WESTERN CAPE FREIGHT DEMAND MODEL

2020 Model | Report | March 2022

Western Cape Government

Transport and Public Works

Globally, successful national and regional macrologistics interventions have all been dependent on a data-driven approach. Evidence-based macrologistics planning for infrastructure investment and policy direction require activity-based data and costing, much the same as for logistics on a business level. In business, the trade-offs between various strategic alternatives and investment choices are difficult without a disaggregation of all logistics activities and the same is true for national and regional logistics planning. Business logistics is about flows - the forward flow of commodities through value chains, reverse flow of funds and the bi-directional flow of information. For policy and infrastructure investment, flow on a national and regional scale must be understood as well; a need that can be fulfilled with a flow model, based on demand. In the case of South Africa, a national freight flow model captures freight flows between 372 districts on 5 modes, namely road, rail, maritime, pipeline and aviation, and for 83 commodities for export, import and domestic freight, over a 30-year forecast horizon.

Demand-based flow models have been highly successful in the developing world. In India, using such a model led to the identification of various infrastructure gaps[1]. In Uzbekistan, it informed a new transport policy for the country[2] and in Mongolia[3] it assisted with the identification of various value chains and the integrated logistics infrastructure investments that could assist in sizeable economic growth for the country. In South Africa, the model assisted with, and often provided the basis for, various policy documents such as Moving South Africa (1998), the National Freight Logistics Strategy (2005), and The National Infrastructure Plan (2022).

[1] Simpson ZP. Havenga JH. Witthoft IE. Aritua B. Freight Transport Modeling in Emerging Countries, Kourounioti I, Tavasszy L, Friedrich H (ed) WCTRS Elsevier, Amsterdam, Netherlands (2021) : Chapter 8: Spatially and commodity-level disaggregated freight demand modeling in emerging economies: applications for South Africa and India 151-183

[2] World Bank: Transport Global Practice, 2020. Uzbekistan - Building Blocks for Integrated Transport and Logistics Development: Policy Paper, Washington, D.C., World Bank Group, available at: http://documents.worldbank.org/curated/en/620601593145818606/Uzbekistan-Building-Blocks-for-Integrated-Transport-and-Logistics-Development-Policy-Paper (accessed 28 March 2022).

[3] World Bank, Mongolia InfraSAP. Washington, DC: World Bank, 2020 at https://openknowledge.worldbank.org/bitstream/handle/10986/34779/Mongolia-InfraSAP-Infrastructure-for-Connectivity-and-Economic-Diversification.pdf?sequence=4&isAllowed=y (accessed 28 March 2022)

A freight flow model provides information on flows throughout the region and can, for the present, indicate the volume of freight on each transport mode in that region and can also assign costs to these flows. This is current demand which is related to the current GDP of the region in question, also often called "GDP in motion". With forecasts, future demand for each of these flows can be determined and thereby enable a range of analytical opportunities for the decision-maker. The demand side can be influenced; for instance, what will the effect on infrastructure be with certain industrialisation actions, and which industrialisation strategies will best be enabled by specific interventions? Also, the cost-benefit analysis of modal choices, terminals, freight villages and special economic zones is enabled – all of which have been illustrated successfully on a global scale. Policy interventions can also be evaluated; such as the cost of congestion measures in cities, the effect of loading restrictions and law enforcement. In all cases, because activity (freight flows) and the cost drivers of these activities are known, the systemic effect of each infrastructure and policy decision can be modelled.

The effect of COVID-19 on national and regional planning instruments has been an area of interest. Because the relationship between GDP and its components and freight flows were known, it was easy to adapt forecasts and provide meaningful insights. GDP forecasts were quickly adapted by economists, but the relationship between flows and lockdown levels was also identified quickly. With these two levers planning could be adapted. The largest long-term effect of COVID-19 on logistics is the global disruption of supply chains, a phenomenon that can also be incorporated into the planning approach.

The Western Cape Provincial Government (WCG) has developed the Provincial Freight Strategy to initiate sustainable freight transport delivery in the province. The strategy is informed by a data-driven approach and the WCG invested in the development of the Western Cape Freight Demand Model (WC FDM™) in the 2017/18 financial year. Since then, the WC FDM™ has been updated annually, making this the fifth iteration of the model and the basis for this report. The major new inputs were an updated national Freight Demand ModelTM (updated for 2020 during the course of 2021), and the full calendar year of Western Cape-specific data for 2020. This report was developed to outline the development of the WC FDM™ and the main insights from the latest model. It describes the sources of data for the updated model and the methodology followed and presents various results that support strategic decision-making and implementation of the Western Cape Freight Strategy.

Report content include:

Western Cape Freight Demand Model (WC FDM™)

Western Cape Government

Transport and Public Works

Executive summary

The WC FDM™ supports strategic decision-making in the implementation of the Western Cape Freight Strategy. This report outlines the methodology and data sources of the model, and summarises key characteristics and costs associated with freight flows to, from, and within the Western Cape, as well as potential scenarios for improvement.

Methodology

The national and provincial freight demand models comprise econometric and flow modelling. Econometric modelling identifies and analyses causes and effects, and correlates relationships between total freight transport demand and its drivers. Flow modelling uses the supply and demand values of the econometric model to represent freight movement between supply and demand areas for all commodities and modes.

Data

The models are based on Logistics Service Provider cost and tariff data (interview-based), Transnet Freight Rail data, Transnet National Ports Authority data, Western Cape-specific data (agriculture, crops, and mining), and publicly available industry and business data, and Western Cape specific Air freight data.

National freight flows

Freight to, from, and within the Western Cape constitutes 17.1% of the total national freight (tonnes), and 14.7% if the iron ore and manganese export lines are excluded. The Western Cape contributes 10.6% to the national transportable GDP and 36.8% of the total tonne-kms (31.3% when excluding bulk export freight). With the exclusion of bulk exports, the manufacturing sector freight contributes 56.3% and 67.6% of national and provincial tonne-kms respectively, and the agricultural sector contributes 19.5% and 24.5% respectively. Manufactured goods constitute 48.7% of Western Cape and 31.2% of national general freight business (GFB)[1] tonnes. Western Cape consignments are transported over the highest average transport distance of any province in South Africa. The beneficiation efforts of the province are hampered by significant transport and spatial challenges, and high logistics costs considerations. Given that GFB performance is not nearly what it should be nationally and provincially, a national rail solution is required to achieve significant rail volumes in the Western Cape.

Provincial modal split

The total freight with an origin or destination in the Western Cape amounted to 134.3m tonnes in 2020, showing a decrease of 10.6% from the 150.2m tonnes in 2019 due to the impact of COVID-19. The modal split of the total Western Cape freight is 56% on road and 44% on rail. For GFB freight, 98% is transported on road and 2% on rail. Rail is used mainly for low value, bulk agricultural and mining (e.g., iron ore) commodities. Fruit presents a major opportunity that has not been realised due to the lack of consolidation facilities and rail freight service levels. The manufacturing sector is dominant in GFB freight volumes but shows a decline from previous years. Opportunities exist in the Western Cape for long-distance GFB rail freight.

---

[1] GFB is defined as the competitive market space, and consists of the total freight tonnes less iron ore exports, manganese exports, pipelines and, for the analysis that follows, stone and aggregate. The latter has been removed from the subsequent GFB analysis because it is typically a very short-distance movement of mostly construction aggregate, which is challenging to quantify and has extremely dispersed transport.

GAIN GROUP Insight drives growth

Provincial trade

The Western Cape GFB freight (62.2 million tonnes) is split approximately between intra-Western Cape freight (21.2 million tonnes), freight transported to other provinces (23.8 million tonnes) and freight received from other provinces (17.5 million tonnes). Waste is an intra-provincial flow only, and amounts to 2.6 million tonnes (13% of intra-provincial flow). Almost half (41%) of intra-Western Cape freight and 78% of freight to other provinces, amounting to 27.2 million tonnes, consists of manufacturing commodities. Processed foods represent the largest manufactured commodity group (33%), followed by beverages (10%). The effect of the COVID-19 lockdown is visible where mining and manufacturing activities were impacted, but the Western Cape experienced good crops. KwaZulu-Natal is the Western Cape's main GFB trading partner, followed closely by Gauteng. If it were not for the Port related trade with KZN, Gauteng would have been the Western Cape's biggest trading partner, because 29% of trade with KZN is related to the Port of Durban.

Corridors

Rail has a 2.3% tonnage market share of non-ring-fenced[2] total Western Cape road and rail freight. In terms of tonne-kms, there was a decrease from 2% in 2019 to 1.7% in 2020. Corridor freight transport is dominated by road, with 98.5% non-ring-fenced tonnage market share on the N1 corridor, 99.6% on the N2 corridor and 85.1% on the N7 corridor. The average travel distance of freight on the N1, N2 and N7 is 1 420 km, 606 km and 369 km, respectively. More than half of N1 freight is food commodities. Modal shift opportunities exist for long-distance road freight in the Western Cape and are discussed in more detail in the modal shift scenario.

Flow segmentation

Manufactured goods, transported over long distances on road, present two opportunities for rail, namely (1) siding-to-siding freight, that is, long-distance freight that is usually moved from large manufacturing plants to other plants for further beneficiation; and (2) FMCG palletisable and containerisable freight, which can be transported through domestic intermodal solutions from private distribution centres through public intermodal terminals. Historically, the railway faced challenges in developing these solutions collaboratively with road. This impacts transport cost and competitiveness of industries in the Western Cape. There are positive indications of private sector, provincial and local government cooperation with Transnet to participate and develop terminal and consolidation centres. These developments might create a conducive environment for palletisable freight modal shift.

Economic forecast

Iron ore and manganese exports constitute the majority of the Western Cape's mining sector freight intensity[3]. Manufacturing and agricultural commodities from the Western Cape are transported over significantly longer distances than the mining commodities. The impact of COVID-19 results in a more pessimistic view of manufacturing in the long term. Social and economic factors are also believed to be more challenging than before due to the longer-term impact of COVID-19.

Freight transport costs

In 2020, road freight accounted for 83% of the total transportation cost. The main road freight transport cost drivers were fuel (R15.7 billion; 30.1% of total cost), maintenance and repairs (R8.0 billion), and driver wages (R6.4 billion). The South African freight railway's challenge is that it needs a substantial modal shift from road to realise density benefits.

Externality costs

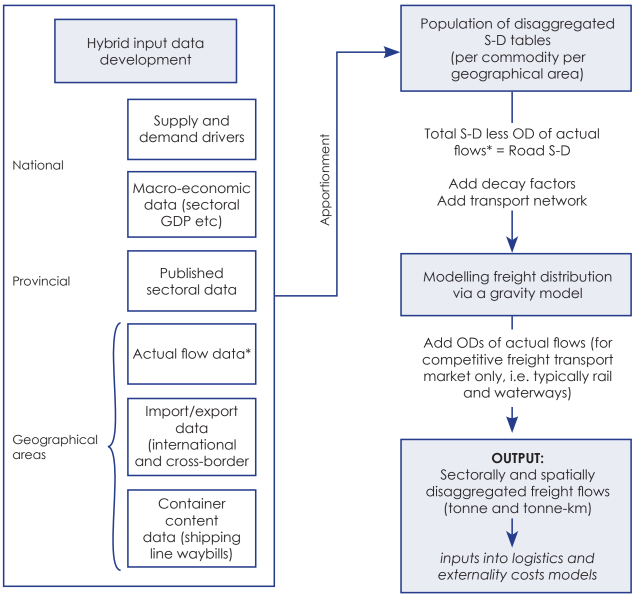
The total externality cost for road freight transport in the province amounts to R12.8 billion, which is 29.6% of current direct road freight transport costs. Road freight transport contributes 93% of the total freight transport externality cost of R13.74 billion, of which 80% is contributed by the four largest cost drivers (i.e., emissions, accidents, noise and congestion). These impact the general population while not being carried by the users of the service. Policy interventions could induce the internalisation of externality costs, and a systemic shift of rail-targetable freight to rail.

[2] "Ring-fenced" freight is freight that is usually part of a specific ring-fenced system that is not impacted by provincial-level strategic interventions, for example iron ore from Sishen to Saldanha. Non-ring-fenced freight refers to the freight that falls outside of this definition.

[3] Freight transport intensity is the ratio of freight transport demand (measured in tonne kilometres) and the economic output measured by Gross Domestic Product (GDP). Freight intensity is the quantum of freight transport required to achieve the same output. Freight transport intensity, for instance, for income received from gold mining versus income received from coal mining is very low. Meaning much less freight activity is required to achieve the same income. In a general sense high freight intensity means low returns for many tonne-kilometres. It can be reduced by higher value economies (services and high value products where the freight to product value ratio is low) or more efficient logistics (less kilometres for the same task, achieved through (inter alia) lower empty haul, better routing, better load factors).

Western Cape Freight Demand Model (WC FDM™)
Methodology

The process and key data sources that are used to develop the Western Cape Freight Demand Model[1] are indicated in Figure 1. The model produces supply and demand data which, in turn, defines freight flows in terms of origin, destination, commodity, volume and transport mode. The primary steps are the gathering and development of actual and modelled commodity-level data, disaggregation of this data to supply and demand per geographical district and modelling of the freight flows between origins (supply) and destinations (demand). These supply-and-demand tables are developed based on a hybrid approach that utilises the available datasets for each geography.



S-D = Supply and demand
OD = Origin-destination
** Rail, waterways, pipelines, conveyor belts (where applicable)*

Figure 1: Adapted from key data sources and process detail of the FDM (Havenga and Simpson, 2018)

The national model was first developed and used in 1998. The model was improved in 2006 to become a complete repeatable model, and has since been updated annually with Transnet sponsorship. The WCFDM was developed for the first time in 2017/18, based on the national FDM, with the objective of adding richer and more refined known data for the province and enable the development of more refined strategies.

The methodology for developing the FDMs (both national and provincial) consists of two steps: (1) econometric modelling and (2) flow modelling.

Econometric modelling

This modelling approach is required to develop multi-commodity, multi-regional national freight demand models (Havenga and Simpson, 2018). Econometric models identify and analyse cause-and-effect and correlative relationships between the total freight demand and its drivers. Figure 2 shows the econometric modelling steps.

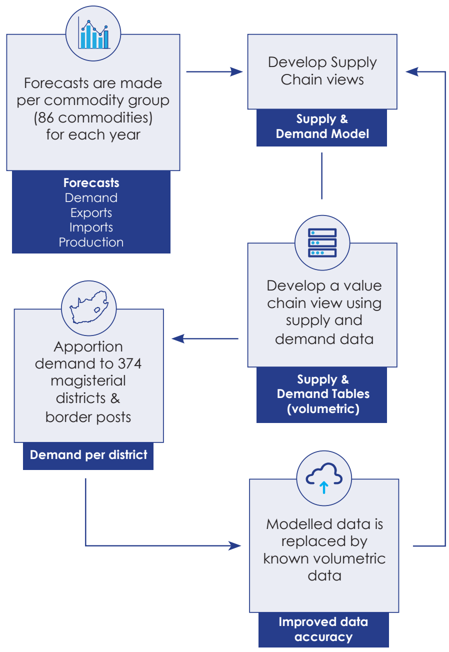


Figure 2: Econometric model

Supply and demand are forecasted 30 years into the future. This provides likely high and low growth scenarios. These forecasts are based on assumptions regarding the international economic outlook, Gross Domestic Product (GDP) growth, inflation, national capital spending, population growth, and various other forecasting factors.

Flow modelling

Flow modelling uses the supply and demand values of the econometric model to model the movement of freight between supply areas (origins) and demand areas (destinations) throughout the country, for all commodities and modes.

The input data is created by subtracting the volume of known flows per geographical district (rail, pipeline, conveyor) from the total supply and demand volumes. The balance of supply and demand is then modelled as road flows, by means of gravity modelling.

Gravity modelling is based on the premise that freight flows between geographical districts are determined by supply and demand volumes for each commodity, and by a measure of transport resistance[2] per commodity.

Distance and travel time are the most common measures of transport resistance as an objective, readily-available variable. Road cost components, such as diesel consumption and truck wear-and-tear, also typically have a linear relationship with distance and time. A distance-decay function describes the attraction value between origins (supply) and destinations (demand). The decay factor determines the slope of the decay function and its relative change over distance and time. Distance decay varies from one commodity to another based on many characteristics, including its value, nature and utility.

[1] Western Cape Freight Demand Model utilises in part the "FDM" (a registered trademark of GAIN Group (Pty) Ltd)

[2] Transport resistance is a commodity's propensity to be transported over a specific distance, with that propensity being determined by the utility and desirability which is traded-off with transport cost as a percentage of delivered cost. Propensity is, therefore, estimated through a decay function for each commodity in question. In cases where the transport cost percentage is very low, the commodity will move even if the utility and desirability is low.

Low value, bulk commodities that generate a transport demand disproportionate to their value tend to have a sharp rate of decay (i.e., they tend not to be transported over long distances), while the impact of distance is smaller for higher-value commodities, thus suggesting low decay parameters (mostly used for manufactured and end-use agriculture commodities, that is, heterogeneous agglomerations with use that is more dispersed over a number of geographical districts).

Figure 3 shows the Flow Model.

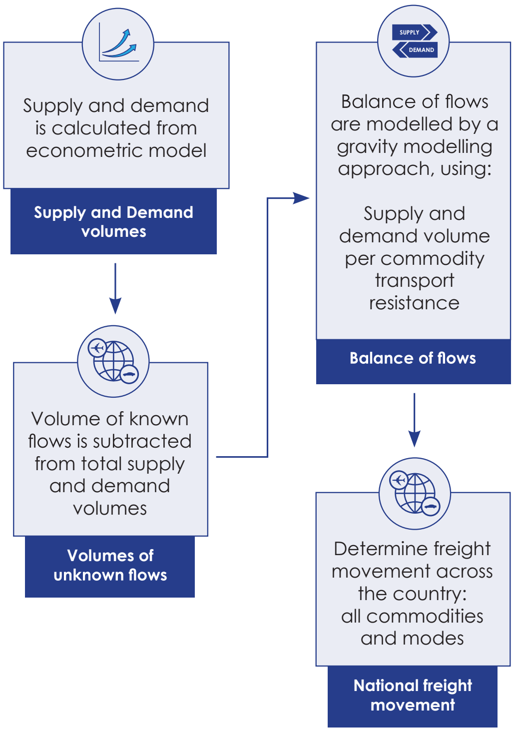


Figure 3: Flow Model

The Western Cape Freight Demand Model (WCFDM)

The WCFDM is confined to those Western Cape geographical districts from the national FDM (42 magisterial districts, 3 ports) for which freight either originates, is destined for, or moves within the district. The model is a complete set of origin and destination freight movements, per commodity (currently 86 commodities) and per transport mode (road, rail, and pipeline). A geographic representation of the WCFDM districts is presented in Figure 4.

