are owned by freight owners or groups of freight owners in an industry, or intermodal facilities owned by established LSPs, as well as warehouses and distribution centres owned and operated by large retailers and manufacturers. The important point is to consolidate freight and services and insert rail in the value chain nodes, which is much easier in such a design.

Figure 27: Example of a potential nodal/terminal design



Source: authors' illustration.

Service design

Service design refers to the development of services on the line- and node network that capture the 'missing' 11 billion tonne-km of export minerals and the 30 billion tonne-km of general freight that should have been on rail, and allows for the general freight railway to quadruple in size by 2050.

To enable this, motive power to service the slots on the lines is required, as well as wagons that relate to freight and terminal handling. The stationary equipment could belong to the terminal operator but it is the ownership of the moving equipment which is at play here and should be carefully considered. There is no reason why freight owners and LSPs cannot own fleets in the same way that road fleets are owned now. Private ownership of different locomotives will however create huge complexities. In a mature economy it is envisaged that a few train 'companies' can own locomotive fleets that provide hook-and-haul services for the wagons. This would mean around 20 to 50 wagon fleet owners and at most, in South Africa, 2 to 3 locomotive operators.

9.3 Overarching structure

The overarching structure refers to the horizontal separation discussed earlier in this section. There are three elements to consider:

1. Horizontal separation between a low-density and a high-density network;

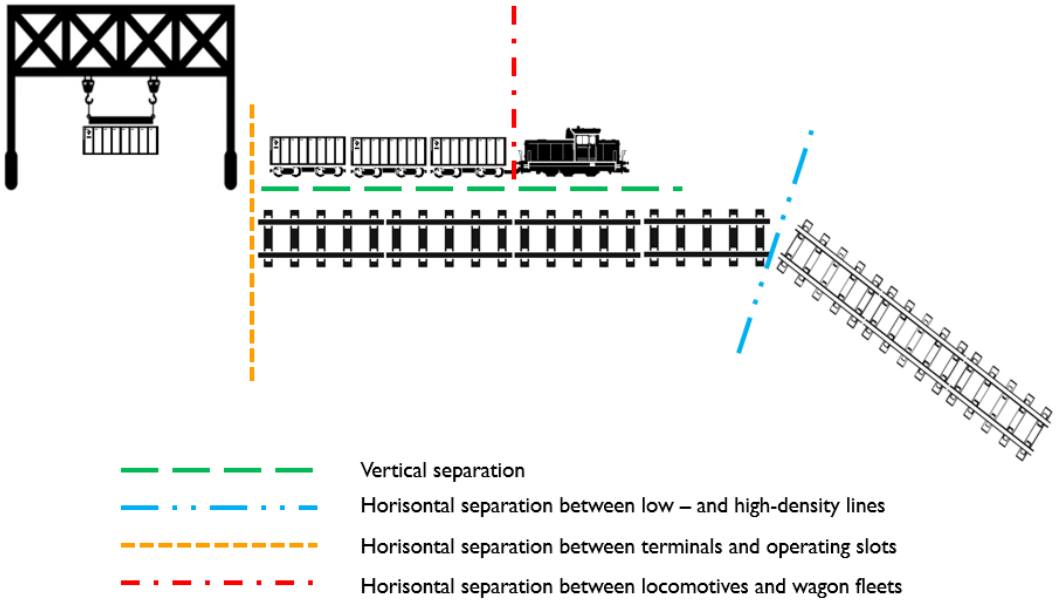
2. Within the high-density network horizontal separation occurs between lines (permanent way) and terminals (akin to the separation between roads and depots).

    a. As far as lines are concerned, vertical separation could be possible, initially through accounting separation of the permanent way (maintenance and line building) and the slot creator (signalling and operations).

3. Within the high-density network horizontal separation also occurs between motive power and wagons for the trains using the lines and terminals.

This separation allows for a singular focus on three distinct and discrete elements of the railway system, that could then be managed and financed separately, but still as a working system, to deliver modal shift. These options are summarised in Figure 28.

Figure 28: Separation options



Source: authors' illustration.

9.4 Funding mechanisms

Terminals and wagons can easily be privately funded. Locomotives can remain part of a state-owned railway, but once the system behaves tolerably separate rail locomotive companies can be allowed. Low-density lines that are strategic should be subsidised in the same way as the government subsidises roads.

In the short term, government has two options. To either match the government's road infrastructure investment with investment in rail, or to divide the current investment in road infrastructure more optimally between road and rail to achieve the objectives discussed in this paper (which is of benefit to the whole economy). In terms of matching infrastructure spend, it means a separate funding mechanism for fixed rail infrastructure on the same principle as the South African National Roads Agency Limited (SANRAL) for the high-density network and as provincial roads for the low-density network. The extent to which ring-fenced funds generated by fuel levies and toll fees from road freight transport are cross-subsidised by passenger car transport (and other allocations) should be equally matched by infrastructure spending on rail. Doing this will go a long way towards ensuring the correct economic modal split as rail service delivery will improve.

This option is however suboptimal and should, in the long-term, be replaced by a self-sufficient high-volume intermodal transport network, with government support for low-density lines (and passenger transport, as discussed later in the paper).

9.5 Policy

A stable policy environment will see the treatment of rail and road 'slots' in the same way. The same safety and economic considerations, user-pay principles and externality charges should apply,

which will enable freight that should be on rail to shift to rail given adequate service levels. This will require real transport economic regulation that levels the playing field through the consideration of emissions taxes, congestion charges and other externality cost recovery measures.

The overarching philosophy should however not initially be to regulate, but to build the correct railway system. This means, in order of progress:

- designing the ideal rail and road network
- immediately fixing the railway in terms of asset utilisation and service
- restructuring a successful railway to maximise the design
- establishing how a restructured railway, together with a road network, should be regulated.

This suggests a phased approach with immediate first steps, discussed in the next section.

9.6 Singular short-term focus

Solving the immediate issues of asset utilisation (i.e., to create maximum filled and sold slots), service execution and design, are achievable in two years provided it is the core strategic focus of management. The first two years must see the fixing of the nearly broken railway at all cost. Everybody should get involved in achieving this singular objective.

For clarity, with regards to the strategic objectives described in section 0, the singular short term focus means to recover as much as possible of the 'missing' 11 billion tonne-km of export minerals and 30 billion tonne-km of general freight currently on road within the current system.

The medium-to-long-term focus is on specific sectoral strategies, the development of domestic intermodal solutions, service design for the 2050 growth, and the horizontal separation options discussed in section 0.

Focusing now on strategies such as the vertical separation of permanent way (maintenance and line building) and the slot creator (signalling and operations), as well as low-density line concessioning, will require a large volume of complicated changes, and will dilute strategic focus. The complicated changes include safety cases (operators will have to be 'certified' with the network), agreement on access pricing, harmonising of infrastructure planning and operating entities, as well as other external interventions.

In the short term the strategic energy must be focused on saving the business. This means that top leadership should be held accountable for the missing 41 billion tonne-km achievement only.

In closing, it is interesting to observe the close correlation between the proposed strategy and the Russian reform process followed over the past two decades. The salient points of their reform process are discussed in Box 1.

Box 1: Russian railway reform process

During the Soviet era the Russian Railways was an integrated ministry within the Soviet Union, requiring restructuring within the Russian Federation post-1990. One of the restructuring proposals that Russia opposed was vertical separation due to the mixed successes in for example the United Kingdom, but instead envisioned a more gradual and storied reform process. This included the streamlining of the business by removing non-essential functions, separation of the business from regulation, the creation of various wagon rolling stock- and operating companies with access regimes (wagon owners and freight forwarders, not locomotives) and removing the cross-subsidisation of freight to passengers (World Bank 2017). The result of the reform was a dramatic 87% improvement in freight tonne-km performance from 1995 up to the 2008 recession. Financial performance improved as well, but was hampered in subsequent years by the recession and sanctions against Russia.

A subsequent drive to horizontally separate networks into a few railway companies, similar to the various somewhat competing but domain-specific Class I railroads in the USA, was considered too expensive and abandoned. Instead, a push emerged to allow open access to locomotive companies, but this has not been successful yet. Pittman (2020) discusses the options for Russia in adopting vertical separation and open access specifically, and proposes that the economies of vertical integration, size and density will be challenged. He also maintains that above-the-rail competition of wagon companies and horizontal separation (rather than vertical separation between locomotives and track) could attract huge investments.