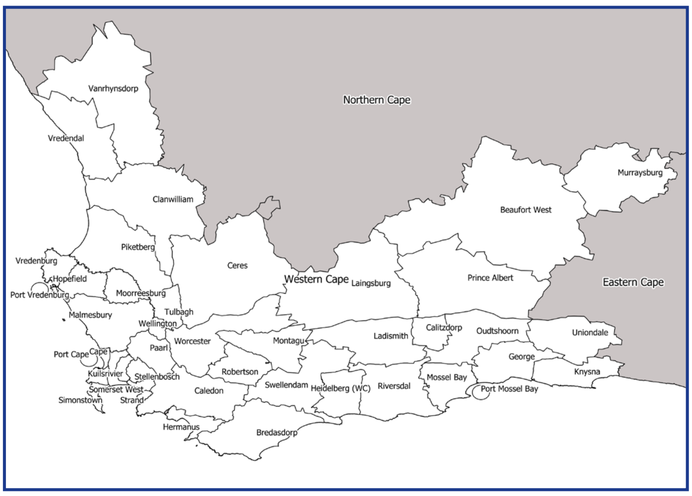


Figure 4: Geographical districts within the Western Cape

Data sources

During the development of the WCFDM, the following data sources were used:

- Inputs from participating Logistics Service Providers (LSP);
- Transnet Freight Rail data;
- Transnet National Ports Authority data – bulk and containers;
- Western Cape specific data: agriculture crops, waste and mining data;
- Publicly available data for industry and businesses.
- Western Cape specific Air freight data

Figure 5 and the text box below provide a summary and explanation of the datasets used and updated:

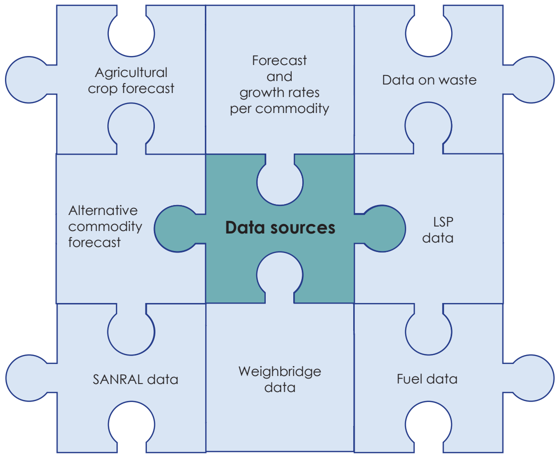


Figure 5: Data Sources

1. Forecasts and growth rates: Revised in line with the national FDM for imports, exports, production, intermediate demand and final demand/consumption in WCFDM.
2. Waste: Data collected and included in the model.
3. Participating Logistics Service Provider (LSP): Company origin-destination freight movements were further interrogated and verified with more detailed cost and tariffs.
4. Liquid fuels and the imports and exports of refined petroleum products: Additional research was conducted and comparisons made between data from industry, the South African Petroleum Industry Association (SAPIA) and the Department of Energy.
5. Weighbridge data: Used to validate WCFDM flows. It largely confirmed the modelled WCFDM road flows.
6. South African National Roads Agency Limited (SANRAL) data: New SANRAL data for analysis and comparison with modelled data on the N1, N2 and N7.
7. Agricultural data: Latest data, including estimated current crops and future plantings and yields, were incorporated.
8. Air freight data: Included but not yet integrated with other modes of transport in the FDM as the origin destination (OD) detail is not available.

Refer to Chapter 6 of Havenga et al (2020), Havenga (2013) and Chapter 8 of Havenga (2007) for a more technical description of the FDM model:

Havenga, J.H. (2007), 'The development and application of a freight transport flow model for South Africa', dissertation presented for the degree of Doctor of Philosophy (Logistics Management), Stellenbosch: University of Stellenbosch.

Havenga, J.H. (2013), 'The importance of disaggregated freight flow forecasts to inform transport infrastructure investments', Journal of Transport and Supply Chain Management, Vol. 7 No. 1, pp. 1-7.

Havenga, J.H., Witthoft, I.E., De Bod, A. and Simpson, Z. 2020. *From Logistics Strategy to Macrologistics: Imperatives for a developing World. London. Kogan Page Publishers.*

Havenga, J.H. and Simpson, Z.P. (2018), 'National freight demand modelling: a tool for macrologistics management', International Journal of Logistics Management, Vol. 29 No. 4, pp.1171-1195, https://doi.org/10.1108/IJLM-11-2017-

Of the 784m tonnes of freight being moved in South Africa, 133.8 million tonnes (17.1%) of freight have either an origin or destination, or both, within the Western Cape, as shown in Figure 1 (a). This figure is skewed by the iron ore (53.7 million tonnes) and manganese exports (4.4 million tonnes), which are almost entirely destined for the Port of Saldanha. This ring-fenced freight is shown in Figure 1(b). Without the two export commodities that originate outside of the boundaries of the province, 9.7% of all national freight moves through the Western Cape, as shown in Figure 1 (b). The iron ore and manganese export lines account for 6.8% and 0.6% of the national freight, respectively. This highlights that a large portion of freight that moves through the Western Cape does so without contributing significantly to the province's1 Gross Domestic Product (GDP).

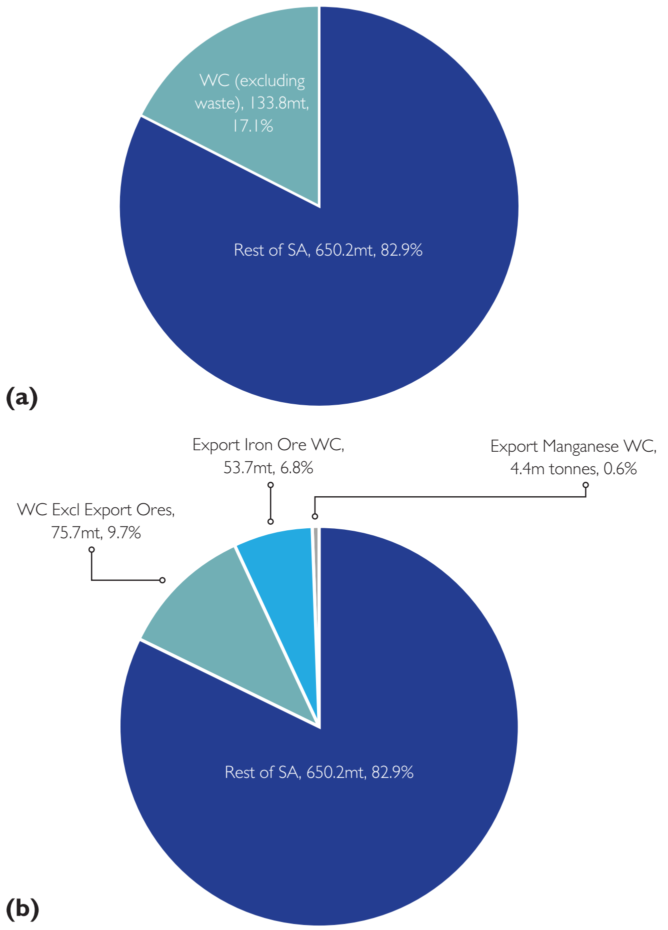


Figure 1: Western Cape freight as percentage of national freight in 2020 (WC = Western Cape)

Figure 2 shows the total contribution of the Western Cape freight volumes as a percentage of the total national freight volumes, both per tonne and per tonne-km. If the export lines are included in the freight moving in the Western Cape, the results show a very high freight transport intensity[2] in terms of tonne-kms, with 17.1% of the national tonnes accounting for 36.8% of the national tonne- kms.

The difference in the Western Cape percentage share of the national total based on tonnes and tonne-km shows how moving bulk freight over long distances can affect freight intensity measurements. Therefore, in order to conduct a fair analysis of the remaining non-bulk freight, that is, General Freight Business (GFB) freight, the bulk lines (iron ore export, manganese export and pipelines[3], hereafter referred to as "the bulks" or "bulk commodities") have been excluded from the Western Cape freight, considering that they skew the freight intensity. The export coal and conveyor belt coal are excluded from the national freight.

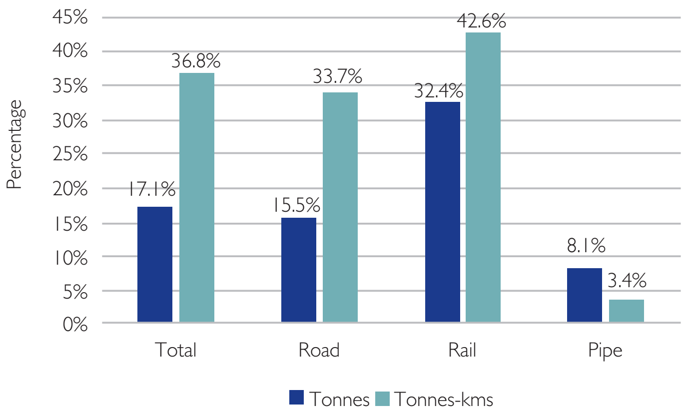


Figure 2: Western Cape volumes as a percentage of South Africa's total freight (2020)

With the bulk commodities excluded from freight flows, Figure 3 shows that the Western Cape share of national freight intensity (tonne-kms) is still high compared to its contribution to national freight volumes (tonnes). The Western Cape is one of nine provinces but contributes one in three national GFB tonne-kms (31.3%) and only accounts for 14.7% of the national GFB tonnes.

In addition, rail's contribution is low compared to that of road, especially given the long distances to inland markets. The national FDM indicates that rail's corridor market share is the highest on the Natal corridor (next to the N3), and low on the Cape corridor (next to the N1). Historically, the majority of rail freight developments were concentrated along the Natal corridor, even though it is much shorter than the Cape corridor. Therefore, due to the long distances and less development along the Cape corridor, the Western Cape experiences a lower relative rail market share (with bulk commodities excluded). The Western Cape is therefore in a position where the leveraging of initiatives that encourage modal optimisation and transportation cost efficiencies for GFB traffic will have the greatest positive effect.

[1] The iron ore and manganese mining contribute to the primary sector GDP of the Northern Cape. The export of the commodities at the port of Saldanha contributes to the tertiary sector GDP of the Western Cape.

[2] Freight transport intensity is the ratio of freight transport demand (measured in tonne kilometres) and the economic output measured by Gross Domestic Product (GDP). Freight intensity is the quantum of freight transport required to achieve the same output. Freight transport intensity, for instance, for income received from gold mining versus income received from coal mining is very low. Meaning much less freight activity is required to achieve the same income. In a general sense high freight intensity means low returns for many tonne- kilometres. It can be improved by higher value economies (services and high value products where the freight to product value ratio is low) or more efficient logistics (less kilometres for the same task, achieved through (inter alia) lower empty haul, better routing, better load factors).

[3] The other bulk commodities of significance to the South African economy are coal exports through Richards Bay and conveyor belt coal to power stations. The physical flows of these two bulk commodities do not interact directly with the Western Cape's economy.

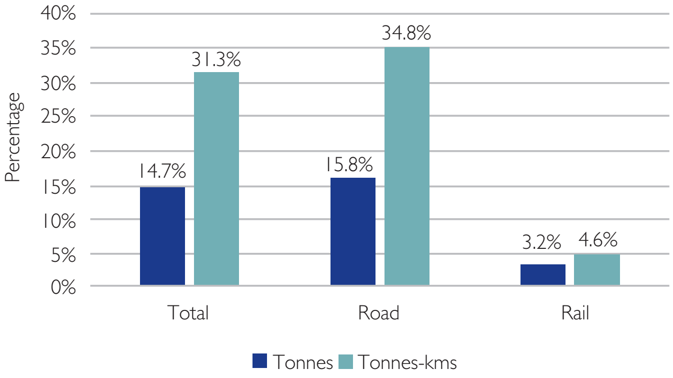


Figure 3: Western Cape GFB volumes as a percentage of South Africa's total GFB freight (2020)

Table 1 shows the Western Cape's overarching freight position. Due to the slightly larger tertiary sector[4] of the Western Cape, the province's contribution to transportable GDP is lower than its contribution to total GDP. Although the Western Cape contributed only 10.6% to the national transportable GDP, it contributed 36.8% of the total tonne-kms, or 31.3% when considering GFB freight. Please note, that the GDP figures[5] for the Western Cape were estimated by adapting GDP growth figures for 2020 published in 2021.

Table 1: Western Cape's overarching freight position (2020)

	South Africa	Western Cape	%
GDP (R Billions current prices)	4 974	665^e	13.4%
Transportable GDP (Rbn current prices)[6]	1066	113^e	10.6%
Tonnes (Millions)	784	134	17.1%
Tonnes (Millions) GFB	499	74	14.7%
Tonne-km (Billions)	299	110	36.8%
Tonne-km (Billions) GFB	180	56	33.1%

The contribution of the Western Cape's mining flows to the total provincial freight in tonnes was 60%, which approaches the sector's 63.3% contribution to the total national freight in tonnes, as shown in Figure 4. As described before, the significant role played by the mining sector in the province's freight flow economy is attributable to the provision of an export gateway for iron ore through the Saldanha Bay port. When the bulk exports are excluded, the contribution of the GFB mining tonnes to the Western Cape's total sectoral freight flows declines to 29.4%, with manufacturing (mostly consisting of agro-processing) and agriculture increasing to 48.7% and 21.9%, respectively (compared to the sectoral contribution to total tonnes).

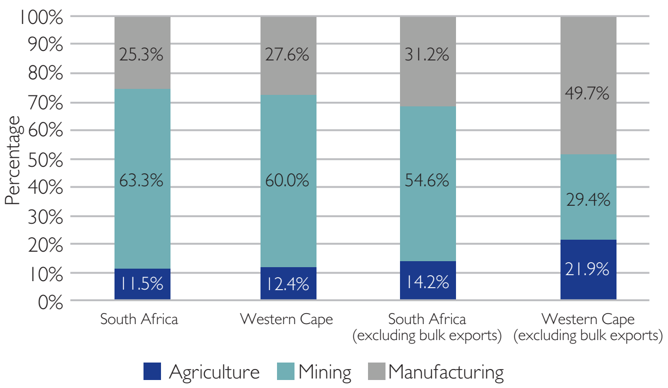


Figure 4: Tonnes per sector as percentage of total tonnes for South Africa and the Western Cape (2020)

Figure 5 shows the percentage contribution of tonne-kms per sector, both nationally and at a Western Cape level and both including and excluding bulks.

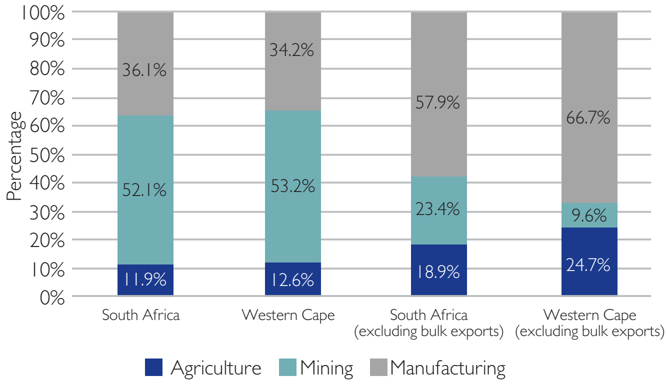


Figure 5: Tonne-kms per sector as percentage of total tonne-kms for South Africa and the Western Cape (2020)

As described above, in 2020 the mining sector contributed near two thirds of the freight flow tonnes both nationally and in the Western Cape, while accounting for 52.1% and 53.2% of the tonne-kms respectively. The relatively lower tonne-km contribution is due to the Western Cape's mining activities being relatively shorter haul (mostly the Namaqua Sands projects) than mining activities in the rest of South Africa. The manufacturing sector freight makes up 25.3% of national tonnes and 27.6% of Western Cape tonnes. This sector's freight makes up 36.1% of national tonne- kms and 34.2% of Western Cape tonne-kms.

The agricultural sector freight makes up 11.5% of national tonnes and 12.4% of Western Cape tonnes; and 11.8% of national tonne- kms and 12.6% of Western Cape tonne-kms.

The discrepancy between tonnes and tonne-kms national contribution share (especially in the manufacturing sector) results from the Western Cape's longer inter-provincial trading distances compared to any other province in South Africa; this requires longer trips for exporting and importing finished goods and processed and unprocessed food.

A comparison between the total tonnes and tonne-kms per sector shows that, on average, manufacturing and agricultural commodities are being moved over longer distances than mining commodities. This becomes more evident when excluding the bulk exports. The manufacturing sector contributes 57.8% of the national tonne-kms after the bulk exports have been excluded, and 66.7% in the Western Cape. The agriculture sector contributes 18.9% of the national GFB tonne-kms and 24.7% in the Western Cape.

[4] The primary sector refers to economic activity pertaining to the extraction of raw materials/goods from the earth (mining and agricultural commodities). The secondary sector receives products from the primary sector (either from the domestic economy or imported) for economic activities related to construction, the manufacturing of intermediate demand goods for further manufacturing processes, and the manufacturing of final consumer products. The tertiary sector consists of the production of services such as banking, insurance and telecommunications.

[5] Western Cape Government Provincial Treasury. 2021. *Provincial Economic Review and Outlook*. [Cape Town]: Western Cape Government.

[6] While national economies are segmented into the primary, secondary and tertiary sectors, the FDM only accounts for transportable GDP, that is, the primary (agriculture and mining) and secondary sectors. The tertiary (economic) sector is not transportable and therefore not accounted for in the FDM.

South Africa's beneficiation is on average more successful in the Western Cape. Manufactured goods constitute 48.7% of the Western Cape's GFB tonnes, while only 31.2% of the national GFB tonnes consist of manufacturing commodities. However, there are significant transport challenges (such as modal split) and spatial issues (integrated terminal design) causing high logistics costs that impact this strategy in the Western Cape. One of the advantages of beneficiation is that it reduces transport costs relative to GDP (delivered higher value commodities will always attract a lower transport cost percentage than lower value commodities). However, beneficiated commodities in the national context must still be moved to markets and if these markets are relatively further away, transport costs will be relatively higher. This is because these commodities compete with local or imported commodities closer to the market.[7] This implies that greater transport efficiency is required. For instance, a national rail solution is required to achieve significant rail volumes for Western Cape freight.

South Africa has a huge road to rail potential as identified in the proposed road to rail strategy for South Africa[8], which is depicted in Figure 6. The flows in red show what GFB rail freight performance is, while the flows in blue show what it should be if all rail suitable commodities and flows are considered. GFB performance is less than half of what it should be. The current GFB tonne-km of 18 billion should be 47 billion tonne-kms and should reach 77 billion tonne-kms by 2050. This means that South Africa's GFB rail performance should quadruple by 2050 if it were to fulfill its full economic task.

Almost no freight that should be on rail, is on rail in the Western Cape. This is due to the railway's challenge in attracting clients and implement domestic intermodal solutions. Current GFB rail tonne-km that serves the Western Cape is 0.9 billion (please note this is flows right through South Africa, not only within the Western Cape borders, that either originates from or is destined for the Western Cape). This volume should be 12.6 billion tonne-kms and is expected to reach 25 billion tonne-kms by 2050. Many of the Western Cape's freight challenges relate to long-distance freight that either originates from or is destined for other provinces. Currently 38% of GFB rail tonne-kms which serve the Western Cape are incurred outside its borders.

Highlights

- 17.1% of national freight has either an origin or destination, or both, within the Western Cape.
- 14.7% of all national GFB freight moves through the Western Cape.
- The Western Cape contributed 10.6% to the national transportable GDP; it contributed 36.8% of the total tonne-kms, and 31.3% when excluding the bulks.
- Excluding the bulk exports:
  - The manufacturing sector freight constitutes 56.3% of national tonne-kms and 67.6% in the Western Cape.
  - The agricultural sector freight contributes 19.5% of national GFB tonne-kms and 24.5% in the Western Cape.
- Manufactured goods comprise 48.7% of the Western Cape's GFB tonnes, and only 31.2% of national GFB tonnes.
- The average transport distance of each Western Cape consignment is higher than the national average; this is the highest for any province in South Africa.
- The Western Cape has significant transport and logistics cost challenges and spatial considerations that impact its beneficiation efforts.
- A national rail solution is required to achieve significant rail volumes for Western Cape freight.

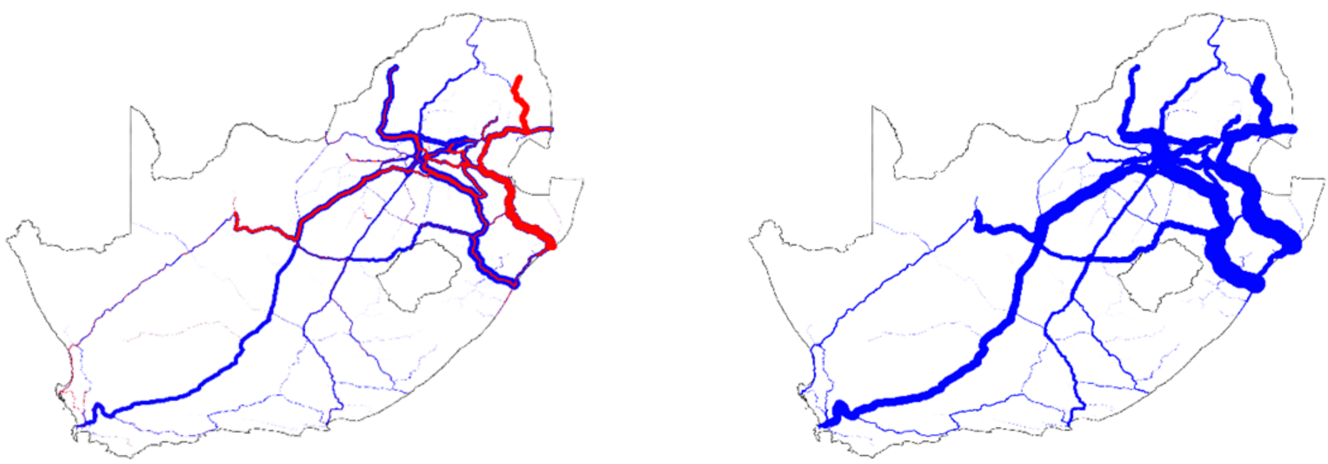


Figure 6: Current GFB rail flows (red) and GFB flows that should be on rail (blue)

---

[7] In practical terms, a tin of preserved food that is moved from the Western Cape to Gauteng has to, for example, compete with locally produced food from Gauteng and Mpumalanga or cheap imports from Durban, all of which are closer.

[8] Havenga, J.H., de Bod, A., Simpson, Z.P., Swarts, S. & Witthöft, I.E. 2021. A proposed freight and passenger road-to-rail strategy for South Africa. [Helsinki]: UNU-WIDER

In this chapter, Western Cape freight is discussed from two perspectives, namely, total freight and general freight business (GFB). GFB is defined as the competitive market space and consists of the total freight tonnes less iron ore exports, manganese exports, pipelines and, for the analysis that follows, stone and aggregate. The latter has been removed from the subsequent GFB analysis because it is typically a very short-distance movement of mostly construction aggregate, which is challenging to quantify and has extremely dispersed transport. Previously iron ore on the export line, that was used for Saldanha Steel was included in GFB. This iron ore however uses the same dedicated line and station infrastructure as the export iron ore and was revised to be non GFB freight, as it was not mode competitive.

Modal split

Total road and rail freight with an origin or destination in the Western Cape in 2020 is shown in Figure 1 and amounted to 134.3m tonnes, representing a decrease of 10.6% from the 150.2m tonnes in 2019. This decrease is largely due to the impact of COVID-19.

The total tonnes per sector for road and rail are given in Figure 2. The waste data[1], consists of municipal waste, garden waste and construction and demolition waste. The largest concentration of waste generation and transportation occurs within the City of Cape Town, which has a substantial impact on local flows.

The GFB tonnes are shown in Figure 3, in which the dominance of manufacturing is evident. The 2020 data shows a decrease in manufacturing and mining activities, and a slight increase in agricultural activities from 2019. The road market share of the GFB market space for 2020 was 98%, marking a 2 percentage point change in the modal split in favour of road which had a 96% modal share in 2019 and 2018.

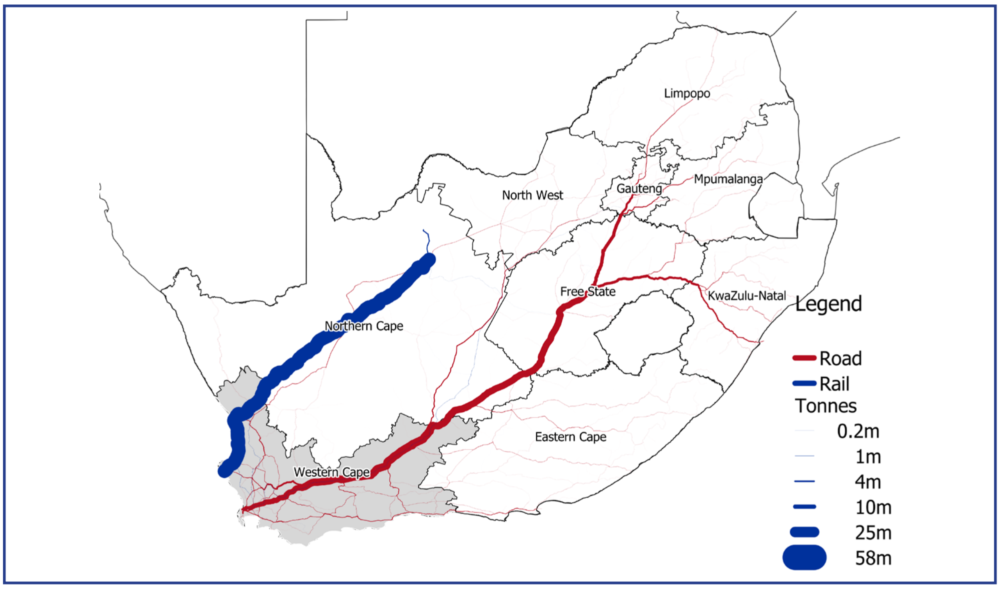


Figure 1: Total freight with an origin or destination in the Western Cape scaled to iron ore export line (2020)

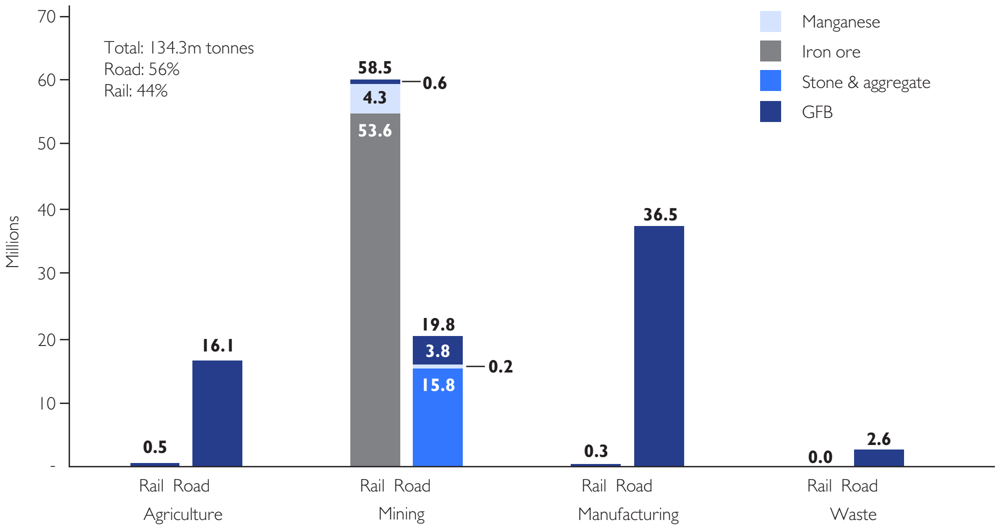


Figure 2: Total road and rail tonnes per sector in the Western Cape (2020)

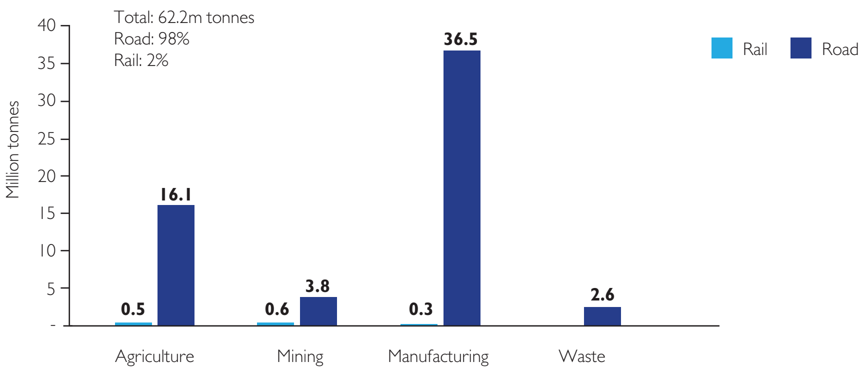


Figure 3: GFB road and rail tonnes per sector (2020)

Figure 4 (same scale as Figure 1) shows GFB rail freight movements that touch the Western Cape.

Rail is mostly used in agriculture and mining, although declining in both sectors, with a decline of 310 730 and 340 387 tonnes respectively from 2019 to 2020. Agricultural dry bulk like wheat, maize and barley are still transported on rail to a limited extent but year-on-year volumes have declined, for instance maize and barley were 249 920 tonnes (46%) and 71 880 tonnes (31%) less respectively. Fruit presents a major opportunity that has not been realised due to the lack of consolidation facilities, rail service levels and capacity. The closure of Saldanha Steel impacted the rail volumes significantly. Apart from coal and iron ore needed for the plant, rail is basically only used at Namakwa Sands (Tronox), a stable half million tonne per annum. Previously rail transported limestone to Saldanha. The decline in steel volumes, due to Saldanha Steel's closure, was exacerbated by the loss of more than 50% of manufacturing commodities other than steel (mostly cement). The contrast with Figure 1 highlights the limited role of rail, once the bulk coal and iron ore have been removed.

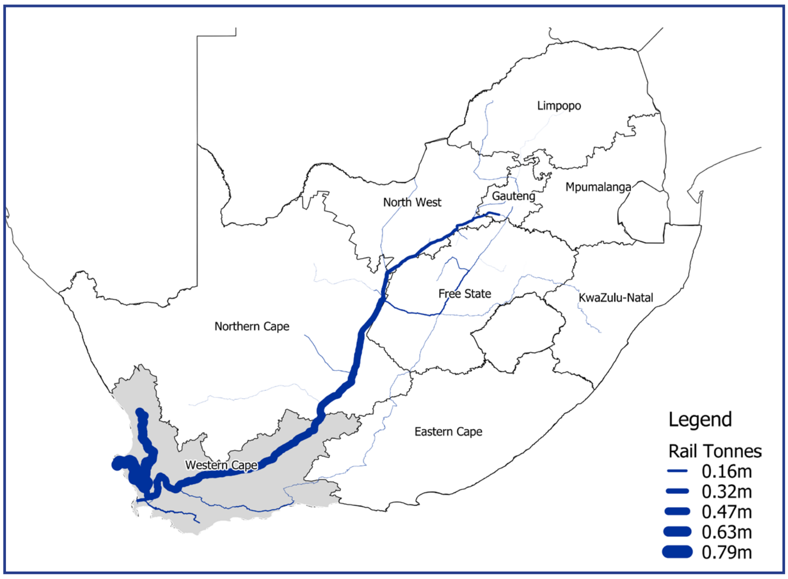


Figure 4: GFB rail freight that touches the Western Cape (2020)

Apart from road and rail freight, there are three movements of commodities in pipelines amounting to 2.1m tonnes. These movements are crude oil from the Port of Saldanha to the Astron Refinery (1.2m tonnes), crude oil from the Port of Mossel Bay to the PetroSA refinery (0.8m tonnes) and gas from the offshore production wells to the Mossgas production patform (0.1m tonnes).

Commodity splits per mode

Freight volumes per commodity per mode for Western Cape-related GFB freight can be seen in Figure 5.

The commodity "Other Agriculture" mostly consists of unmanufactured agricultural animal feed (namely lucerne and hay).

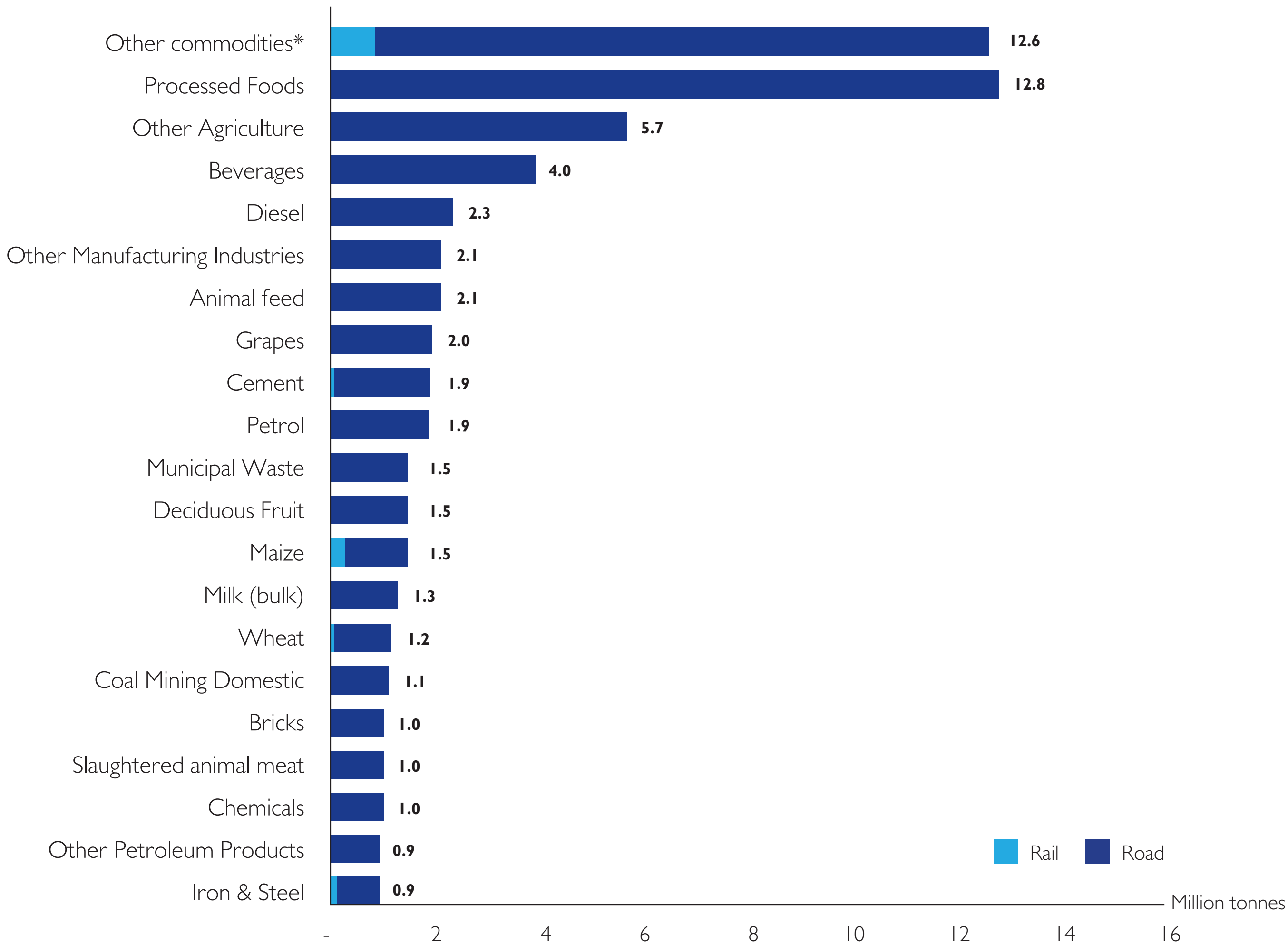


Figure 5: Western Cape related GFB freight volumes per commodity per mode (2020)

* See section 15-1, for detail on "other manufacturing industries" and the grouping "other commodities"

Table 1 provides the Western Cape rail volumes and market share for commodities that have rail market share.

Globally, the largest rail market share has historically been in low value, bulk commodities with large parcel sizes (i.e., consignments). The traditional belief was that these freight categories serve rail economics better; the bulk mining and agricultural commodity market share was usually the highest. However, intermodal traffic, and especially domestic intermodal[2] , has grown faster in most developed countries' railways over the last decade.

Rail has a captive market in bulk mining exports; the current success of their business therefore depends largely on exogenous factors, such as global economic growth, strong commodity prices, and proximity to transport facilities. Globally, rail service providers have realised that the most stable growth opportunity is fast-moving consumer goods (FMCG), which can be palletised, containerised, and moved through a domestic intermodal solution. This should also be the case for South Africa, especially for the Natal and Cape corridors. Rail transportation becomes more efficient than road over long distances, given a sufficient level of density. Therefore, based on the long average distance freight travels on the Cape Corridor[3], it presents the biggest opportunity.

Despite rail tonnes in the Western Cape growing faster than national rail tonnes since 2010, it was not resilient to the drop in rail freight in 2020, as can be seen in Figure 6.

Note that it is mostly inter-provincial freight volumes that are growing, as the tonne-kms have been growing faster than tonnes since 2014. Whereas the national increase in volumes between 2018 and 2019 was driven by the three major export commodities: iron ore, manganese, and coal, these have declined significantly in 2020. Western Cape coal volumes on rail have mostly disappeared.