The debate, currently, is what to do next. An interesting proposal comes from Kibalov (2018) to horizontally separate the network in Western (highly-densified) and Eastern (lower-density) vertically integrated blocks. The Western Block will be a competitive market mechanism and the Eastern Block, as a strategic asset, will require direct government support, maybe even from the military. Persianov et al. (2020) contend that solving future problems will require management efficiency in two areas, i.e., transport infrastructure and flow-organisation goal-setting; and optimised design and planning to achieve lowest economic cost. They even propose a return to state-controlled central planning and ownership with price regulation, but with private business participation.

Another important discussion point looking at the future is one that arose during the initial stages of the vertical separation debate, i.e., economic security and the fact that the railway is a critical strategic asset of the state. Past reforms and future actions should not impact on the stability and availability of the system, should protect state assets and avoid social tension (Sedykh et al. 2019).

The correlation of all these factors with South Africa's position is striking. South Africa did separate the business from regulation in 1990, passengers from freight between 1990 and 2008, and followed a streamlining of the business in that time, removing many non-essential portions such as SAA. The proposal is now to create various horizontally separated wagon companies and terminals, but initially retain vertical integration between rail and locomotives. The network separation that is proposed in Russia is also directly in line with the low-density and high-density proposal for South Africa. Finally, economic security can only be achieved by focusing on saving the railway as a strategic asset, through a focused national strategy of slot creation and filling, and not destabilising the railway during the reform process.

PART 2: PASSENGERS

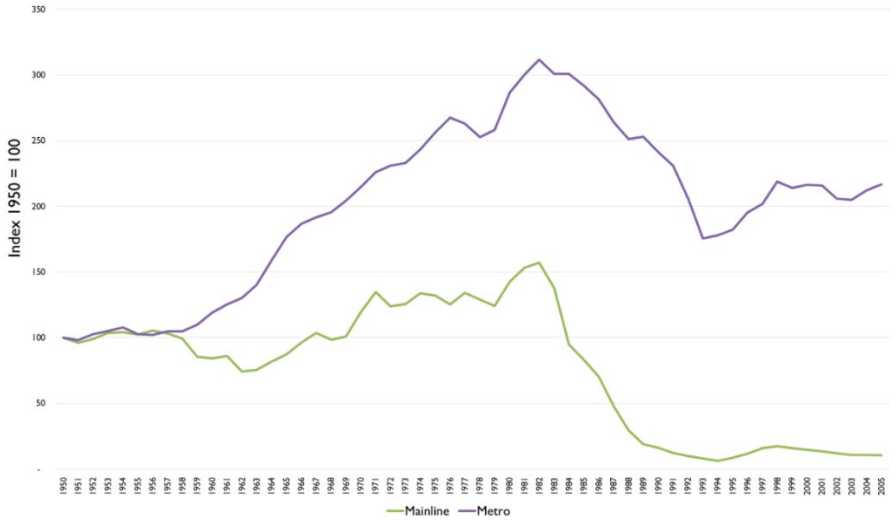
10 Passengers: background

Prior to the deregulation of road transport in 1989, and the legal succession of Transnet and the South African Rail Commuter Corporation (SARCC) in 1990, freight and passenger rail transport in South Africa was wholly functionally integrated and managed by the South African Transport Services (SATS). In practice, this meant that the same operational units that dispatched freight trains also dispatched passenger trains. Train operational crews were integrated; infrastructure was shared; depots often serviced passengers, parcels and freight; and depot-level management was the same. In smaller towns responsibility for all functions resided in the station master; at larger stations a 'goods and passenger' superintendent; and in regions a systems manager (later called a regional manager).

As mentioned in the introduction to the report, the 1989 Legal Succession to the South African Transport Services Act created the mechanism to commercialise SATS and separate rail commuter services from rail freight and long-distance rail passenger services — with rail commuter services resorting under the then newly-formed SARCC. In the period immediately post legal succession, Transnet continued to deliver commuter rail services through an annual management contract. Employees were still employed by Transnet and often still interchangeable in the business. Transnet created a division called Metrorail, which slowly began to focus resources into a single division, and towards the end of the first lustrum post legal succession a major project was launched to ring-fence the division properly and transfer it to the SARCC.

During this time long-distance passenger services remained within Transnet in a rail division called Mainline Passenger Services and the operations and coach fleet was only transferred to the SARCC in 2008. The DoT currently manages both long-distance and commuter rail passenger services in South Africa under the Passenger Rail Agency of South Africa (PRASA), with the exception of the Blue Train and Gautrain.

Figure 29: Long-term trends in rail passenger journeys in South Africa



Source: data from Transnet Freight Rail.

A major decline in passenger numbers occurred between 1980 and the mid-90s, driven by a more than 90% decline in long-distance journeys from 45 million to 2.5 million, and a 30% decline in suburban journeys from 710 million to 410 million (Figure 29). This was the result of modal shift enabled by increasing access to more cost-effective flights (the airline industry was deregulated in 1991), as well as more accessible, door-to-door services offered by taxi services (the minibus taxi industry expanded operations in the late 1970s following the promulgation of the Road Transport Act in 1977 which allowed business operations in informal settlements) (Vegter 2020). An intermodal solution with taxis could have stemmed this tide, but this option was never pursued.

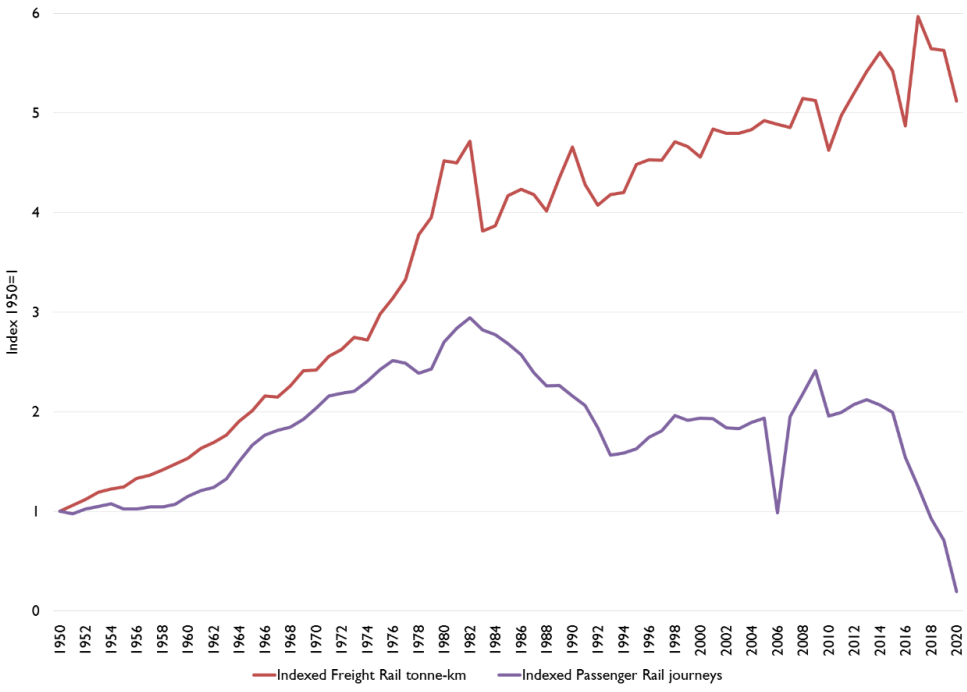
11 History

Historically (in the absence of other accessible transport modes for all), long-distance passenger journeys on rail fulfilled a number of basic mobility needs in the economy. These included holidays, tourism, student travel and annual home visits of especially migrant workers. Bus transport on major routes was scarce and, especially before the emergence of the national road system in the 1950's, even car travel was limited.

Suburban and metro rail travel grew because of urbanisation and the unfortunate spatial reorganisation enforced by the Apartheid regulations (the displacement legacy of which still persists). A major shift to taxis caused a move to road, but many of the routes remained the same.

In the 70 years that has elapsed since the emergence of South Africa's national road system (which provided the impetus for the loss of high-value freight traffic to road, as well as the growth in motor vehicle transport) passenger and freight movements in South Africa followed very different pathways (Figure 30).

Figure 30: Historical trends in passenger rail journeys and freight rail tonne-km



Source: data from Transnet Freight Rail.