Table 1: Rail volumes and market share (2019 and 2020)

Commodity on Rail	Rail volumes (thousand tonnes)		Rail market Share	
	2020	2019	2020	2019
Ilmenite (Titanium ore)	363.7	318.2	46%	39%
Maize	288.4	538.3	19%	40%
Barley	161.0	232.9	35%	89%
Iron & Steel	125.8	386.5	14%	26%
Zircon	109.4	120.1	69%	72%
Rutile	68.2	70.3	41%	40%
Cement	64.8	334.2	3%	15%
Wheat	60.6	49.8	5%	5%
Beverages	28,1	43.3	1%	1%
Fertilizer	27.7	44.8	6%	10%
Coal Mining Domestic	25.1	337.9	2%	18%
Chemicals	19,7	5.8	2%	0%
Gypsum	7.9	27.8	7%	18%
Other Manufacturing Industries	6,2	60.0	0%	2%
Granite	4.9	3.5	7%	4%
Diesel	0,9	2.3	0%	0%
Grain Sorghum	0.7	0.4	5%	2%
Limestone	0.6	42.3	0%	5%
Metal products, machinery and electronic equipment	-	1.5	0%	0%

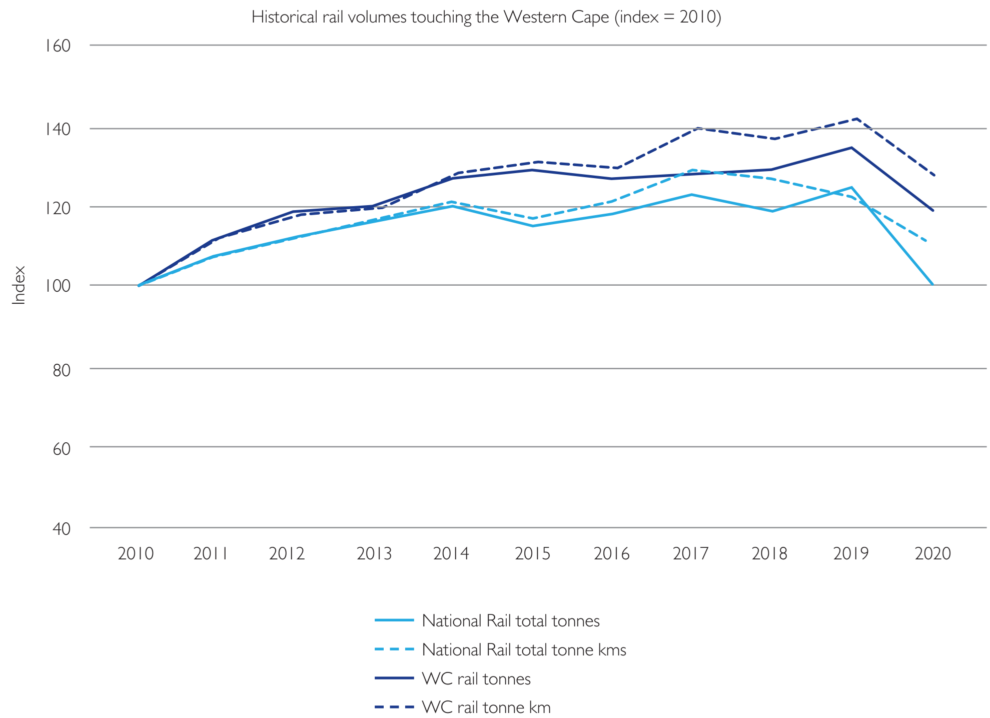


Figure 6: Time series of indexed rail tonnes and tonne-kms from 2010 to 2020 (index = 2010)

From the indexed GFB tonnes (i.e., excluding export iron ore and manganese), it is evident that rail had a further decline in general freight market share (see Figure 7).

In 2015 and 2016, rail lost long- distance volumes, as the tonne-kms increased less than the tonnes for those two years. For the Western Cape, which has the longest average freight travel distance, it would make economic sense to try to increase rail market share on long-distance GFB freight where possible.

The decrease from 2018 continuing to 2020 in the Western Cape's GFB tonnes is attributed to a decrease in market share of iron and steel, domestic coal, gypsum and limestone.

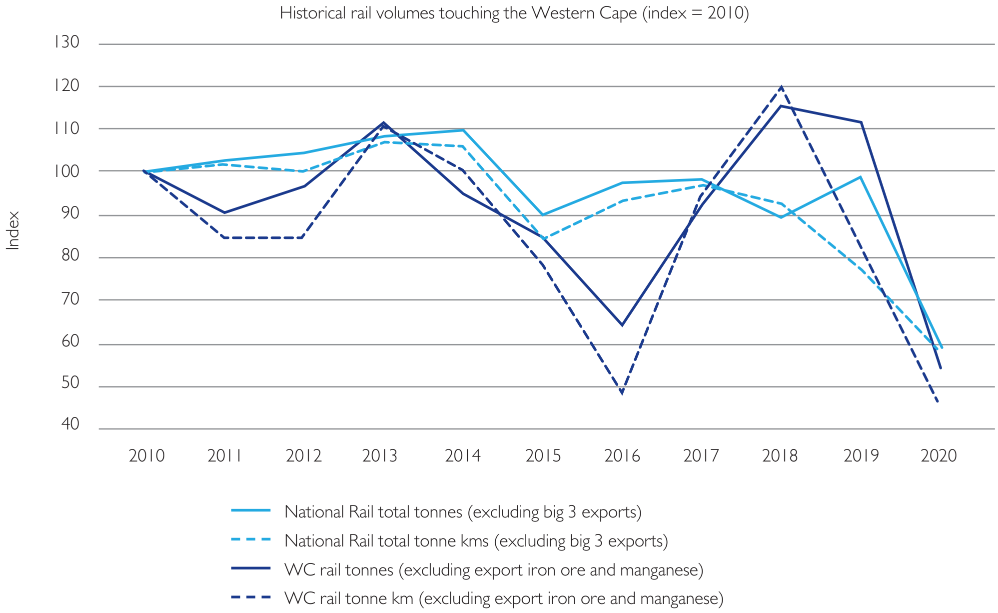


Figure 7: Time series of indexed GFB rail tonnes and tonne-kms from 2010 to 2020 (index = 2010)

Highlights

- Total road and rail freight (2020) with an origin or destination in the Western Cape amounted to 134.3m tonnes, showing a decrease of 10.6% from the 150.2m tonnes in 2019 due to the impact of COVID-19.
- Modal share in the Western Cape is 56% (road), 44% (rail) for total freight and 98% (road), 2% (rail) for GFB freight, marking a 2% change in the modal split of 96% (road) and 4% (rail) in 2019 and 2018.
- The mining sector is dominant due to export iron ore.
- Rail's presence is driven by mining sector (iron ore).
- Rail is used mainly for mining and agricultural commodities – low value, bulk commodities.
- Fruit presents a major opportunity that has not been realised due to the lack of consolidation facilities and service levels.
- The manufacturing sector is dominant in GFB freight volumes but shows a decline from previous years.
- Western Cape opportunities exist for rail on long-distance GFB freight.

[1] Available waste data has been integrated, despite not fully visible in terms of all routing and movements, as well as limited detail on other waste categories such as hazardous waste.

[2] **Intermodal:** Seamless use of more than one transport mode for a single shipment by unitising freight in a large container that can be easily transferred between modes. It differs from multimodal, which means the use of more than one mode in a shipment, in any form.
Domestic intermodal: Intermodal transport within a country, or without crossing a quay wall, i.e. both the origin and destination of the shipment is in the country. Domestic intermodal technologies are, however, possible for land-based transport that crosses land borders, that are common in Europe. It is not so common in Southern Africa, but should develop in future.

[3] The Cape corridor is the main arteries that connect Gauteng and regions close to it with the larger Cape Town region. It consists of four major pieces of infrastructure, i.e. the N1, the alternative N12/N1 connection on road and the rail connections via Bloemfontein and Kimberly.

The 62.2 million tonnes of Western Cape General Freight Business (GFB)[1] freight is split between 21.2 million tonnes intra-Western Cape freight, 23.8 million tonnes transported to other provinces and 17.5 million tonnes received from other provinces.

There was a slight decrease in intra-Western Cape freight of 0.1 million tonnes for 2020 (21.3 million tonnes in 2019). Furthermore, the tonnes transported to and received from other provinces decreased by 1.2 million (25 million tonnes in 2019) and 1 million (18.5 million tonnes in 2019) respectively in 2020. These flows are shown per sector in Figure 1. Waste was modelled as a separate sector to determine its impact on the Western Cape's freight flow economy. Waste is not moved to or from other provinces and, is thus only an intra-provincial flow. At 12% (2.6 million tonnes), it forms a substantial part of intra- provincial tonnes.

In 2020, the Western Cape sent and received 0.2 and 0.4 million tonnes less mining commodities respectively compared to 2019. Similarly, 1.2 and 1.3 million tonnes less manufacturing commodities were sent and received, while agriculture commodities sent and received increased by 0.2 and 0.7 million tonnes respectively. The effect of the COVID-19 lockdown is clearly visible where mining and manufacturing activities were impacted but the Western Cape experienced good crops.

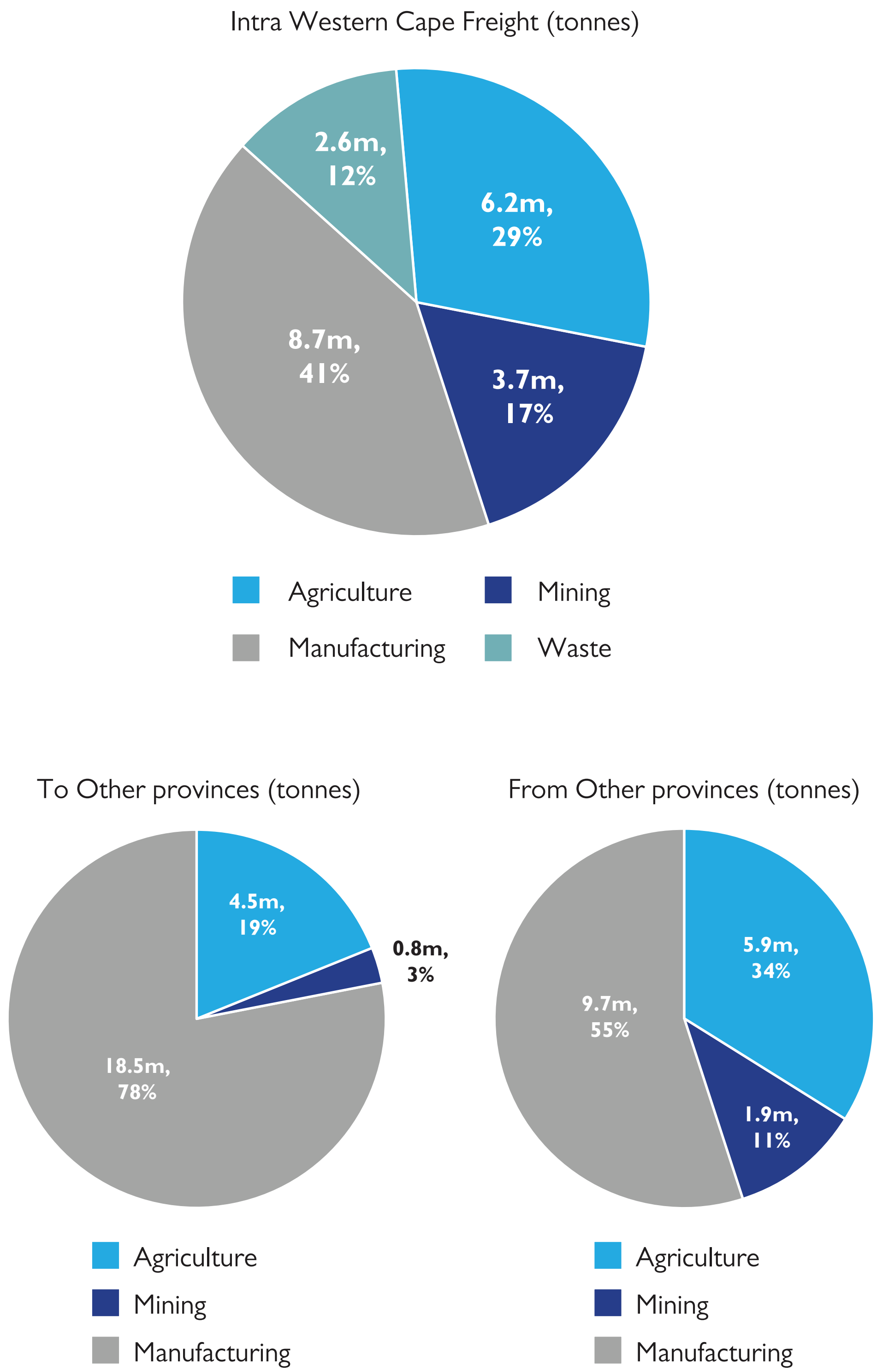


Figure 1: Provincial GFB freight-flows per sector (tonnes 2020)

[1] GFB is defined as the competitive market space, and consists of the total freight tonnes less iron ore exports, manganese exports, pipelines and, for the analysis that follows, stone and aggregate. The latter has been removed from the subsequent GFB analysis because it is typically a very short-distance movement of mostly construction aggregate, which is challenging to quantify and has extremely dispersed transport.

An industry breakdown of the Western Cape manufacturing sector is shown in Figure 2 (i.e., the intra-Western Cape manufacturing freight flow tonnes, as well as the manufacturing tonnes flowing to other provinces, to depict the manufacturing base of the province). Of the 27.2 million manufacturing tonnes that the Western Cape distributes within the province (8.7 million tonnes) and sends to other provinces (18.5 million tonnes), the largest commodity group is processed foods, which contributes 33%, followed by beverages (10%). Provided that there is no structural change to the South African economy, processed foods will continue to be the mainstay of the Western Cape's manufacturing sector.

KwaZulu-Natal again dominates as the Western Cape's main GFB trading partner, followed closely by Gauteng. The Western Cape receives 5 million tonnes (28.6%) of its GFB freight from KwaZulu-Natal and 2.6 million tonnes (14.9%) from Gauteng. Of all the GFB freight originating from the Western Cape, 5.1 million tonnes (21.4%) are destined for Gauteng and 4.3 million tonnes (18.1%) for KwaZulu-Natal, as shown in Figure 3. If it was not for the Port-related trade with KZN, Gauteng would have been the Western Cape's biggest trading partner, because 29% of trade with KZN is related to the Port of Durban.

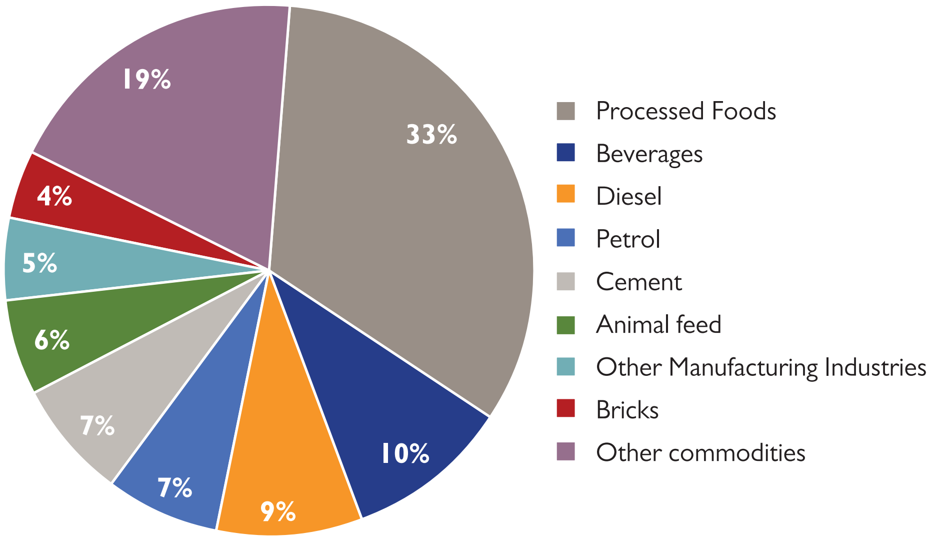


Figure 2: Manufacturing commodities with origin Western Cape (intra-provincial and outgoing, 2020)

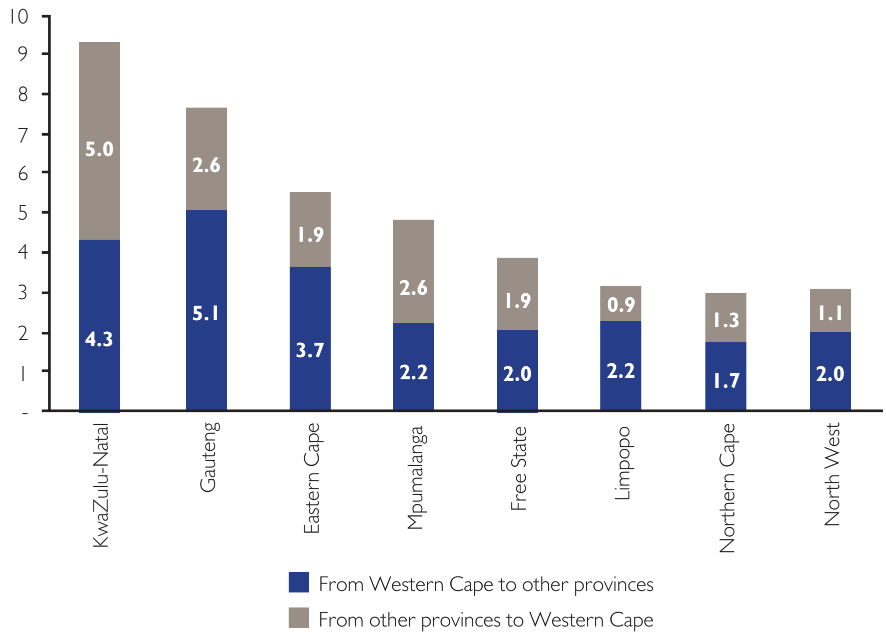


Figure 3: Western Cape inter-provincial GFB freight (2020)

Highlights

- The Western Cape GFB freight (62.2 million tonnes) is split between intra Western Cape freight (21.2 million tonnes), freight transported to other provinces (23.8 million tonnes) and freight received from other provinces (17.5 million tonnes).
- Waste is an intra-provincial flow only and amounts to 2.6 million tonnes (12% of intra- provincial flow).
- Almost half (41%) of intra-Western Cape freight and 78% of freight to other provinces are manufacturing commodities, amounting to 27.2 million tonnes.
- The largest commodity group in the Western Cape's manufacturing sector, is processed foods (33%), followed by beverages (10%).
- The effect of the COVID-19 lockdown is visible where mining and manufacturing activities were impacted, but the Western Cape experience good crops.
- KwaZulu-Natal is the Western Cape's main GFB trading partner, followed closely by Gauteng. If it was not for the Port related trade, Gauteng would have been the Western Cape's biggest trading partner, because 29% of trade with KZN is related to the Port of Durban.

Western Cape Freight Demand Model (WC FDM™)
Corridors

In order to determine corridor freight for the N1, N2 and N7, the magisterial districts of South Africa are divided into five (5) zones, of which the first four are illustrated in Figure 1:

1. N1 Corridor;
2. N2 Corridor;
3. N7 Corridor;
4. Core Western Cape (districts within which freight movements are not considered to be on any of the national corridors); and
5. Metropolitan (a combination of the Cape Town Metropolitan area and its peripheral areas).

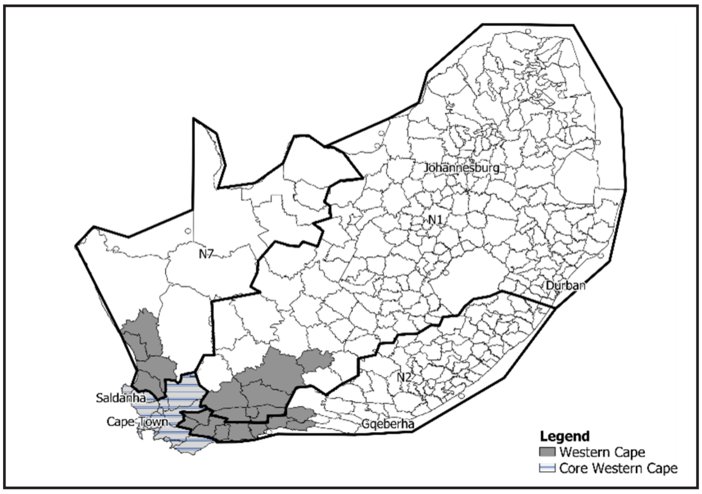


Figure 1: Corridor definitions for Western Cape freight

As shown in Figure 2, freight in the Core Western Cape zone is further sub-divided into Cape Town Metropolitan freight.

The Cape Town Metropolitan (Zone 5) freight is defined as freight that has its origin and destination inside the metropolitan areas.

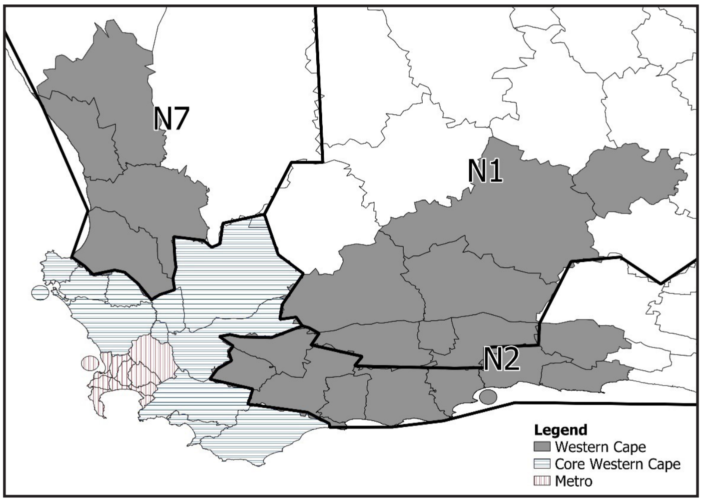


Figure 2: OD pairs for Cape Town Metropolitan freight

The Origin-Destination (OD) pairs are clustered into corridors by applying the following rules:

Cluster rules

- If the origin and destination are both within either the N1, N2 or N7 zones, the OD pair is assigned to that corridor.
- If the origin and destination are within different corridor zones, the OD pair is not assigned to a corridor.
- If the origin and destination are both within the core Western Cape zone, the OD pair is not assigned to a corridor.
- If either the origin or destination is within the core Western Cape zone, the OD pair is assigned to the corridor zone in which the non-core Western Cape origin or destination is.

Table 1 provides the volumes and percentage split of the General Freight Business (GFB)[1] road and rail freight per zone.

Table 1: GFB road and rail freight (tonnes) per zone (2020)

Zonal Grouping	Road tonnes (million) (% of zone freight)	Rail tonnes (million) (% of zone freight)	Total (million)
N1 Corridor traffic	27.9 (98.5%)	0.42 (1.5%)	28,3
N2 Corridor traffic	7.6 (99.6%)	0.03 (0.4%)	7,7
N7 Corridor traffic	3.2 (85.1%)	0.57 (14.9%)	3,8
Metropolitan traffic	6.7 (99.7%)	0.02 (0.3%)	6,7
Core Western Cape	5.4 (95.3%)	0.26 (4.7%)	5,7
Non-corridor traffic	8 (99.3%)	0.06 (0.7%)	8,1
Total	**59 (97.7%)**	**1.36 (2.3%)**	**60,3**

The 3.8 million tonnes of N7 corridor freight include what is deemed "ring-fenced" freight, that is, freight that is usually part of a specific ring-fenced system that is not impacted by provincial-level strategic interventions. In the Western Cape's case, the majority of the GFB rail freight on the N7 is transported on the Iron Ore Export Line. Even though the export line follows the N7 corridor quite closely, it cannot really be regarded as GFB for which road can compete. More than half of the freight on the N1 corridor is food commodities.

[1] GFB is defined as the competitive market space, and consists of the total freight tonnes less iron ore exports, manganese exports, pipelines and, for the analysis that follows, stone and aggregate. The latter has been removed from the subsequent GFB analysis because it is typically a very short-distance movement of mostly construction aggregate, which is challenging to quantify and has extremely dispersed transport.

The ring-fenced freight has been removed from Table 2. The very low contribution of rail to N1 corridor freight, which is a very long corridor, is an issue of great concern that needs to be resolved.

Table 2: GFB (excluding domestic iron ore and coal) road and rail freight (tonnes) per zone (2020)

Zonal Grouping	Road tonnes (million) (% of zone freight)	Rail tonnes (million) (% of zone freight)	Total (million)
N1 Corridor traffic	27.3 (98.5%)	0.42 (1.5%)	27,7
N2 Corridor traffic	7.6 (99.6%)	0.03 (0.4%)	7,7
N7 Corridor traffic	3.2 (85.1%)	0.56 (14.9%)	3,8
Metropolitan traffic	6.7 (99.7%)	0.02 (0.3%)	6,7
Core Western Cape	5.4 (95.3%)	0.26 (4.7%)	5,6
Non-corridor traffic	7.7 (99.5%)	0.04 (0.5%)	7,7
Total	**57.9 (97.7%)**	**1.34 (2.3%)**	**59,2**

Table 3 shows the tonne-km per zone.

Table 3: GFB (excluding domestic iron ore and coal) road and rail freight (tonne-km) per zone (2020)

Zonal Grouping	Road tonne-kms (billion) (% of zone freight)	Rail tonne-kms (billion) (% of zone freight)	Total tonne-kms (billion)
N1 Corridor traffic	38.7 (98.6%)	0.6 (1.4%)	39,3
N2 Corridor traffic	5 (99.7%)	0.01 (0.3%)	5
N7 Corridor traffic	1.2 (81.8%)	0.3 (18.2%)	1,4
Metropolitan traffic	0.2 (99.3%)	0.001 (0.7%)	0,2
Core Western Cape	0.4 (94.7%)	0.03 (5.3%)	0,5
Non-corridor traffic	9.3 (99.1%)	0.1 (0.9%)	9,4
Total	**54.9 (98.3%)**	**0.9 (1.7%)**	**55,8**

The tonne-km view confirms a slightly smaller rail market share, indicating that longer distance freight is transported by road. This means that a long-distance market exists that can potentially benefit from rail's economies of scale, given that rail operators can provide a competitive service.

Table 4 shows the breakdown of road freight per corridor. Note that 47.1% of Western Cape road freight travels on the N1 road corridor, with an average distance travelled of 1 383 km, representing a 1.3% increase from 2019.

Table 4: Freight intensity per zone (2020)

Zonal Grouping	Road tonnes (million)	Percentage of total traffic
N1 Corridor traffic	27.3	47.1%
N2 Corridor traffic	7.6	13.2%
N7 Corridor traffic	3.2	5.5%
Metropolitan traffic	6.7	11.6%
Core Western Cape	5.4	9.3%
Non-corridor traffic	7.7	13.3%
Total	**57.9**	**100.0%**

Highlights

- Rail has a 2.3% tonnage market share of non- ring-fenced total Western Cape road and rail freight. In terms of tonne-kilometres, this is a decrease from 2% in 2019 to 1.7% in 2020.
- Corridor freight is dominated by road, with:
  98.5% market share on the N1 corridor;
  99.6% market share on the N2 corridor and
  85.1% market share on the N7 corridor.
- The average travel distance of freight on the N1, N2 and N7 corridor is 1 420 km, 606 km and 369 km, respectively.
- More than half of N1 corridor freight is food commodities.
- Modal shift opportunities exist for long- distance road freight in the Western Cape.

Background to the segmentation of freight flows based on economic structure

The segmentation definitions are illustrated in Figure 1. A pit refers to a source where raw materials are extracted from the earth. Ore from the pit can be transported to a bulk terminal, port or directly to a plant for beneficiation. Beneficiated ore can be transported to another plant (intermediate demand), directly to metropolitan or rural areas, to distribution centres (DC) for consolidation before it is transported to a metropolitan or rural area, or it can be exported.

Based on this view of freight flow segmentation, class 1 (T1) represents freight flow from a pit to a bulk port (exports) and from a bulk port to a plant (imports). T2 refers to direct flows from pit to plant. T3 are flows from one plant to another for beneficiation, to a distribution centre for final consumption, or between plants and MPTs for exports and imports. T4 represents commodity flows between distribution centres (typically over long distances between metropolitan areas) for final domestic consumption, or between DCs and port container terminals for exports and imports. T5 represents all flows to and from rural areas; T5a flows originate at a rural tank or silo, while T5b are all flows destined for a rural distribution centre.

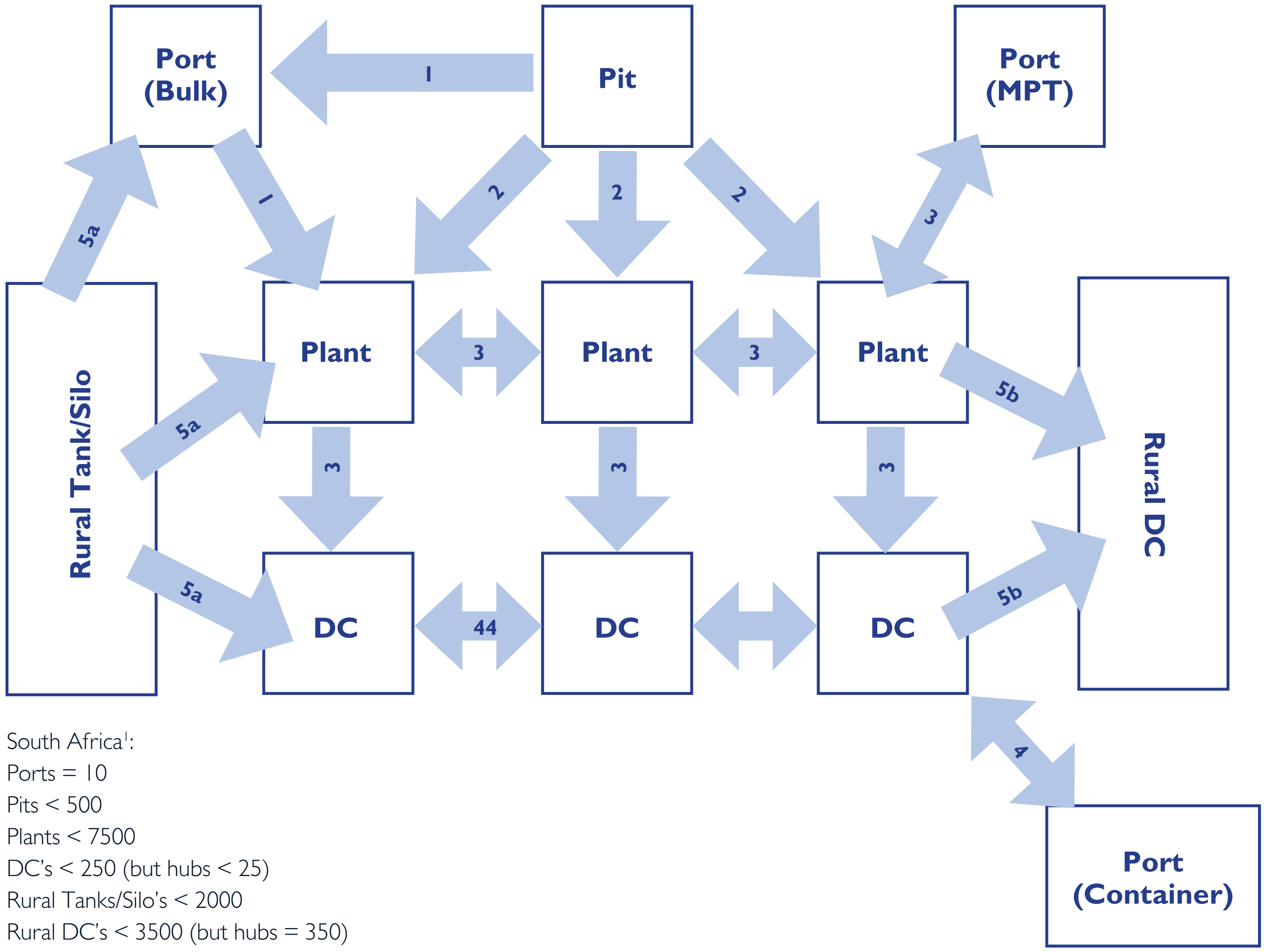


Figure 1: The different typologies of freight flows[2]

As depicted in Figure 2, these segments can be summarised in terms of extraction, intermediate manufacturing, final manufacturing and consumption, and can be divided into imports, domestic flows, and exports. The transportation of domestic consumer goods from points of final manufacturing to points of consumption account for 35% of the Western Cape's total transportation cost. Eighty-four percent of the 18% of extraction to exports refers to the handling of iron ore and manganese exports in Saldanha. Beneficiation thereof

[1] Indication of the number of nodes, terminals and distribution centres in South Africa.

represents a significant growth opportunity, changing the Western Cape's status from a "handler" of cargo to an industrial centre. If not for these minerals, the province's beneficiated exports and long-distance imports of final products would exceed the national average, indicating a pressing need to solve the cost concerns of this freight flow segment.

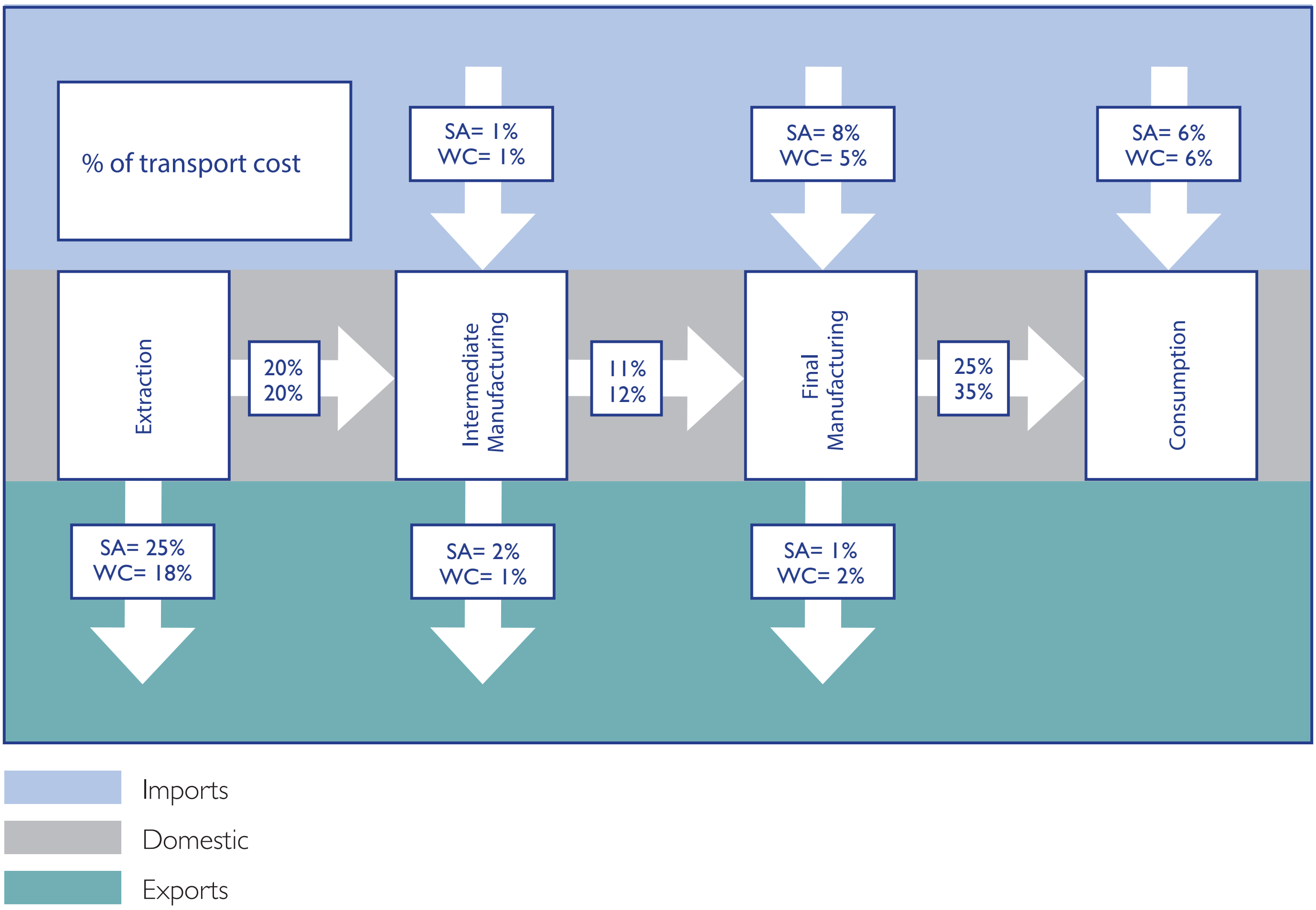


Figure 2: National and Western Cape transport cost per freight flow segment (2020)[2]

Western Cape freight flows informed by economic structure

An analysis of the 2020 modal split in tonnes for General Freight Business (GFB)[3] in the Western Cape confirms that the province transports relatively more manufactured goods, over long distances on road (refer Figure 3). The data highlights two specific opportunities for rail. The "siding-to-siding" market defines long distance freight that is usually moved from large manufacturing plants to other plants for further beneficiation. In these cases, dedicated sidings are usually the best rail solution. Rail sidings are in place in South Africa, but many have fallen into disuse and have large maintenance backlogs. The revival of branch lines is on Transnet's strategic agenda, but progress is slow[4].