Freight rail grew by a factor of 5 (albeit driven by export coal and iron, see Figure 21) while passenger transport disappeared for all practical purposes. This dramatic collapse leads to a few important initial observations:

- with a nearly destroyed system, questions around the cause is important;
- if a complete rebuild is required, questions around idealised design are important — the solution would need to be so dramatic as to never be incremental;
- funding will be critical. passenger rail almost always requires subsidies. the subsidy levels in a developmental state context could be high.

The best understanding of the objectives of passenger rail transport in South Africa could probably be gleaned from policy development over time.

12 Passenger transport policy evolution

The RDP (ANC 1994) called for a safe and affordable passenger rail service that should be extended and integrated with other modes providing feeder services. The expectation in the RDP was that taxis should only be used if rail and bus is not available (given direct and externality cost impacts). The 1996 White Paper on National Transport Policy confirms the RDP objective, making specific reference to sustainable funding, rural access and affordability; most pertinently calling for operating and maintenance concessions. In 1998, Moving South Africa (MSA) also emphasized innovation and accessibility, urging for the internalisation of road transport externalities as an important tool to engineer modal shift to rail. As far as subsidies were concerned, a highly focussed strategy was developed to mobilise 'the stranded' (unemployed, scholars and commuters), with MSA calculating that R1.74 billion, or an additional 50% of the then subsidy payments, would be required to achieve this objective. MSA, in fact, goes far beyond mere policy statements and provides a comprehensive strategic plan based on three strategic pillars to meet customer needs and lower the overall cost of the transport system:

- densification of transport corridors;
- optimising economics and service mix — focusing on infrastructure, the operation of public transport, road space management and subsidies; and
- improving firm level performance (including tendering/concessioning, regulated competition, industry regulation and sustainability/investment).

The intended impact of these strategic objectives on customer needs are detailed in Figure 31: Interpretation of Moving South Africa's strategic plan for urban passenger transport, followed by the importance of transparency surrounding the potential trade-offs (Source: authors' illustration adapted from Department of Transport (1998).

). These trade-offs are essential to understand and manage for the successful implementation of the strategy, for example:

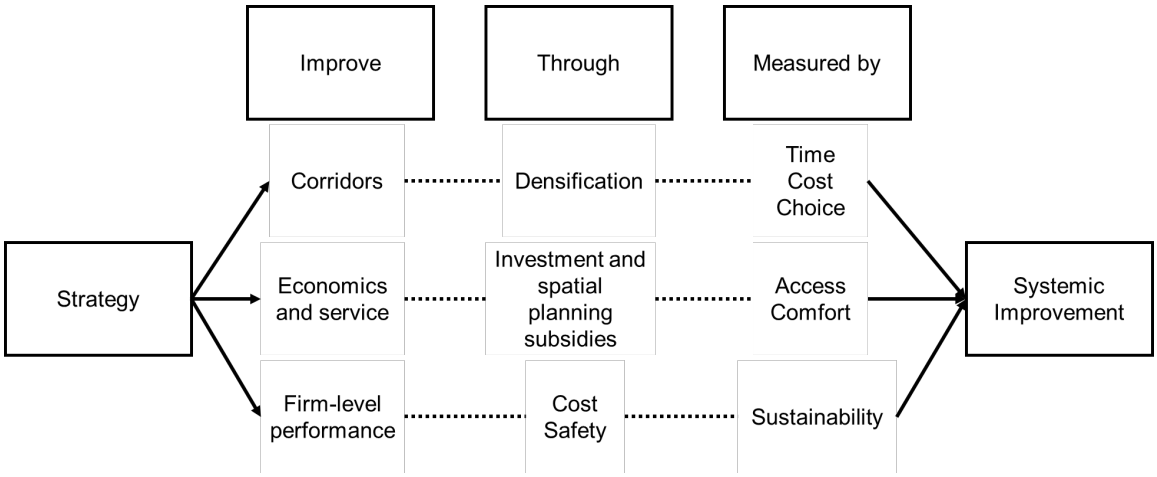
- The creation of corridors will reduce distances and increase trip densities, but might require higher land purchase costs. (One could add that corridor creation will eventually make commercial land more valuable); or

- Road space management efforts will reduce journey times for public transport customers, but might increase them for private car owners.

These strategic objectives and trade-offs remain valid.

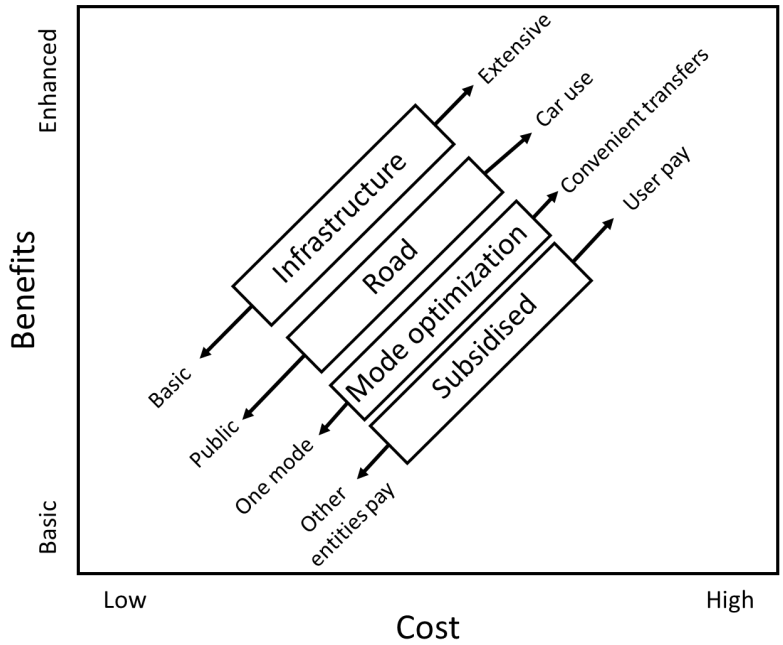
The National Transport Master Plan (NATMAP) built on the corridor approach (Department of Transport 2009b) with detailed descriptions, modal allocations and proposals on how to proceed. These included work and task teams around appropriate modal technology, subsidies and the devolution of responsibilities. When the report was released, there was optimism that the required actions were understood and that implementation would follow. However, it is not clear that any of these initiatives were successfully executed over the past decade. The most recent White Paper, accepted by cabinet (South African Government 2021) does not seem to report on any progress in this regard.

Figure 31: Interpretation of Moving South Africa's strategic plan for urban passenger transport



Source: authors' illustration adapted from Department of Transport (1998).

Figure 32: Interpretation of Moving South Africa: trade-offs in the urban transport strategy

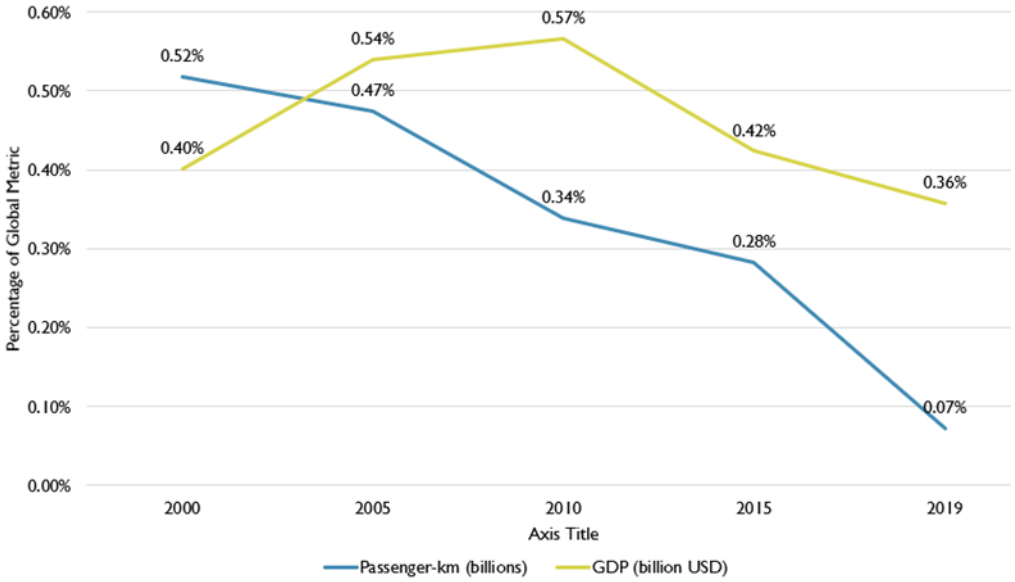


Source: authors' illustration adapted from Department of Transport (1998).

13 Passenger rail status quo

It has been widely reported in studies and the press that, except for the Gautrain, most rail passenger services in South Africa are either close to ruin or non-existing (for example, some of the recent history is summarised in Daily Maverick 2021). South Africa's passenger rail obliteration also does not follow a global trend, where passenger journeys on rail have been increasing. In the year 2000, South Africa's rail passenger journeys as a share of global passenger journeys was slightly higher than South Africa's share of global GDP, but by 2019 South Africa's passenger journey ratio was five times lower than the GDP ratio (Figure 33). That is a dramatic and systemic collapse before the pandemic, but with asset destruction during the pandemic it is not conceivable that the system in its current form can be saved. It would require a totally new approach.

Figure 33: South Africa's share of global GDP and passenger kilometres



Source: authors' illustration. Data: global passenger km from International Union of Railways (UIC); global GDP from Statista; South African passenger km from Transnet Freight Rail; South African GDP from Statista.

In the last decade many attempts were made to resurrect or rescue PRASA but unfortunately with very little, if any, positive outcomes. The causes of the current gaps can not only be funding, vandalism and other external factors. That would explain why certain routes fail, but total failure is the result of poor governance and poor leadership. Employees are also unwilling or unable to focus on service delivery. In general, a climate of non-stewardship is present. This is one of the main reasons behind the inability to spend allocated capital from the government leading to maintenance backlogs, equipment and infrastructure failures, and business model failures (such as the failure to manage corridors). The fallout is a complete loss of confidence from all stakeholders including customers, and serious safety and asset destruction problems (Makaepea 2017).

The current management experiences an environment where capital funding has been secured but operational funding completely absent, i.e., the finances necessary to actually run the system is not there. Tenders and contracts are not awarded, often driven by the fallout of state capture and the deep scrutiny of contracts. This leads to further maintenance problems, security failures and poor service delivery. Furthermore, in a highly politicised environment tough decisions around choices (such as the trade-off between delivering a few good corridors compared to attempting (and failing) to deliver a total service that will eventually collapse) cannot be taken. Top management is

possibly also out of touch with employees on the ground and the levels of motivation in such a traumatized environment are unclear.

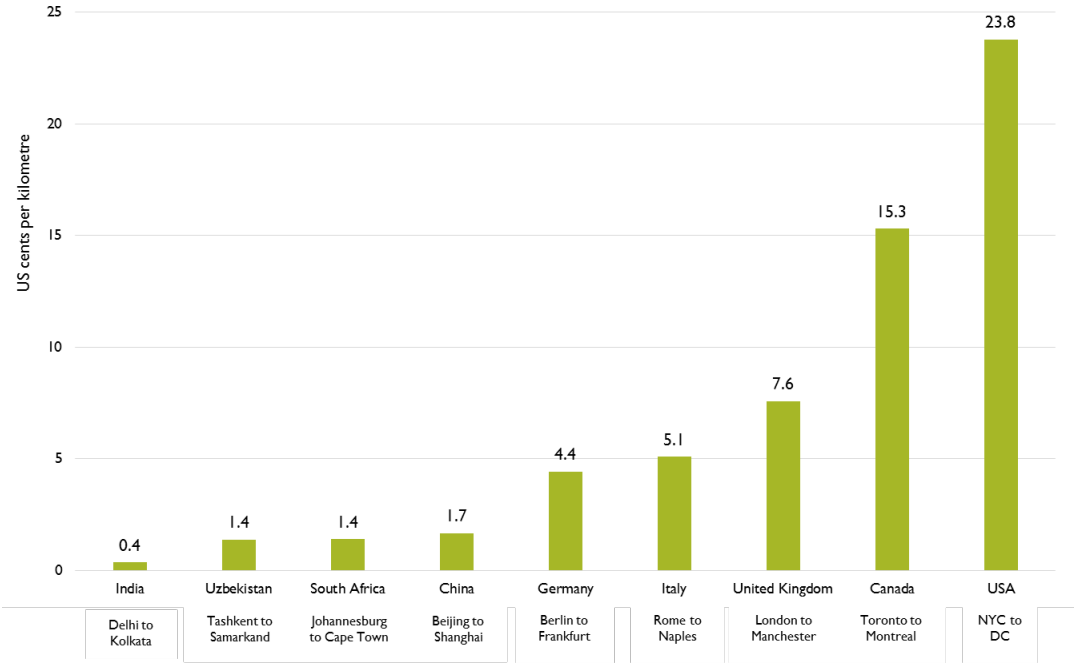
The overarching vision of sustainable mobility for all, described simply and succinctly by the RDP as being safe and affordable, has not been reached and in fact became a giant leap into oblivion over the last lustrum. As predicted by Ehrenreich (2018), the whole system is grinding to a halt. The only feasible option seems to be a fresh start from an idealised design. In order to inform such an idealised design, some insights from the global passenger rail environment are considered.

14 Sustainable mobility for all in the developing world

14.1 Long-distance passenger rail

Long-distance train travel in the developed world can be quite expensive compared to the developing world. The long-distance travel market space has four dimensions i.e., business, vacation, labour and tourism (where the journey itself is the event). Business long-distance travel will use air, except if a dense route can be connected by rail in less than 3 hours. Vacation and tourism typically use private motor vehicles over shorter distances, or train journeys where available. What remains is the development construct of allowing labour to be offered over a large geographical area without transport costs becoming an impediment.

Figure 34: Cost per km for long-distance passenger rail travel



Source: data from various travel websites including Omio, Rail Europe, and Travel China Guide.

These travel market spaces also play out in the three global rail paradigms, discussed in the freight section (see section 0 for the discussion in relation to freight, and Figure 34 for the subsequent discussion). In the geographically large and highly mobile countries of USA and Canada, with extensive rail networks, long-distance train travel is relatively scarce and tourist-orientated, i.e., leisure travel that is seen as a relative luxury. (There are some exceptions, e.g. the Washington-New York route, but in general in the USA and Canada air travel is used for mobility). In Europe,

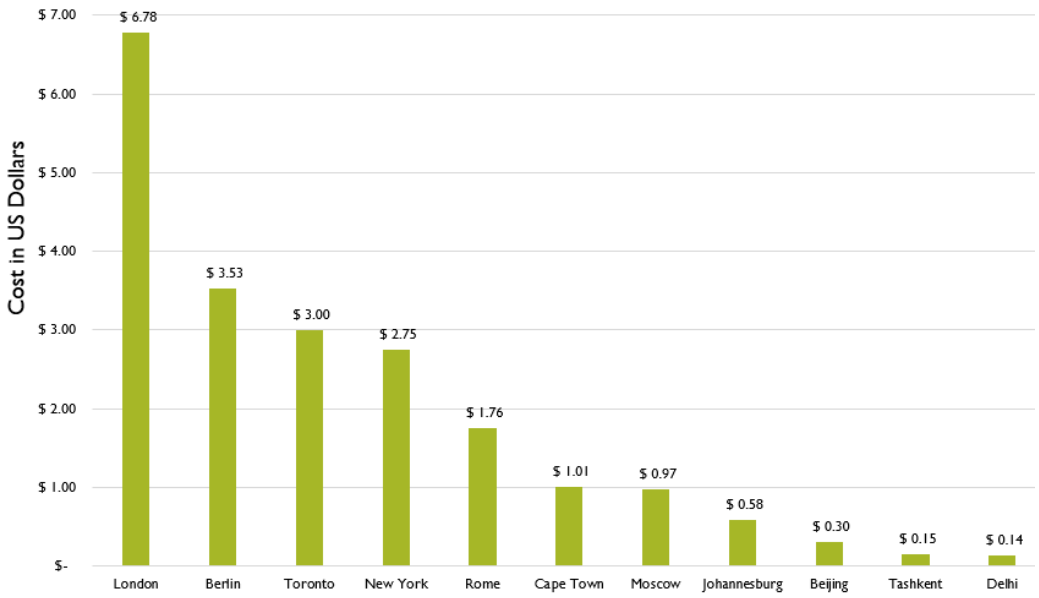
long-distance passenger rail's focus (as is it is for freight) is to alleviate congestion and emissions. Train travel is the standard way of moving around; enabled by high density, relatively short distances, and well-developed services (therefore serving all four market spaces). High-speed rail is also possible due to many origins and destinations that can be connected in three hours or less which makes rail a more attractive option than flying.