The other opportunity is palletisable and containerisable fast-moving consumer goods (FMCG) freight. This freight can be transported from private distribution centres through public intermodal terminals. This domestic intermodal opportunity is still absent in South Africa's rail/road service offering, due to management and resource challenges within Transnet, as well as caution from road hauliers owing to the impact on their traditional business models. The inability of the railway to develop these solutions collaboratively with road to capture long-distance FMCG freight is hampering the competitiveness of the Western Cape's industries owing to the impact on transport costs. The modal shift scenarios identify cost savings, should rail be able to realise these opportunities (see section on "Scenario 1: Modal Shift").

Whereas rail market share declined, positive developments include some indications that the railway would be willing to either cooperate with LSP's to develop solutions or allow private sector participation in its activities. Provincial and local government also wants to get involved by developing terminal and consolidation centres. These developments might create a conducive environment for palletisable freight modal shift.

---

[2] Havenga, J.H. (2012), "Rail renaissance based on strategic market segmentation principles", Southern African Business Review, Vol. 16 No. 1, pp. 1-21.

[3] GFB is defined as the competitive market space, and consists of the total freight tonnes less iron ore export line, manganese exports, pipelines and, for the analysis that follows, stone and aggregate. The latter has been removed from the subsequent GFB analysis because it is typically a very short-distance movement of mostly construction aggregate, which is challenging to quantify and has extremely dispersed transport.

[4] Transnet's branch lines are reported to comprise approximately 35% (3 928km) of its 20 911 route km network. Only 54% of these branch lines are reported to be active. Transnet. (2020), 'Freight Rail 2020', available at: https://www.transnet.net/InvestorRelations/AR2020/Freight%20Rail.pdf (accessed 30 April 2021).

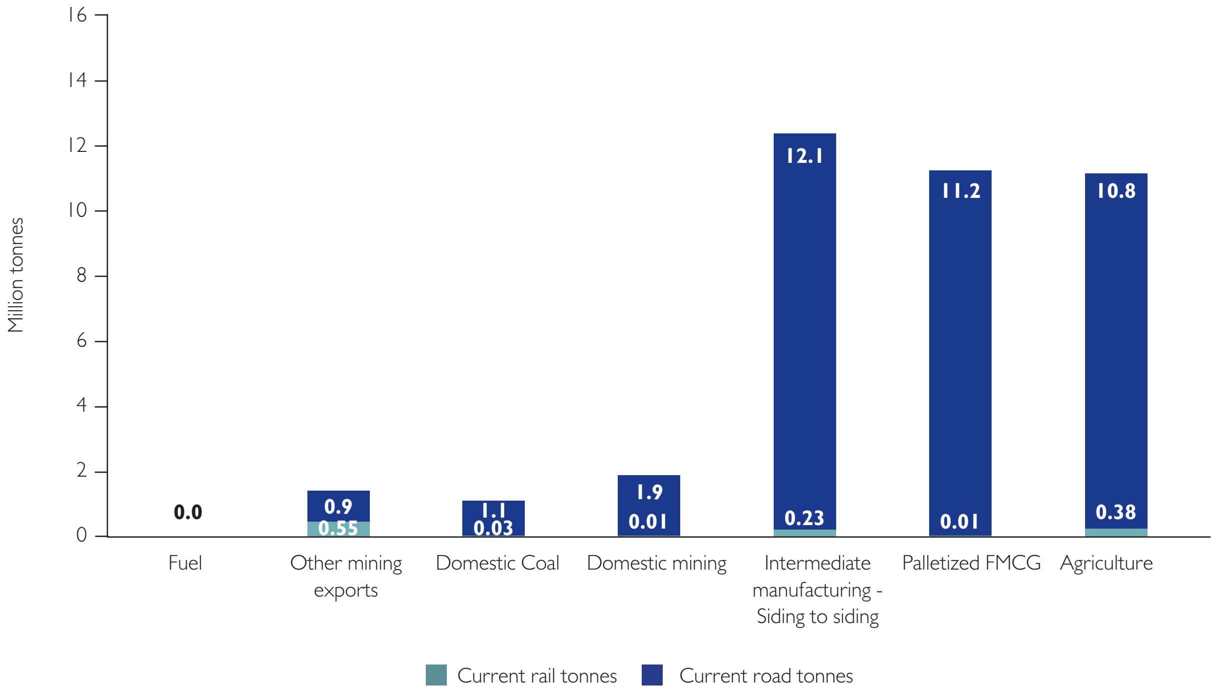


Figure 3: GFB road and rail tonnes per market segment in the Western Cape for 2020

Highlights

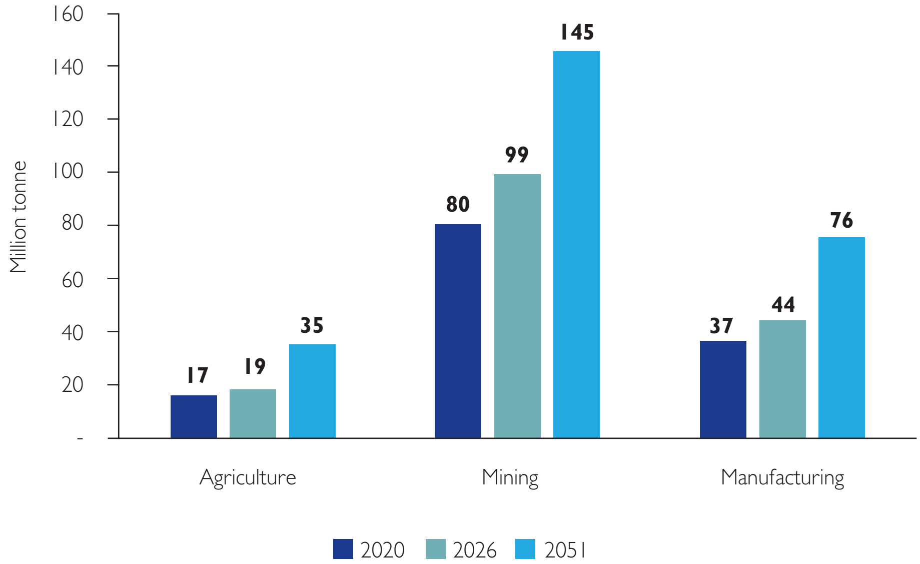
- Manufactured goods, transported over long distances on road, constitute a large volume of the Western Cape GFB freight.
- This presents two opportunities for rail:
  1. Siding-to-siding freight, that is, long-distance freight that is usually moved from large manufacturing plants to other plants for further beneficiation; and
  2. FMCG palletisable and containerisable freight, which can be transported through domestic intermodal solutions from private distribution centres through public intermodal terminals.
- The inability of the railway to develop these solutions collaboratively with road to capture the long-distance FMCG freight impacts transport costs, and hence hampers the competitiveness of industries in the Western Cape.
- There are positive indications of private sector, provincial and local government cooperation with Transnet to participate and develop terminal and consolidation centres. These developments might create a conducive environment for palletisable freight modal shift.

Economic forecast[1]

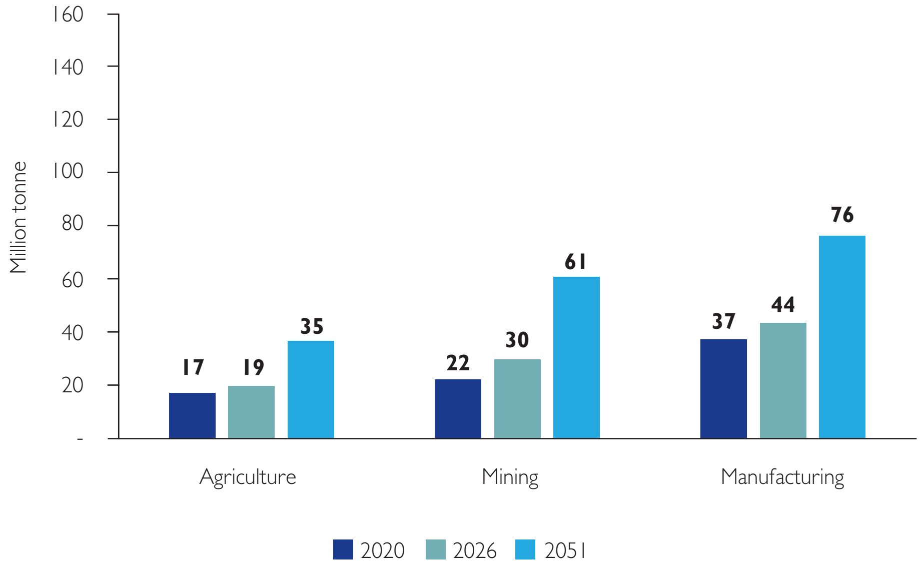
The WC FDM™ considered 2026 and 2051 as the forecast years in the analysis. The total tonnes forecast per sector for 2026 and 2051 are given in Figure 1, both (a) with and (b) without the iron ore and manganese exports.

This latest long-term economic forecast includes the impact of COVID-19 and results in a more pessimistic view of manufacturing in the long term. Social and economic factors are also believed to be more challenging than before due to the longer-term impact of COVID-19.

[1] The forecasting work took place during COVID-19 and therefore includes the impact of COVID-19 on the economy in the WC FDM™.



(a) Total Western Cape



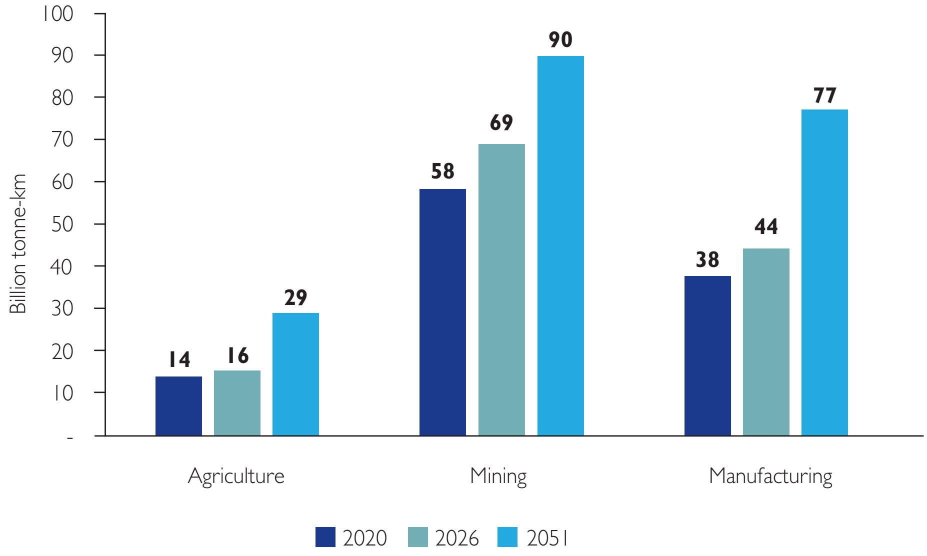
(b) Excluding export iron ore and manganese

Figure 1: Total Western Cape freight flow forecast per sector (tonnes 2020)

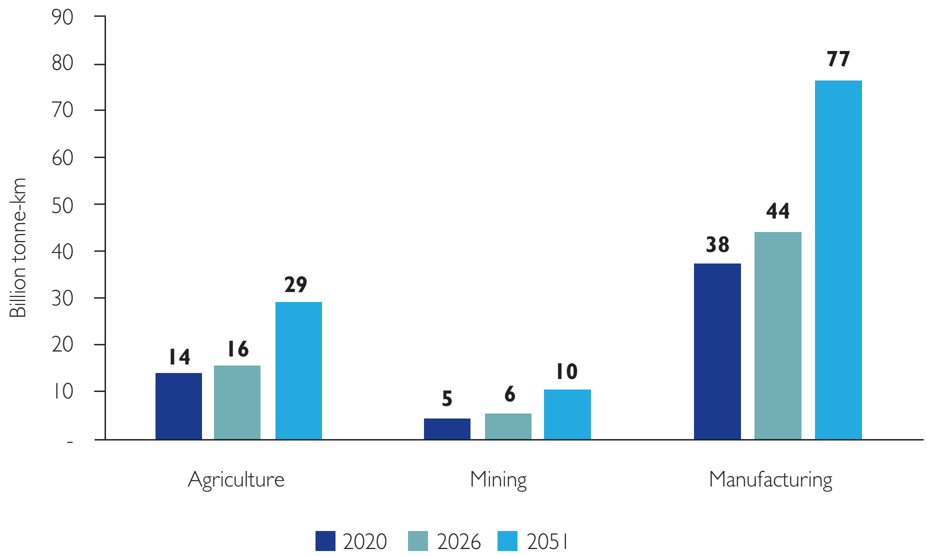
The forecast for mining, when considering GFB, is predominantly driven by sand mining on the West Coast, which is very short-haul and specific. This is evident from Figure 2, which shows the forecasted Western Cape freight flow tonne-kms by sector both (a) with and (b) without the iron ore and manganese exports. Evidently, manufacturing tonne-kms currently far exceed the mining tonne-kms when the export lines are excluded.

As evidenced by Figure 2, manufacturing commodities for the Western Cape are transported over long distances. The forecast also illustrates that there is a ceiling on the export lines[2]. This highlights a systemic problem with the long-term sustainability of the railway lines: their profitability depends on the global demand for South African minerals, despite their high economies of scale. The investment into the export lines was necessary, for both medium-term rail growth and the South African economy; however, it is not a long-term sustainable strategy, for either the railway or South Africa. The economic forecast suggests that the long-term strategy for the Western Cape should focus on developing and supporting efficient logistics solutions to support the growing manufacturing and agriculture sectors, which supply freight to the rest of the country over long distances.

[2] Anglo American, estimated a 14-year reserve life for Sishen in its 2018 global reserves report (Anglo American, 2018).



(a) Total Western Cape



(b) Excluding export iron ore and manganese

Figure 2: Total Western Cape freight flow forecast per sector (tonne-km 2020)

Highlights

- Iron ore and manganese exports constitute the majority of the Western Cape's mining sector freight intensity.
- Manufacturing and agricultural commodities from the Western Cape are transported over significantly longer distances than the mining commodities.
- The manufacturing sector is forecast to generate the largest logistics demand in the absence of the ring-fenced export lines.
- The economic forecast suggests the development of infrastructure that will support the growing manufacturing and agriculture sectors.

Freight transport cost

The freight transport cost model forms part of the national logistics cost model, which was developed by the research team to quantify the direct[1] national logistics costs. The freight transport costs are available on a district-to-district basis per commodity, and can be used to measure the impact of modal changes; they therefore indicate what the impact of certain macro-economic infrastructure-related decisions would be on the economy[2]. For the refinement of the WCFDM, actual road freight transport rates were confidentially received from Logistics Service Providers (LSP) and used to refine the fixed and variable road freight transport cost elements.

The different road transport cost elements are determined by vehicle type which, in turn, is determined by commodity type, typology, and route of travel. A commodity's "preferred" vehicle type will change as each of these variables changes. Once the vehicle type and volume are assumed, the cost elements can be assigned. The approach is based on the core freight transport cost drivers, namely, weight and distance travelled. Each movement can also be attributed to one of 41 possible vehicle combinations, based on the commodity's destination and distance travelled. A separate rate per tonne-kilometre for each of the 41 vehicle types is applied. Other costs that are determined by the typology, such as fuel costs and toll fees, are defined and calculated separately.

Average annual distances and working days are applied to the various combinations, based on current practice, including waiting time for loading and unloading or any other relevant factors. As examples, the sources of information include logistics and supply chain service providers, FMCG manufacturers, retail groups, agricultural food producers, processors, timber plantations, the furniture industry, car carriers, the construction industry, mining (for transport of mined commodities, but excluding transport for mining activities). Payloads for each category are based on transport regulations. Where return loads are not possible or practical, the load factor is set at 50% (e.g., raw milk and liquid petroleum). In other cases, inputs from transporters and suppliers provide an acceptable average load factor. Emerging changes, such as making use of larger pallet footprints in secondary distribution, are taken into account. Few transporters and fleet owners can actually afford to operate without a return leg, which means that load factors increase with distance where commodities and return volumes (as determined in the FDM) allow.

Within these cost measurement combinations, different cost drivers exist for fuel, wages, repairs and maintenance, depreciation, capital cost, insurance, tyres, tolls roads and licence fees.

It is necessary to distinguish between **costs** and **tariffs**.

> **Costs** refer to the actual costs that are directly incurred by the freight movement. That will be the total cost for in-house transport as well as outsourced transport. In the case of outsourced transport, a margin is added to the cost, in order to charge a tariff.
>
> **Tariffs** reflect both the margins and strategic pricing decisions of a transport company, in addition to cost recovery. A transport company, for example, could decide to fund return legs by only recovering variable cost, thus transporting freight below total cost. For the purposes of informing policy and investment decision-making, actual costs are used in modelling national and provincial logistics costs; the impact of margins and of strategic decision-making on costs can then be modelled in scenarios.

Road costs and rail tariffs are typically used (refer Table 1).

Table 1: Overview of underlying aspects of costs and tariffs for road and rail transport:

	Road	Rail
Costs	Can be calculated with a fixed and publicly available schedule[3]. The freight owner incurs road cost by utilising in-house road transport.	Estimated using a well-researched algorithm. (Even the railway service providers find it difficult to apply activity-based rail costing. This is a global phenomenon, due to the very high fixed cost nature of rail business). In-house rail transport is not possible.
Tariffs	Estimated through fieldwork and interviews in order to add margins to costs. The freight owner incurs road tariffs by outsourcing road transport.	Precisely available for all consignments in South Africa, but confidential at the detail level. The freight owner incurs rail tariffs by utilising Transnet.

[1] Direct costs are internal, monetised costs of inputs and labour that are used in the provision of freight transport. These differ from externality costs that affect third parties who may not be direct users of freight transport services.

[2] For further detail on the methodology and macroeconomic application, refer to: Havenga, J.H. (2010), 'Logistics costs in South Africa: The case for macro-economic measurement', South African Journal of Economics, Vol. 78 No. 4, pp. 460-478.

[3] Data from the Road Freight Association provides detailed fixed and variable cost drivers for the different vehicle classes used in the WC FDM™.

Rail tariffs are used due to the complexity of calculating actual rail costs. Furthermore, freight owners cannot incur actual rail costs since freight rail transport cannot be provided "in-house" (Freight owners in South Africa do not own their own railway). Actual rail tariffs are confidential and cannot be disclosed, but were used in an aggregated way. In cases where rail costs are required for scenario analysis, costs are estimated based on an algorithm developed in conjunction with Transnet[4]. Road cost and tariffs are both possible for freight owners as only about 51% of freight transport in South Africa is outsourced. Where freight transport is provided in-house, the actual cost is all that is incurred by the freight owner. Where it is outsourced, the tariff incurred is made up of the transport supplier's cost and mark-up. For the purposes of comparison, an 8%[5] profit margin was assumed for road transport costs in 2020 (see Figure 2). One of the major drivers of efficiency in road freight is outsourcing, which also contributes to South Africa being more efficient than BRICS partners in comparisons such as the World Bank Group's Logistics Performance Index (LPI). This figure unfortunately does not seem to improve significantly over time.