In the developing world rail passenger travel is a social good used to create social mobility and directly contribute to the development of nations. In India, for example, the ability of people to move around nearly for free (due to subsidies) means that the workforce can offer its labour more or less everywhere with transport not being a barrier. The distance between Delhi and Kolkata is slightly further than Johannesburg to Cape Town, but the cheapest fare of US$5 is one quarter of South Africa's cheapest fare of approximately US$20.

14.2 Urban passenger rail

China links urban development directly with social development, which in turn is directly dependent on mobility (Liu et al. 2020). However, mass urbanisation was expected to lead to an increase in travel demand and sustainability concerns if urbanised citizens move into the middle class and use private vehicles. Urban rail transport projects are therefore seen as an integral part of development plans and, as new cities grow, transit issues are immediately considered. This leads to huge capital injections and is seen as a symbol of modern and advanced technological development (Pucher et. al. 2007). To ensure the success of these urban rail transport projects, China identified the most critical success factors as skilled human resources, funding and project planning (Bao 2018). This approach generally worked and metro fares are development-orientated (Figure 35: Urban rail transport comparisons: average cost of a single metro rail trip).

Figure 35: Urban rail transport comparisons: average cost of a single metro rail trip



Source: data Mapa Metro.

In India, free movement integrated the labour market (Kundu 2019), with massive expansion over the two decades up to 2005, but still not enough cities with urban rail systems (Pucher et. al. 2007). Over the first two decades of the 21st century (up to just before the COVID-19 lockdown in 2020) passenger transport on rail in India more than quadrupled and the average citizen travels more than 1,200 km per annum by train. Densification advantages are evident where extreme low tariffs

still yield returns as 23 million passengers are moved on average per day. That is equal to 7 rail passenger journeys per population member per year, compared to 1 for South Africa before lockdown.

It is clear that a developing nation is dependent on what was planned in all of South Africa's policy documents, i.e., safe and affordable rail access to all. Policy implementation failed. It is prudent to consider an ideal design to facilitate policy implementation.

15 Ideal design for passenger rail services

Considering the prior analysis, the vision for passenger rail in South Africa can be readily articulated as sustainable mobility for all. In order to partake in the economy, stranded people (unemployed, scholars and commuters) must have access to a safe and reliable rail service where dense corridors can develop (see the density principle of the Harris curve, Figure 19: Harris' density curve adapted for South Africa). The corridor service must be integrated to a public road-based transport service for maximum connectivity. It will require subsidies, depending on the level of densification that can be achieved.

If the vision of sustainable mobility is accepted (which it should be), tariffs will probably have to be reduced between 50–80% or, alternatively, targeted subsidies provided in line with a social grant system. The problem is less about convincing people to use rail than it is to provide a service informed by ideal design principles. The transversal aspects of an ideal design can be summarised in terms of internal, market and external aspects (see Table 3 for a definition of aspects), summarised in Table 6.

Table 6: Transversal aspects of ideal design for passenger rail transport

Internal	Market	External
Technically sound	Targeted network	Economically feasible
Safe	Adequate capacity	Financially sustainable
Performance measured	Comfort	Environmentally sustainable
	Customer orientated	Politically supported
	Multimodal integration	Socially supported

Source: authors' illustration, based on Mondragón-Ixtlahuac et al. (2017) and Jasti and Ram (2019).

The three standard dimensions of sustainability emerge, i.e., economic (meaning sustainable funding), social (meaning equitable access to a safe and capacitated service) and environmental (meaning clean, low emissions). Given the poor legacy of the current passenger rail transport system, the social aspect must be clearly delineated at the outset. Equitable access in this regard means that a very small portion of income should be spent on transport for people with earnings below a certain threshold. Subsidies should target this specific intervention and should also consider negative subsidies to the taxi industry (negative subsidies are subsidies earned through unsafe service provision).[2] Equitable access also means a service must be available to all, everywhere, although not always rail, but it should be rail if enough density can be achieved.

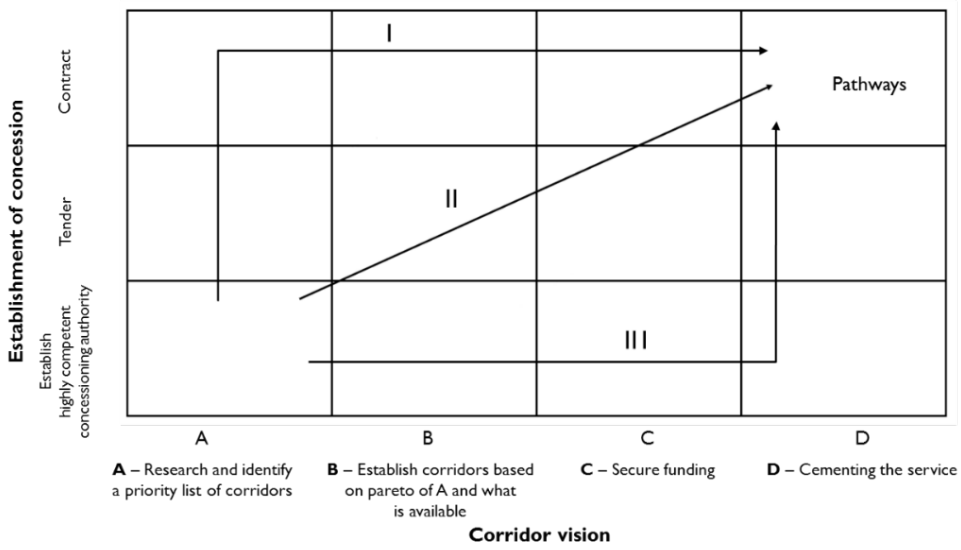
[2] It is important to note the importance of engaging with the taxi industry about potential redeployment or training given the potential impact on the industry of a fully-functioning metro rail system

The ideal design has to distinguish between suburban and regional metro systems, and long-distance passenger travel.

15.1 Suburban and regional metro rail systems

As with freight, the critical structural intervention will be horizontal separation, between the various regions (with oversight involvement from a concessioning authority), and within the regions more than one system will be operational, as is the case with Gauteng already. Systemically it will be corridor-focussed, just as has always been proposed, and the identification of priority corridors is a critical aspect. This ideal design does not necessary relate to PRASA. In fact, the role that PRASA, as basically a failed institution, can play should be carefully considered in realising this vision. It might not have a role at all. This question forms part of the steps required to achieve the ideal design.

Figure 36: Pathways to sustainable transport for all



Source: authors' illustration.

To achieve the vision four steps are necessary, namely identification (research), corridor formation (including ranking), Pareto-based funding and cementing the service. In the final instance, the services can only be provided by a competent concessionaire (probably an operational concessionaire with very specific outputs), however, the route to that position is also important: firstly the establishment of a highly competent concessioning authority (not the current PRASA), tendering and then contracting. The two processes (corridor development and concessioning) are depicted in Figure 36, with three possible pathways to achieve the strategy.

Given the current state of PRASA, pathway I is proposed, i.e., the immediate creation of the concessioning authority to do the research. In order for the ideal design to be achieved the process of establishing the corridors is critical and responsible parties must have a strong corridor establishment approach. It is proposed that the corridor development process is started at the outset, in line with the creation of a highly skilled and functional concessioning authority.

For regional metro rail systems, the central concessioning authority can also set up separate concessions between provinces and concessionaires. It will be a better use of resources to have the authority initially assisting with the contracting but, as the concessions gather momentum,

contracting will take place between the province and concessionaire, with the concessioning authority operating more like a centre of excellence and regulator.

The approach is in line with a typical urban renewal approach of 'inside-out' in the words of Montaner (2020) 'acting on them from the inside and from their own logic, not through imposing external urbanism'. The commuter at its core, and dependants and society around this core, will have to participate. However, the participation must be engineered as a critical and strategic project. Both strong community commitment and sustainable external support will be needed (Meredith et al. 2021).

15.2 Long-distance passenger rail

Three long-distance horizontaly-separated services should be considered. Firstly, a 'special case' high-speed rail service, secondly separation between luxury and other services, and thirdly, family trains split between routes.