The drivers for road freight transport costs are described in Table 2.

Table 2: Cost drivers for road freight transport for 2020

Cost driver	Description
Fuel	The price of fuel is based on the weighted average annual price for 2020, taking cognisance of the different inland and coastal prices, for 500 parts per million (ppm) diesel. Bulk rebates are ignored.
Driver's wage	Driver and assistant wages vary considerably across the country based on vehicle size, primary and secondary distribution tasks, region, operators, and the structure of remuneration packages. All assumptions, in line with wage agreements between the Road Freight Employers' Association and the National Bargaining Council for the Road Freight and Logistics Industry, include an allowance for company contributions, but exclude overtime and bonuses.
Repairs and maintenance	The assumed cost of maintenance is based on current vehicle manufacturer maintenance contract rates, expected economic component life and industry experience. The assumptions consider the complexity of each task, including typical operating conditions such as roads, topography, and traffic density. Repair and maintenance costs for refrigeration operations are calculated in hours.
Depreciation	An annual depreciation percentage is considered per vehicle combination, as well as a residual value per vehicle.
Cost of capital	All estimates are based on a cost estimate for new vehicles and trailing equipment. The initial cost of vehicles, trailers, bodies, and auxiliary equipment (such as refrigeration units) is based on the average of published selling prices of such items in the modelled year in question, less known fleet discounts.
Insurance	Insurance cost assumes that the operator has a low risk rating. Premiums are currently set at 7% of the purchase price for vehicles, equipment, and trailers.
Tyres	Tyre life is based on the typical casing life that is obtained in the various operations.
Toll roads	Assumed route-incurred toll fees are applied proportionally to the number of trips that each movement accounts for, according to the size structure of the vehicle used for its toll fee class.
Vehicle licences	Licence fees for vehicles and trailers are based on the average license fees of each province, as the licensing province of trucks is unknown, and nationally distributed[6].

[4] Note that actual rail costs at a consignment level are very difficult to calculate, even for the railways.

[5] This is based on confidential interviews.

[6] This average assumption is deemed sufficient, given the current status of road freight user-pay charges.

In 2020, road freight transport accounted for 83% of the total estimated freight transportation cost. The main cost drivers were fuel (R15.7 billion; 30.1% of total cost), maintenance and repairs (R8 billion), and driver wages (R6.4 billion)[7]. These costs are shown in Figure 1 and Table 3. Fuel cost declined by 25% against 2019, driven by lower activity but also a lower fuel price. The possibility that this figure could nearly double in the short term is high given a growth in demand and supply challenges. Demand growth is caused by increased economic activity and supply challenges occur when fuel production is challenged by events such as wars and conflict.

Figure 2 outlines the cents per tonne-km (c/tonne-km) for road and rail. The impact of the export lines on rail rates is evident. Given rail's high fixed cost, higher density means that the mode's c/tonne-km cost will decrease with each additional tonne-km of activity over the same track length. With its current low market share, the South African freight railway's challenge is that it needs a substantial modal shift from road to realise these density benefits (see section 10 on externality costs).

[7] The model, as was stated, includes actual rail and pipeline tariffs (pipeline tariffs are not shown on the graph, as they are negligible — only 0.02% of total transport costs in the Western Cape).

Highlights

- In 2020, road freight transport accounted for 83% of the total transportation cost.
- The main road freight transport cost drivers were fuel (R15.7 billion; 30.1% of total cost), maintenance and repairs (R8 billion) and driver wages (R6.4 billion).
- With its current low market share, the South African freight railway's challenge is that it needs a substantial modal shift from road to realise density benefits.

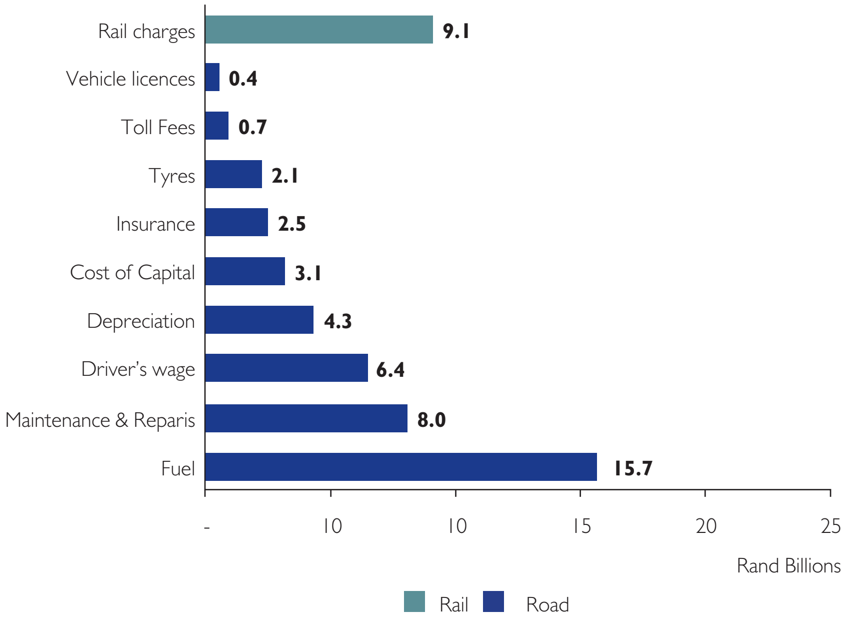


Figure 1: Transport cost components per mode for Western Cape freight (2020)

Table 3: Transport cost drivers

Cost driver	Cost (R bn)	% of total
Fuel	15.7	30.1%
Maintenance and Repairs	8.0	15.3%
Driver's wage	6.4	12.1%
Depreciation	4.3	8.2%
Cost of Capital	3.1	5.9%
Insurance	2.5	4.7%
Tyres	2.1	4.1%
Toll Fees	0.7	1.4%
Vehicle licences	0.4	0.8%
Rail charges	9.1	17.4%
Total	**52.3**	

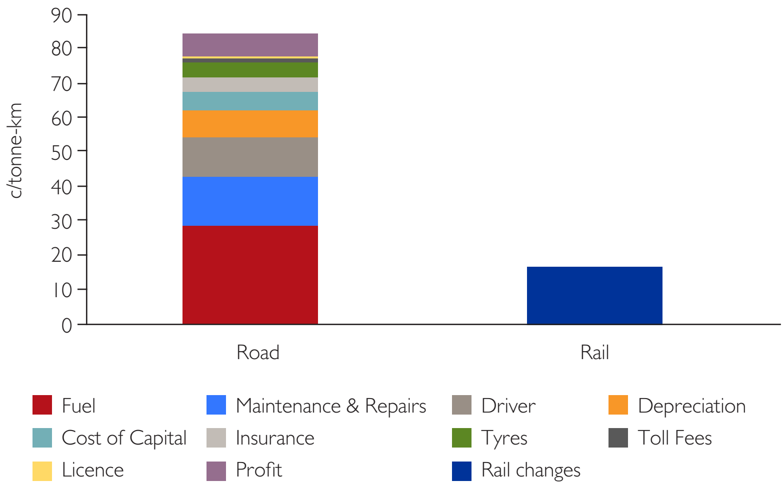


Figure 2: Transport cost in c/tonne-km per mode for Western Cape freight (2020)

Externality cost

The total estimated CO_2 emissions for South Africa are 428 million tonnes[1], of which approximately 26 million tonnes are for freight. In order to have a holistic view of transportation cost, externalities such as emissions need to be taken into account. The externality components are the costs associated with accidents, congestion, emission, land use, noise and policing. These components are calculated as a relative cost per tonne-km per mode and can be applied to any subset of freight movements, such as the Western Cape. South Africa has an established national externality cost model[2] that can be used to estimate these costs. The rates are summarised in Table 1 and are based on the latest available 2017 values.

Table 1: National externality cost rates per component, 2017 (cent per tonne-km)

	Road	Rail
Accidents	4.79	0.41
Congestion	2.95	
Emissions	8.97	1.21
Landway	0.87	0.08
Noise	3.24	0.03
Policing	2.29	

Emissions costs include not only CO_2 gasses, but all emissions that are produced by burning fuel. The emissions produced per litre of burnt diesel are given in Table 2.

Considering the average fuel usage per tonne-km of all freight vehicles, the resultant emissions in grams per tonne-km are given in Table 3, which can be used to compare emissions per modes.

Table 2: Grams produced per litre and estimated costs, per component of emissions

Acronyms[3]	NO_x	PM metro	PM rural*	HC	CO	CO_2**	SO_2
Grams produced, per litre of fuel burnt	26.5	1.19	1.19	0.70	4.00	2 688	12.56
Assumed cost per ton, based on international perceived values (Rand)	27 721	612 906	180 525	8 113	8 113	334	54 090

Table 3: Grams of emissions produced per mode per tonne-km

	NO_x	PM metro	PM rural*	HC	CO	CO_2**	SO_2
Road tonne-km	0.71	0.03	0.03	0.02	0.11	72.41	0.34
Rail tonne-km (electric)						28.34	
Rail tonne-km (diesel)	0.42	0.02	0.02	0.01	0.06	42.96	0.2
Rail tonne-km (weighted average of electric and diesel)	0.04	0.002	0.002	0.001	0.005	29.58	0.02

** While particulate matter (PM) is produced equally in metropolitan and rural areas per litre of fuel burnt, its perceived cost is higher in more densely populated areas*

*** To calculate the cost of CO^2 emissions for South Africa, a cost of R225 per tonne of CO^2 is assumed for 2010, in line with the proposals of the South African National Treasury (2010) and McCarl and Sands (2007)*

---

[1] https://www.iea.org/data-andstatistics/?country=SOUTHAFRIC&fuel=CO2%20emissions&indicator=Total%20CO2%20emissions

[2] For a detailed methodology of the externality costs model, refer:

Swarts, S., King, D., Simpson, Z., Havenga, J., and Goedhals-Gerber, L. (2012), 'Calculation of freight externality costs for South Africa, *Journal of Transport and Supply Chain Management*, Vol. 4 No. 1 and

Havenga, J.H. (2015), 'Macro-logistics and externality cost trends in South Africa – Underscoring the sustainability imperative', *International Journal of Logistics Research and Applications*, Vol. 18 No. 2, pp. 118–139, https://doi.org/10.1080/13675567.2015.1015509.

[3] Acronyms: **NOx**=Nitrogen oxides; **PM metro**=Particulate matter metro; **PM rural** = Particulate matter rural; **HC**= Hydro Carbons; **CO**= Carbon Monoxide; **CO_2**=Carbon dioxide; **SO_2** =Sulphur dioxide

Accidents cost more than the cost of damage to the involved vehicles, which is internalised through insurance policies. Apart from the direct cost of replacing or repairing a vehicle there are additional economic costs due to loss of life and productivity which can be quantified through value of statistical life tables. In South Africa the Road Accident Fund levy directly internalises some, but not all of this externality cost.

Noise externality cost is based on the willingness to pay to avoid the proximity of living near noisy road or rail infrastructure. A small percentage of national GDP is used based on international benchmarks to estimate the total willingness to pay for South Africa and is then disaggregated across road and rail.

Congestion is the increase in travel time road users experience due to travel demand exceeding road capacity constraints. Large trucks take up the equivalent of roughly 3.5 passenger car equivalents on the road. It is calculated by taking the difference between average vehicle speeds and expected free flow speed across counted sections where the number of vehicles per hour per lane exceeds the free flow limit. As all vehicles are traffic and contribute toward congestion different vehicle types' contribution are normalised to passenger car equivalents. This gives a split of the total time lost due to congestion to each vehicle use (passenger and freight) which is monetarily quantified based on a cost per hour.

Policing externality cost is based on the national estimated budget per person spent on traffic policing. This cost is attributed to freight activity based on the live vehicle population composition.

Apart from the necessity of initially connecting different areas of the country, there is an external cost associated with the expanded land use of transport infrastructure that could have been used for other economic activities. Roads are expanded to alleviate congestion, rather than finding more space-efficient means of transportation. This cost is attributed to freight according to an estimate of annual distance travelled per vehicle type and the live vehicle population.

The resultant total externality costs for Western Cape freight are given in Figure 1 and Table 4. Rail externality costs are negligible relative to road externality costs.

The total externality costs for road freight transport in the Western Cape for 2020 amount to R12.8 billion, which is 29.6% of direct road freight transport costs4 for the same period. Road freight transport contributes 93% of the total land freight transport externality costs[4] of R13.74 billion.

The four largest road freight transport externality cost drivers, namely, emissions, accidents, noise and congestion, contribute 80% to total freight transport externality costs in the province, impacting the general population while not being carried by the users of the service. When externality costs are not internalised, road freight operators are effectively cross subsidised by individuals living in polluted air (emissions) or next to noisy roads, or commuters travelling on congested routes. Furthermore, taxpayers fund the clearing of accidents and rehabilitation of damaged roads. The internalisation of externality costs can be induced through both "negative" and "positive" policy interventions. "Negative" policy instruments relate to measures such as congestion charges, emission taxes, noise controls, land use limitations and user-pay principles. "Positive" policy instruments relate to a regulatory framework supportive of the creation of industry associations, logistics hubs and public-private partnership models. This could encourage widespread modal shift to induce a systemic change by which most of rail-targetable freight is shifted to rail[4].

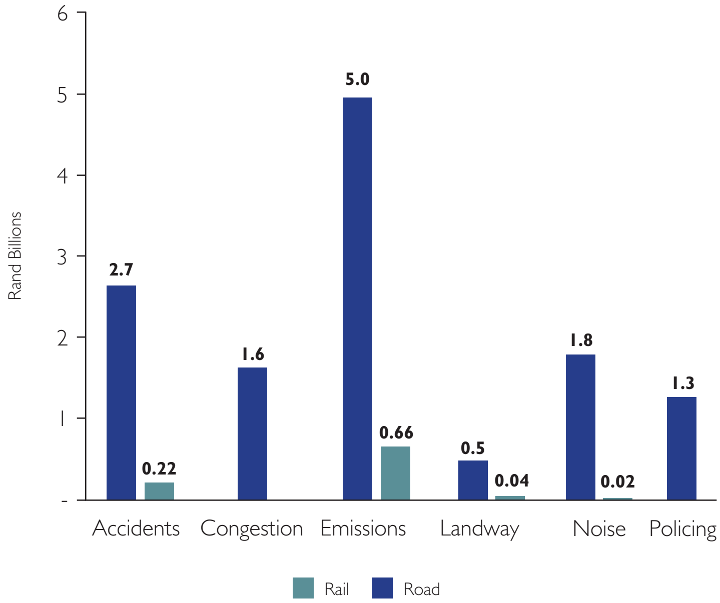


Figure 1: Externality costs for Western Cape freight (2020)

Externality cost driver	Road Cost Rbn (% of driver cost)	Rail Cost Rbn (% of driver cost)	Total Cost Rbn (% of total)
Emissions	4.97 (88%)	0.66 (12%)	5.63 (41%)
Accidents	2.65 (92%)	0.22 (8%)	2.87 (21%)
Noise	1.79 (99%)	0.02 (1%)	1.81 (13%)
Congestion	1.63 (100%)	-	1.63 (12%)
Policing	1.27 (100%)	-	1.27 (9%)
Landway	0.48 (92%)	0.04 (8%)	0.52 (4%)
Total	12.8 (93%)	0.94 (7%)	13.74

Table 4: Externality costs for Western Cape freight (2020)

Highlights

- The total externality for road freight transport in the Western Cape amounts to R12.8 billion, which is 29.6% of current road freight transport costs.
- Road freight transport contributes 93% of the total freight transport externality cost of R13.74 billion.
- The four largest road freight transport externality cost drivers, namely emissions, accidents, noise, and congestion contribute 80% to total freight transport externality costs in the province, impacting the general population while not being carried by the users of the service.
- The internalisation of externality costs can be induced through policy interventions.
- Policy interventions could induce a systemic change to shift rail- targetable freight to rail.

[4] Total direct road cost for 2020 is R43.1bn. If the road externality cost of R12.8bn is internalised, the total road transport cost will increase by 29.6% to R55.9bn.

[5] Refer to Havenga, J.H. and Simpson, Z.P. (2016), 'Freight logistics' contribution to sustainability: Systemic measurement facilitates behavioural change', Transportation Research Part D: Transport and Environment, Vol. 58. pp. 320-331, https://doi.org/10.1016/j.trd.2016.08.035 for a case study on the internalisation of national externality costs

Western Cape Government
Transport and Public Works

Western Cape Freight Demand Model (WC FDM™)
Scenario 1: Modal shift

Scenarios

The WC FDM™ enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies, and spatial planning. Pressing policy issues were identified and high-level scenarios were developed to estimate the potential annual impact on freight transport costs and Gross Domestic Product (GDP) in the Western Cape. The current results are indicative, with the purpose of encouraging discussions to increase the accuracy of the scenario development inputs. Once agreement is reached on the high-level scope and outcomes of these scenarios, priorities will be set to guide the implementation process for these scenarios.

Modal shift scenarios

The modal shift scenario is for commodities that have been identified as rail friendly, based on the density attributed to the origin and/or destination, packaging type and distance. To calculate the potential opportunity cost, at current prices, of a shift of freight from road to rail, or a lack thereof, the following baseline scenarios are quantified:

1. **Stagnant rail volumes,** where rail's volumes remain the same over the forecast period;
2. **Constant rail market share**, where rail's percentage remains the same over the forecast period;
3. **Growth in rail market share** where rail's market share grows to capture all the rail-friendly traffic (i.e. able to be shifted to rail).

The impacts on transport costs and emissions are calculated for each of these baseline scenarios.[1] That is, what is the potential for modal shift, given each of the three baselines.

Assumptions

- Assuming 2020 average transport costs per segment, total transport costs were calculated for each scenario.
- In the absence of an average cost per segment, the overall average cost per mode was used.
- Modal shifts for forecast years are calculated at 2020 prices. This provides a conservative estimate – it has been shown that as rail freight density increases the mode becomes more efficient.
- Modal shift scenarios are developed for the Western Cape portion of each of the three (3) long-distance corridors traversing the Western Cape, namely the N1, N2 and N7, as well as for short distance freight transported locally in the Core Western Cape region.

Results

The modal shift scenario results are depicted in Table 2, 4, 6 and 8.

N1 corridor

The key opportunities for modal shift on the N1 corridor are in the siding-to-siding and palletised FMCG segments. The volumes that could be shifted are shown in Table 1 and depicted graphically in Figure 1[2].