In terms of a 'special case' high-speed rail service, long-distance passenger rail travel for business is only possible over dense routes that can be connected in three hours or less. Technologically-speaking, only the Gauteng-Durban route could be feasible as a special case, not impacting on any other aspect of this strategy. It will be a ring-fenced solution, much like the iron ore line for freight and requires its own feasibility study approach. If funding was made available, and the business case positive, it could work.

In terms of separation between luxury and other services, slower long-distance passenger rail options do not seem to work in the developed world as a feasible high-density solution, but rather as a tourist solution or a special case 'destination' in itself. For this, services such as the Blue Train and Rovos Rail can be continued, and less luxurious options can also be developed, comparable to Via Rail or Amtrak (in Canada and the USA).

Where mass mobility of the stranded is concerned, rail can and should be a better alternative than taxi services over long distances. Horizontal separation between separate routes might be difficult at first so an integrated long-distance service is possible through a concessionaire. These services can be defined by a concessioning authority as well, based on in-depth research and decisions made on subsidy levels and priority routes. The corridor approach is merely extended to longer routes.

15.3 Transition

Transitioning to a concession should consider current infrastructure, equipment and employees. An operational concession is probably the most practical, but only useful assets should be drawn into the agreement. Overarchingly, it has to be taken into account that:

- an effective road-to-rail passenger strategy will always mean subsidies
- in the south african context, the stranded population must be able to move
- the service must be complete
- the solution is also horizontal. all or nothing applies to each selected route, not everything for all routes.

Effective subsidies in this regard mean a concessioning authority with capability and capacity to analyse demand, determine service levels and make depoliticized decisions given available funding

(allocate according to Pareto hierarchy). Subsidies can also be targeted grants (in the form of a coupon system) to specific recipients.

Movement of the stranded in this regard means that the Pareto hierarchy is not only informed by numbers but by a complete suite of socio-economic factors, much like a social grant scheme.

Completeness in this regard means that a specific service (corridor) has to conform to specific standards or not be offered. The standards include ownership by the community it serves, engineered through consultation and other measures; and safety, security and reasonable comfort for all.

Horizontal solutions mean that not all current routes have to be serviced and new ones are possible. In the long run, one safe, heavily subsidised, quality and working solution is preferable to 20 under-performing solutions.

Combating theft and vandalism

A major concern from respondents is that theft and vandalism seriously impact rail reliability and efficiency, and the protection of rail assets is one area where a strong response from government is expected. A community-based strategy based on a multi-faceted approach is potentially the most impactful in the short term:

1. Behavioural. The community gets involved through collaborative measures and increased awareness, and develops a sense of 'ownership' of the railway system. Community members could even 'earn' concessions for protecting railway infrastructure (and penalties for the alternative).

2. Technical. Anti-vandalism technology, such as rapid response teams deployed along railway lines, on a core line such as Natcor perhaps every 50km, further apart in rural areas, and closer in metropolitan areas. With a central control room and 'tagged' assets, i.e., any asset disturbance rings an alarm.

3. Legislative. Trade in (and even possession of) manufactured copper without licences should be banned.

It should however be noted that these are very operational interventions. The scale of theft and vandalism in South Africa point to much larger issues such as unemployment, inequality and lack of education. While short term interventions will be required to facilitate infrastructure investments and service delivery, avenues to engender a bottom-up society-wide culture of sustainability need to be investigated; and very decisive, visible action is required from the Presidency to root out corruption as this has a profoundly negative impact on the resources available to build a sustainable economy, as well a profoundly negative impact on the general levels of motivation and sense of accountability required on an individual level to build a sustainable societal culture from the bottom up.

PART 3: CROSS-CUTTING ISSUES

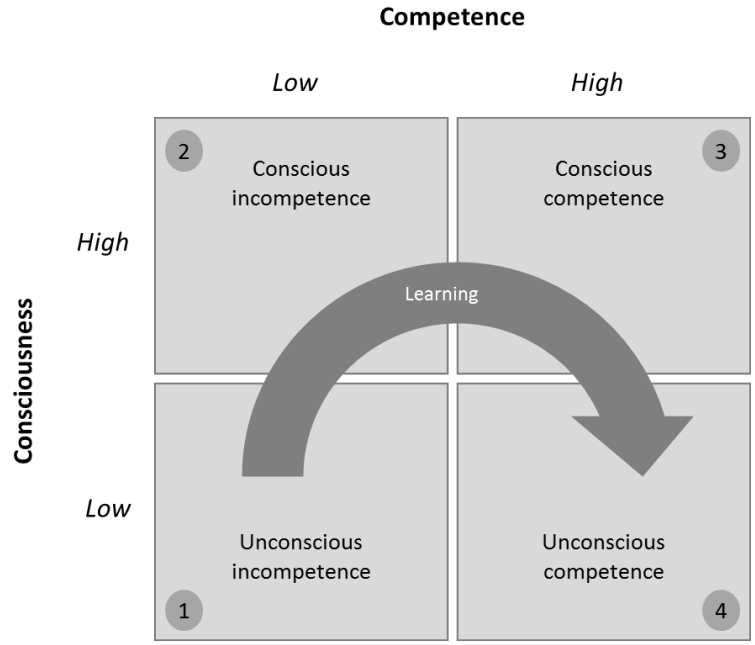
16 Key cross-cutting issues

In closing, key cross-cutting issues that require attention are considered, relating to leadership, governance, developmental state ideals, regulatory capacity, market intelligence and a rail ethos. These issues are closely inter-linked and it is imperative to address them as a matter of urgency. Failing to do so will undermine the strategies presented here, significantly increasing the risk of systemic failure of South Africa's rail system.

17 Leadership

A culture of leadership includes stewardship — i.e., care for the vision, assets and operations of railways in South Africa. From the interviews and analysis conducted it is evident that there are significant challenges in this regard. The challenges can be elucidated in light of the consciousness-competence model depicted in Figure 37.

Figure 37: Consciousness-competence model



Source: adapted from Broadwell (1969).

In a situation of 'unconscious incompetence' change is usually impossible. Individuals first have to be brought to a stage of 'conscious incompetence', i.e., an awareness and ownership of challenges and shortcomings, before change can be affected. Many respondents believe that the DoT is currently in the first quadrant. Discussions with DoT officials and management do not contradict this view and it is clear that critical issues are not receiving attention. The private sector feels that pockets of Transnet are at least in the second quadrant (especially respondents that have deep knowledge of the business). Transnet must be supported to achieve its objectives. It is not clear where PRASA is in this regard. The discussions that were possible reveal that management

is aware of the predicament that PRASA is in (quadrant 2), but most of the problems is seen as outside the agency (pointing to quadrant 1 awareness).

The situation — where none of the main players on aggregate can be rated in quadrant 3 or 4 — is dire for the country. It requires decisive leadership from the Presidency to appoint skilled leaders in these organisations and provide clarity and transparency on their objectives — i.e., appointees to manage the road-to-rail transition need to exhibit leadership in quadrants 3 and 4 — during this urgent transition, the time for up-skilling management from quadrants 1 and 2 has unfortunately been squandered.

To some extent the recent appointment of a full new board and management team at Transnet is a step in the right direction. It looks like competent people were appointed and the strategies that were visible or shared is in line with the proposals in this document. However, Transnet is a large organisation, and a turnaround will be challenging. Performance parameters should therefore be clearly defined and closely monitored. As progress is made in the implementation of the strategy, the organisation should be supported in a viable and transparent manner, in line with its dual responsibility (profit and developmental state).

18 Governance

The legal succession of Transnet in 1990 was the result of many transparent policy developments between 1975 and 1990, starting with a study group established by the then Minister of Transport, culminating in the De Villiers report (1986), the corporatisation of SATS, deregulation, and the eventual creation of Transnet in 1990. One of the underlying themes of that time was the focused objective to remove political meddling from SATS, a problem that dogged the predecessors of the organisation since unification in 1910. The problem has unfortunately still not been solved. During all the interviews conducted in the process of developing this road-to-rail strategy (including the private sector, central government and agencies) concerns were raised about political interference on all levels. A very firm decision is required to protect all the involved institutions from both the overt and covert direct damage that this inevitably results in. This does not conflict with a developmental state approach, as highlighted in the next section.

19 Developmental state ideals

Many SOEs and agencies see developmental state and profit motives as opposing ideals. This is not true. State-owned enterprises and agencies in a developmental state have the mandate of supporting the fulfillment of the country's development goals. In order to best deliver on this mandate, SOEs need to be financially sustainable, and fulfill their roles in an equitable and cost effective manner. This does not exclude the fulfillment of non-commercial mandates where required to fulfill developmental objectives. This could include cross-subsidisation from own funds to operate; e.g., a low-density rail line, or subsidies to deliver against a specific developmental state objective e.g. the Gautrain for congestion alleviation or urban routes to serve the stranded. This however has to take place in an environment of transparency and clear objectives, requiring a capacitated state, good governance, and accounting systems that enable transparent, timely reporting (Muller et al. 2015).

20 Regulatory capacity

Since 1994, the DoT, as regulatory authority, has not delivered a data-driven strategic vision that is capacitated, implemented, tracked and adjusted as required. Significant resources have been expended for the development of the 1996 White Paper, MSA in 1998, NFLS in 2005 and NATMAP in 2009; the challenges however remain. It is not clear what will transpire from the 2021 White Paper. That means more than two decades of crippling inaction around a strategic commodity (transport) that is of critical importance to the South African economy. The focus is often on strategically less-consequential issues, e.g. high-cube containers for freight or the transportation of dangerous goods; or a fixation on regulation while the transport sector is basically 'burning down' due to a lack of strategic vision, competence and execution. A vast improvement in regulatory and oversight capacity is therefore critically necessary. This is a core requirement of a successful road-to-rail strategy.

The role of the regulator (the DoT) in this space must also be phased. In the short term, attempts at regulation will detract from the singular focus required to save the railways. In parallel with implementing the key short term elements of the freight and passenger strategies as proposed in this paper, the DoT should be capacitated (both in terms of skilled human resources and a market intelligence system) to enable the entity to add value in the longer term. In the medium term, the regulator can provide support for the implementation of the freight and passenger rail strategies. This could include access pricing, competition rules, and delineating relationships between high and low-density lines. Only in the long term, when some balance has been created in the system and the DoT is functioning in an improved capacity, can regulation make its optimal contribution.

21 Market intelligence

It is inconceivable that the DoT still has not taken custodianship of the establishment of detailed knowledge of passenger and freight flows in South Africa from which to develop and track the implementation of a strategic vision. This requirement was paramount in the 1996 White Paper, MSA, NFLS and NATMAP. In all these policy initiatives, the DoT highlighted the need for such a market intelligence system, pointed to the gaps and committed to take it forward. It is, however, still a complete gap. Data-driven planning is one of the cornerstones of successful policy formulation and implementation (see Source: authors' illustration.

and Figure 37), and is another critical shortcoming that has to be addressed.

22 A rail ethos

Rail should not be peripheral to public and commercial life; it must be an integral part of it. In order to be a successful freight carrier, the railway must be inserted in a value chain, with freight naturally, and for portions of its journey, attracted to it. That attraction will include other modes, seamless transfer points and ease of use. It could also mean that fair policy makes it harder for freight to use other options for a part of the journey. This seamless insertion is also true for passengers.

23 Concluding remarks

Democratic South Africa was endowed with important positive and negative aspects as far as the country's rail system is concerned. Due to the country's history, geography and political background the network is far larger than the global average for a comparable country. For similar reasons the Cape Gauge was used and never replaced due to substantial sunk costs, bringing with it the resultant technical limitations. However, these issues brought about a very strong engineering ethos to overcome technical challenges, such as high-speed bogies, seamless welding and moveable frogs. These engineering developments, however, were frequently deployed only on the export coal and iron ore lines to create world class heavy haul capabilities, where South Africa became a respected leader in the field, but the GFB network was poorly attended to.

From a management perspective rail development was driven by:

- a colonial drive to connect port cities to the hinterland, reach gold and diamonds, and facilitate raw mineral exports;
- to unify South Africa in 1910;
- to develop agricultural and mineral resources by cross-subsidising the operations with high-value freight (a cross-subsidy tax regime) and creating a larger network than necessary to serve the primary and secondary economy;
- to secure and protect the subsidy with regulation limiting road transport service provision;
- to create long-distance and urban passenger mobility that could support the apartheid economic development ideals around especially mining and some intermediate manufacturing;
- to create world-class heavy-haul lines to leverage substantial mineral deposits; the income of which was however also employed to cross-subsidise general freight when it failed due to increased competition from road, poor rail service delivery and density challenges due to the excessive GFB network size; and
- to keep the network integrated, which became unaffordable and uncompetitive in its current form.

These events resulted in a seriously compromised system which can only be overhauled by applying proper development state principles for both freight and passengers (including committing to private enterprise ownership where commercially viable). The freight railway, in the very immediate short term, needs far higher levels of asset utilisation and a splitting of the low and high-density network. Once successful, and this should not take more than two or three years, procedures must already be in place to either privatise terminals and wagon fleets, or implement public-private partnerships around these assets. As a final step, granting open access to various locomotive operators should be possible. Implementing the final step immediately will create complexities that will render all the other steps near impossible. Given its current state, the passenger railway can only be rebuilt from the ground up based on a concession model. PRASA should be dissolved and a new concession-governing authority should be appointed with urgency, taking over only those assets and people that are useful and fit-for-purpose.

There is enough for South Africa to work with to save both the freight and passenger railways if immediate actions are taken. A strong political will to actually do that might be the only problem that cannot be solved.

References

ANC. 1994. The reconstruction and development program, available at: https://omalley.nelsonmandela.org/omalley/index.php/site/q/03lv02039/04lv02103/05lv02120/06lv02126.htm, accessed 8 June 2021.

Ansell, C. and Geyer, R. 2017. Pragmatic complexity - A new foundation for moving beyond 'evidence-based policy making'?, *Policy Studies*, 38(2): 149-67.

Antonowicz, M. 2011. Regulation and logistics in rail freight transport, The Archives of Transport, XXIII (3): 275–284.

Australian Government Productivity Commission. 2005. Review of National Competition Policy Reforms, Report no. 33, Canberra, available at: http://www.pc.gov.au/inquiries/completed/national-competition-policy/report/ncp.pdf, accessed 30 June 2021.

Bao, X. 2018. Urban rail transit present situation and future development trends in China: Overall analysis based on national policies and strategic plans in 2016–2020. *Urban Rail Transit*, 4: 1–12, available at https://doi.org/10.1007/s40864-018-0078-4.

Broadwell, M.M. 1969. Teaching For Learning (XVI) *The Gospel Guardian*, 20(41):1-3.

Daily Maverick. 2020. Vossloh: The German railway giant that derailed Prasa, available at: https://www.dailymaverick.co.za/article/2021-06-23-vossloh-the-german-railway-giant-that-derailed-prasa/, accessed 28 June 2021.

De Villiers, W.J. 1986. Strategic planning, management practices and systems of the South African Transport Services. Pretoria: South African Transport Services.

Department of Transport (South Africa). 1996. White Paper on National Transport Policy, available at: https://www.comair.co.za/Media/Comair/files/level-playing-field/White-Paper-on-Nat-Transport-Policy-1996.pdf, accessed 14 June 2021.

Department of Transport (South Africa). 1998. Moving South Africa: A Transport Strategy for 2020 — Report and Strategy Recommendations, Department of Transport, Pretoria.

Department of Transport (South Africa). 2005. National Freight Logistics Strategy, Department of Transport, Pretoria.

Department of Transport (South Africa). 2009a. NATMAP Phase 2: Consolidated Analysis (inclusive of Provincial Reports).

Department of Transport (South Africa). 2009b. NATMAP Chapter 8: Passenger transport, available at, https://www.transport.gov.za/documents/11623/39906/8_PassengerTransport2017.pdf/432d88ee-8502-4b24-8412-3a6426294cab, accessed 20 June 2021.

Department of Transport (South Africa). 2015. National rail policy, available at: https://www.transport.gov.za/documents/11623/21629/NationalRailPolicyGreenPaper.pdf/ea72ecab-2990-41cd-a0dd-f5e7a2c3e82a, accessed 14 June 2021.

Department of Transport (South Africa). 2016. NATMAP 2050 — National Transport Master Plan Synopsis update, available at: https://www.transport.gov.za/documents/11623/39906/00_TableContents2017.pdf/1f534d84-dba9-4bff-b252-b5acb3a97deb, accessed 22 June 2021.

Department of Transport (South Africa). 2017a. Rail policy: Draft White Paper, available at: https://www.gov.za/sites/default/files/gcis_document/201708/draftwhitepapernationalrailpolicy.pdf, accessed 14 June 2021.

Department of Transport (South Africa). 2017b. Road Freight Strategy, Pretoria, Department of Transport.

Dollery, B.E. and Wallis, J.L.. 1985. Conflict resolution and the deregulation of the South African transport sector. Development Southern Africa 2(4): 522–36.

Ehrenreich, T. 2018. Transport crisis paralyzing South Africa, New Agenda, Issue 69, available at https://journals.co.za/doi/pdf/10.10520/EJC-e6861645e, accessed 21 June 2021.

Frankel, S.H. 1928. The railway policy of South Africa: An analysis of the effects of railway rates, finance and management on the economic development of the Union, Johannesburg, Hortors, p. 113.

Harris, R.G. 1977. Economies of Traffic Density in the Rail Freight Industry, The Bell Journal of Economics, 8(2): 556-64.

Havenga, J.H. 2011. Trade facilitation through logistics performance: The enabling role of national government, Journal of Transport and Supply Chain Management, November: 123-48.

Havenga, J.H. 2012. Rail renaissance based on strategic market segmentation principles, Southern African Business Review 16(1): 1 -21.

Havenga, J.H. and Hobbs, I.E., 2004. A practical guide to strategy: Making strategic thinking, development and implementation accessible, Stellenbosch, AFRICAN SUNMeDIA, https://doi.org/10.18820/9781919980348.

Havenga, J.H. and Pienaar, W.J. 2012. Quantifying freight transport volumes in developing regions: lessons learnt from South Africa's experience during the 20th century, *Economic History of Developing Regions*, 27(2): 87-113.

Havenga, J.H., Pienaar, W.J. and Simpson, Z.P. 2011. A case for measuring logistics costs on a national level: A South African application, *Corporate Ownership and Control*, 8(3): 622–31.

Havenga, J.H. and Simpson, Z.P. 2018. National freight demand modelling: a tool for macrologistics management, The International Journal of Logistics Management, https://doi.org/10.1108/IJLM-11-2017-0290.

International Transport Forum. 2021. ITF Transport Outlook 2021, OECD Publishing, Paris, available at: https://www.oecd.org/publications/itf-transport-outlook-25202367.htm, accessed 29 June 2021.

Interporto Bologna SpA. 2020. Bilancio Sociale 2020, Interporto Bologna SpA, Bologna, available at: https://www.interporto.it/data/upload/bilancio-sociale-2020.pdf, accessed 1 October 2021.

Jasti, P.C. and Ram, V.V. 2019. Integrated and sustainable benchmarking of metro rail system using analytic hierarchy process and fuzzy logic: A case study of Mumbai, *Urban Rail Transit*, 5: 155–71, https://doi.org/10.1007/s40864-019-00107-1.

Jones, T. 1999. The South African transport sector in the 1970s, *South African Journal of Economic History*, 14: 162–94.

Khuthele Projects. 2007. Comprehensive regulatory framework for setting up the rail economic regulator, Khuthele Projects, Pretoria.

Kibalov, E.B. 2018. Failure of Railway Reforms: A Look at the Persons Involved, Problems of Economic Transition, *Transport Infrastructure*, 60(1-3): 39-49, https://doi.org/10.1080/10611991.2018.1456197.

Kundu, A. 2018. Mobility in India: Recent trends and issues concerning database, *Social Change*, 48(4): 634-44.

Liu, Y., Zhang, X., Pan, X., Ma, X. and Tang, M. 2020. The spatial integration and coordinated industrial development of urban agglomerations in the Yangtze River Economic Belt, China, Cities, 104: 102801.

Makaepea, K. 2017. The implementation of the national passenger rail plan on priority corridors, research presented for the degree of Masters of Management in Public Policy to the faculty of Commerce, Law and Management of the University of the Witwatersrand, School of Governance, available at: https://core.ac.uk/download/pdf/188770924.pdf, accessed 21 June 2021.

Meredith T., MacDonald M., Kwach H., Waikuru E., Alabaster G. 2021. Partnerships for successes in slum upgrading: Local governance and social change in Kibera, Nairobi, in Home, R. (ed), Land Issues for Urban Governance in Sub-Saharan Africa, Local and Urban Governance, Springer, Cham, https://doi.org/10.1007/978-3-030-52504-0_15.

Mercer. 2004. Infrastructure Separation and Open Access: Lessons from Experience, Transnet.

Mitchell, M. 2006. Confronting land freight challenges in South Africa. South African Road Federation.

Mondragón-Ixtlahuac, M.M. Cortés-Martínez, C.C. and Delgado-Hernández, D.J. 2017. A strategic planning model for the passenger rail implementation process: The case of Mexico, *Transport Policy*, 55: 29-37, https://doi.org/10.1016/j.tranpol.2017.01.004.

Montaner, J.M. 2020. Remaking slums: international examples of upgrading neighbourhoods, *Buildings*, 10(12): 216.

Muller, S.M., Amra, R., and Jantjies, D. 2015. Report on state-owned enterprises for the standing committee on finance, South African Parliament, available at: https://static.pmg.org.za/150812report.pdf, accessed 29 June 2021.

Palley, J. 2011. Impact of the Staggers Rail Act of 1980, Office of Rail Policy and Development, Federal Railroad Administration, available at: https://railroads.dot.gov/sites/fra.dot.gov/files/fra_net/1645/STAGGER_%20RAIL_ACT_OF_1980_updated_31811.pdf, accessed 29 June 2021.

ParlyreportSa. 2015. South Africa remains without a plan: Minister Peters fails on rail policy, available at: https://parlyreportsa.co.za/cabinet-2/south-africa-remains-without-rail-plan/, accessed 14 June 2021.

Persianov, V.A., Lyalin, A.M., Kurbatova, A.V. and Eremina, T.N. 2020. Problematic issues of goal setting and optimization in the development of the Russian transport complex, *Advances in Social Science, Education and Humanities Research*, 531: 276-83, available at: https://www.atlantis-press.com/article/125953276.pdf, accessed 30 June 2021.

Pirie. 1993. Slaughter by steam: Railway subjugation of ox wagon transport in the Eastern Cape and Transkei: 1886-1910, *International Journal of African Historical Studies*, 26(2): 319-43.

Pittman, R. 2020. On the economics of restructuring world railways, with a focus on Russia, Man and the Economy, 7(2): 20200014, https://doi.org/10.1515/me-2020-0014.

Pucher, J., Peng, Z., Mittal, N. Zhu, Y. and Korattyswaroopam, N. 2007. Urban transport trends and policies in China and India: Impacts of rapid economic growth, *Transport Reviews*, 4: 379-410.

Sedykh, K.A., Khaletskaya, S.A. and Yakovleva, N.V. 2019. Economic security of natural monopolies in the reforming context (Case of rail transport), *Advances in Economics, Business and Management Research,* 113, available at https://www.atlantis-press.com/article/125931808.pdf, accessed 30 June 2021.

Smith, W.J.J. 1973. A quantitative study of road hauliers and ancillary road transport users in the Republic of South Africa, Johannesburg, Rand Afrikaans University.

South African Government. 2021. Statement on virtual Cabinet Meeting of 24 February 2021 available at: https://www.gov.za/speeches/statement-virtual-cabinet-meeting-wednesday-26-feb-2021-0000, accessed 14 June 2021.

South African Railways and Harbours. 1960. *A Century of Transport: A Record of the Achievement of the Ministry of Transport of the Union of South Africa*, Da Gama Publications, Johannesburg.

Union of South Africa. 1909. South Africa Act, available at: https://media.law.wisc.edu/s/c_8/jzhy2/cbsa1.pdf, accessed 12 June 2021.

Vegter, I. 2020. South Africa's minibus taxi industry — Resistance to Formalisation and Innovation, available at: https://irr.org.za/reports/occasional-reports/files/web-irr-south-africas-minibus-taxi-industry-report.pdf, accessed 28 June 2021.

World Bank. 2017. Railway reform: Toolkit for improving rail sector performance, available at: https://ppiaf.org/sites/ppiaf.org/files/documents/toolkits/railways_toolkit/PDFs/RR%20Toolkit%20EN%20New%202017%2012%2027%20CASE13%20RUSSIA.pdf, accessed 30 June 2021.

World Bank. 2021. GDP current US$, available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD, accessed 29 June 2021.