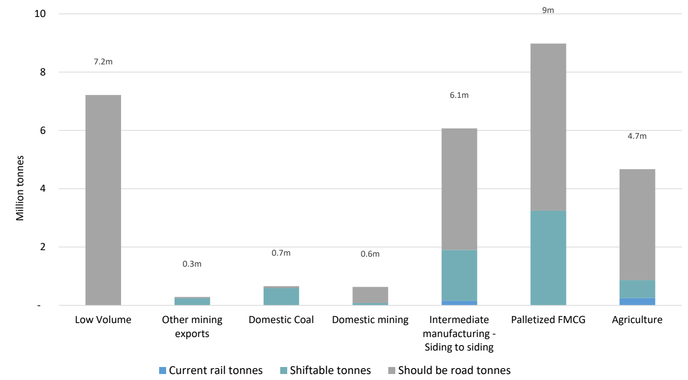


Figure 1: Modal shift opportunity per segment on the N1

Table 1: Modal shift opportunity per segment on the N1

Segment	Road tonnes	Rail tonnes	Shiftable tonnes
Low volume targetable	7 213 618	3 204	(0%)
Other mining exports	289 025	-	247 204 (85.5%)
Domestic Coal	657 763	1 681	591 209 (89.9%)
Domestic mining	630 943	-	78 838 (12.5%)
Intermediate manufacturing - Siding to siding	5 912 905	157 406	1 744 029 (29.5%)
Palletized FMCG	8 979 547	-	3 247 593 (36.2%)
Agriculture	4 412 966	256 931	607 567 (13.8%)
Total	28 096 767	419 223	6 516 439 (23.2%)

Transport costs[3] on the N1 corridor for these segments are currently 13.1% higher, compared to costs under a scenario in which all shiftable freight was transported by rail (see Table 2). If rail volumes remain stagnant up to 2051 this premium will be 12.6%. If rail market share remains constant up to 2051 this premium will be 12.3%.

Table 2: Cost and emission savings potential due to modal shift on the Western Cape section of the N1

Scenarios	Transportation cost before shift (Rbn)	% Transport cost premium with no modal shift	Shift Saving (Rbn)	CO_2 emission reduction (000' tonnes)
2020 - Current market share	29.4	13.1%	3.4	339.0
2026 - Stagnant rail volumes	34.2	13.3%	4.02	398.3
2026 - Constant market share	34.1	13.2%	3.98	395.2
2026 - Growth market share	30.0		-	
2051 - Stagnant rail volumes	60.4	12.6%	6.76	695.9
2051 - Constant market share	60.2	12.3%	6.58	678.2
2051 - Growth market share	53.3		-	-

[1] Where current rail rates are above road market rates it is assumed that freight switching to rail will do so at road market rates.

[2] For this analysis, which focuses on modal shift to rail, the segments in Figure 1 to Figure 4 are sorted according to rail's suitability (including density and number of OD pairs).

[3] These transport costs are road and rail costs for the identified rail friendly segments.

GAIN GROUP
Insight drives growth

N2 corridor

The key opportunities for modal shift on the N2 corridor are in the siding-to-siding, palletised FMCG and agriculture segments. The volumes that could be shifted are shown in Table 3 and depicted graphically in Figure 2.

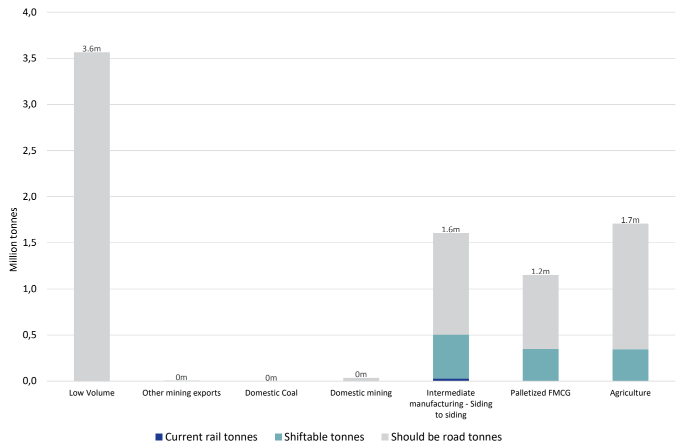


Figure 2: Modal shift opportunity per segment on the N2

Table 3: Modal shift opportunity per segment on the N2

Segment	Road tonnes	Rail tonnes	Shiftable tonnes
Low volume targetable	3 564 888	514	(0%)
Other mining exports	5 963	-	5 100 (85.5%)
Domestic Coal	-	-	(0%)
Domestic mining	35 661	-	4 456 (12.5%)
Intermediate manufacturing - Siding to siding	1 574 278	29 729	474 376 (30.1%)
Palletized FMCG	1 150 591	-	348 591 (30.3%)
Agriculture	1 708 594	-	345 655 (20.2%)
Total	8 039 975	30 243	1 178 178 (14.7%)

Transport costs on the N2 corridor across all segments are currently 1.6% higher than they would be if all shiftable tonnes were transported by rail (see Table 4). If rail volumes remain stagnant this will be 1.0% by 2051.

Table 4: Cost and emission savings potential due to modal shift on the Western Cape section of the N2

Scenarios	Transportation cost before shift (Rbn)	% Transport cost premium with no modal shift	Shift Saving (Rbn)	CO_2 emission reduction (000' tonnes)
2010 - Current market share	4.2	1.6%	0.07	30.2
2026 - Stagnant rail volumes	5.1	1.9%	0.1	38.2
2026 - Constant market share	5.1	1.9%	0.09	37.9
2026 - Growth market share	5.0		-	
2051 - Stagnant rail volumes	8.0	1.0%	0.08	56.4
2051 - Constant market share	8.0	1.0%	0.08	56.2
2051 - Growth market share	7.9		-	-

N7 corridor

The key opportunity for modal shift on the N7 corridor is in agriculture, and to a lesser extent siding-to-siding freight. The volumes that could be shifted are shown in Table 5 and depicted graphically in Figure 3.

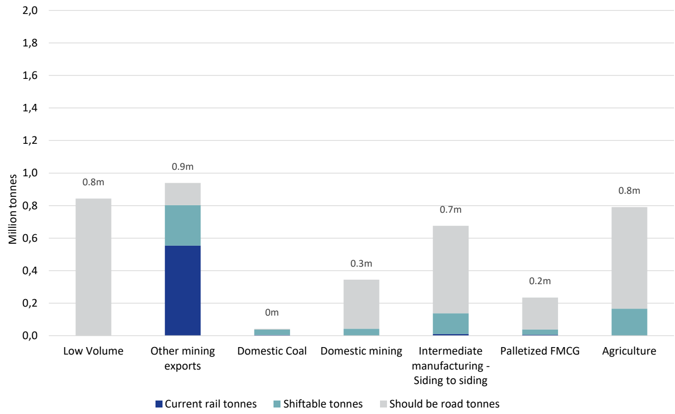


Figure 3: Modal shift opportunity per segment on the N7

Table 5: Modal shift opportunity per segment on the N7

Segment	Road tonnes	Rail tonnes	Shiftable tonnes
Low volume targetable	843 400	-	(0%)
Other mining exports	384 995	553 833	249 149 (64.7%)
Domestic Coal	37 438	4 413	33 214 (88.7%)
Domestic mining	344 426	-	43 037 (12.5%)
Intermediate manufacturing - Siding to siding	665 325	10 824	127 171 (19.1%)
Palletized FMCG	228 569	6 167	32 320 (14.1%)
Agriculture	790 645	-	166 344 (21%)
Total	3 294 797	575 238	651 236 (19.8%)

Transport costs on the N7 corridor are currently 14.6% higher than they would be if all shiftable tonnes were transported by rail (see Table 6). If rail volumes remain stagnant this will increase to 18.0%, by 2051. If rail market share remains constant this will increase to 16.7%.

Table 6: Cost and emission savings potential due to modal shift on the Western Cape section of the N7

Scenarios	Transportation cost before shift (Rbn)	% Transport cost premium with no modal shift	Shift Saving (Rbn)	CO_2 emission reduction (000' tonnes)
2020 - Current market share	1.3	13.0%	0.17	8.4
2026 - Stagnant rail volumes	1.7	19.0%	0.25	12.3
2026 - Constant market share	1.6	15.3%	0.23	11.5
2026 - Growth market share	1.4		-	
2051 - Stagnant rail volumes	3.2	23.5%	0.60	27.7
2051 - Constant market share	3.0	15.3%	0.39	18.9
2051 - Growth market share	2.6		-	-

Western Cape core traffic

The key opportunity for modal shift in the Western Cape core traffic is in agriculture, and to a lesser extent domestic coal and siding-to-siding traffic. The volumes that could be shifted are shown in Table 7 and depicted graphically in Figure 4. Due to the low freight transport distances and density outside metro areas, road is currently more competitive for certain commodities than rail in segments such as agriculture and intermediate manufacturing.

GAIN GROUP Insight drives growth

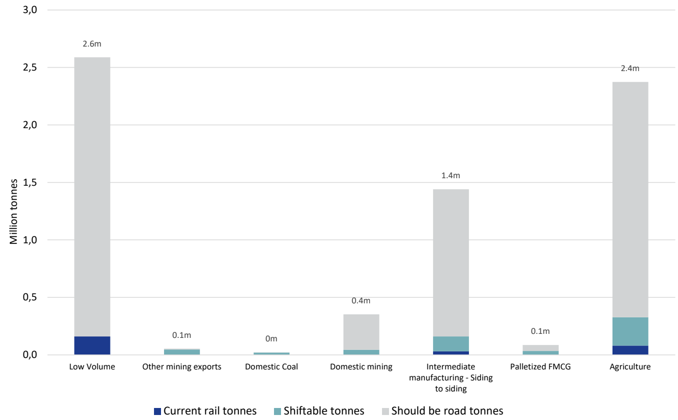


Figure 4: Modal shift opportunity per segment for Western Cape core traffic

Transport costs for the Core Western Cape across all segments are currently 0.9% higher in the absence of modal shift (see Table 8). By 2051 if rail market share remains stagnant this is will be 1.0%, given that rail rates remain relatively high. This is due to the growth in the freight flows in which road is more competitive.

Table 8: Cost and emission savings potential due to modal shift on the Western Cape section of the N7

Scenarios	Transportation cost before shift (Rbn)	% Transport cost premium with no modal shift	Shift Saving (Rbn)	CO_2 emission reduction (000' tonnes)
2020 - Current market share	0.56	0.9%	0.00	2.1
2026 - Stagnant rail volumes	0.65	1.1%	0.01	2.6
2026 - Constant market share	0.65	1.1%	0.01	2.6
2026 - Growth market share	0.65			
2051 - Stagnant rail volumes	1.24	1.1%	0.01	5.0
2051 - Constant market share	1.24	1.0%	0.01	4.7
2051 - Growth market share	1.23			

Summary

In 2020 the total transportation bill for freight touching the Western Cape was R52.3bn. The combined effect of the modal shift on the three corridors and core Western Cape traffic would have been a reduction of R4.67 billion or 7.8% in transport costs for the Western Cape (the 2020 market share data in the tables above)[4].

Table 9: Summary - cost and emission savings potential due to modal shift in the Western Cape

Freight traffic zone	Shift saving 2018 (Rbn)	% saving on total Western Cape transport bill	CO_2 emission reduction (000' tonnes)
N1	3.40	6.5 %	339.0
N2	0.07	0.1 %	30.2
N7	0.17	0.3 %	8.4
Core Western Cape	0.03	0.01 %	2.1
Total	3.64	7.0%	379.7

Highlights

- As rail traffic becomes dense, it becomes more efficient.
- An estimated 7.0% of the Western Cape's total freight transportation cost could be saved through modal shift at current rail tariffs.
- Reduced potential for modal shift cost savings (when compared to the 2019 results) was driven by the decline in freight movement on the N1 and N2, combined with a lower fuel price in 2020.
- At current rail volumes, road is more
- competitive within the WC Core area.
- The largest modal shift opportunity is for the N1 corridor freight. This could potentially save 6.5% of total transport cost.

[4] These results refer to the transport cost saving. Additional investments can be included in a high-level business case.

Western Cape Freight Demand Model (WC FDM™)
Scenario 2: Road Transport Management System

Overview

The Road Transport Management System[1] (RTMS) is an industry-led, government-supported, voluntary, self-regulation scheme that encourages consignees, consignors, and road transport operators to implement a management system through the RTMS national standard, SANS 1395:1:2019. Through the thirteen elements of the standard, the RTMS seeks to foster a corporate culture of observing the law, promote good corporate governance – and citizenship, and provide a foundation for the development of structural management systems that ensure road transport operators achieve legal compliance, reduce corporate risk, and improve profits. These outcomes are achieved by a specific focus on the following key areas identified for heavy vehicle transport: loading control, safety, driver wellness, and training.

Adoption of the RTMS standard, which is published by the South African Bureau of Standards (SABS) and certified by South African National Accreditation System (SANAS), demonstrates a transport operator's compliance with road traffic regulations and contributes to preserving road infrastructure, improving road safety, and increasing productivity.

This adoption has proven to reduce logistics costs, with the assumptions below based on reported figures in RTMS-related publications. These overall figures are supported by findings presented in RTMS presentation. For instance, the City of Cape Town realised a 24% improvement in its carbon footprint by reducing fuel consumption from 17 litres per 100 kms to 13 litres per 100 kms between 2008 and 2016. The City of Cape Town also benefitted from a 44% reduction in crashes. In 2016, the road freight operator, Dawn Logistics, reported a 20% improvement in fuel consumption thanks to adoption of RTMS principles. Other RTMS certified fleets, namely Barloworld Logistics, Timber Logistics Services and Vehicle Delivery Services, have also reported crash reduction rates of 66%, 50% and 42% respectively. Many other transport cost savings, such as savings related to insurance premiums, maintenance, fines, etc. have been reported, but are difficult to integrate with the WC FDM™ data at this stage.

The RTMS scenario is modelled to calculate the savings that would result from its wider adoption. Generalised savings figures for RTMS adoption are taken and conservatively adjusted from various reported cases and applied to the WC FDM™ tonne-kms to quantify how such a culture shift could impact the Western Cape's logistics costs.

The Western Cape-registered truck[2] population reached 46 078 vehicles in 2020, which represents 12.2% of the 377 788 heavy vehicle trucks in the country. Trucks accounted for 2.5% and 3.3% of all Western Cape and national road vehicles respectively. It is important to note that many of the road freight vehicles operational in the Western Cape's are not necessarily registered in the province itself. Furthermore, there are heavy vehicle trucks operational in the Western Cape originating from neighbouring countries such as Namibia. Unfortunately, these heavy vehicle trucks are, therefore, captured in neither the Western Cape nor South African vehicle population.

According to published RTMS membership statistics[3], the number of RTMS certified companies reached 255 in 2020, a 5.4% increase from the 242 in 2019. Furthermore, the overwhelming majority in 2020, namely 98.4% (251 companies), were related to freight transport. The number of certified vehicles reached 17 847 in 2020, marking an increase of 4.2% on the 17 125 vehicles in 2019. Around 17 500 of the RTMS certified vehicles in 2020 are estimated to be related to freight activities. Therefore, given the Western Cape's contribution to the overall heavy vehicle truck population, the province should have around 2 135 RTMS certified vehicles in 2020.

Preliminary investigation[4] of RTMS membership data shows that the Western Cape outperformed this expectation, while also seeing a respectable increase in RTMS certifications since 2019 despite the impact of COVID-19. Based on the actual RTMS data, an estimated 5% of the entire Western Cape truck population have adopted the RTMS.

Assumptions[5]

Although an estimated 5% of freight transporters have already implemented RTMS, it is assumed that more road freight operators can adopt the RTMS in the future. By using the current RTMS adoption rate as a baseline, the RTMS results can be forecasted for various levels of adoption.

It is further assumed that adherence to RTMS principles will result in a 20% reduction in fuel consumption for the same number of vehicle kilometres driven. This is largely due to improved driver behaviour such as increased defensive – and economic driving, and reduced harsh acceleration, harsh braking, and speeding. Essentially, the reduction in fuel consumption can be attributed to better skilled drivers, along with improved maintenance practices.

Finally, it is also assumed that RTMS will result in a 60% reduction in crash rates. Overall, it is believed that the RTMS can reduce overall transport costs by 30%. These assumptions are summarised in Table 1.

Table 1: Summary of RTMS savings assumptions

Assumptions	
Current baseline RTMS adoption rate	5%
RTMS fuel consumption reduction	20%
RTMS accidents reduction	60%
RTMS overall transport cost reduction	30%

Results

Table 2: Summary of RTMS scenario results

	Current baseline 5% adoption	10% adoption	25% adoption	50% adoption	75% adoption
Litres of fuel usedby trucks (billion litres)	1.24	1.23 *(0.8% saving on baseline)*	1.19 *(4% saving on baseline)*	1.13 *(8.9% saving on baseline)*	1.07 *(13.7% saving on baseline)*
Road accidents externality costs (R billions)	2.65	2.57 *(3% saving on baseline)*	2.33 *(12.1% saving on baseline)*	1.94 *(26.8% saving on baseline)*	1.54 *(41.9% saving on baseline)*
CO_2 emissions (million tonnes)	3.35	3.31 *(1.2% saving on baseline)*	3.21 *(4.2% saving on baseline)*	3.05 *(9% saving on baseline)*	2.88 *(14% saving on baseline)*

Using these assumptions and forecasting future changes in RTMS adoption rates as 10%, 25%, 50% and 75% provides the overall savings for freight transport in the Western Cape shown in Table 2. The table presents changes further RTMS adoption will have on fuel consumption, road accident externality costs, and CO2 emissions – along with the additional percentage savings it represents relative to the current baseline adoption.

It is estimated doubling the current adoption rate to 10% will result in a 0.8% fuel saving, which will also result in carbon emissions reducing by 1.2% - a saving equivalent to 40 000 tonnes of CO2. However, should adoption increase, the fuel saving will be 4%, 8.9% and 13.7% at 25%, 50% and 75% adoption levels respectively. Similarly, the CO2 emissions will reduce by 4.2%, 9% and 14% respectively when compared to the baseline result.

Likewise, doubling the current adoption rate to 10% will result in a 3% saving in externality costs related to road accidents, which will rise considerably to a significant savings of 12.1%, 26.8% and 41.9% for the 25%, 50% and 75% adoption levels respectively.

Highlights

- An estimated 5% of the Western Cape truck population is RTMS certified, with the province showing promising growth in adoption relative to others. It is also important to note (1) the impact of COVID-19 on truck fleets downsizing and (2) that many RTMS certified trucks operational in the Western Cape might be registered to other provinces and therefore, not reflect perfectly in the adoption statistics.
- Doubling current RTMS adoption in the Western Cape could reduce fuel consumption by a million litres (0.8% saving), reduce road accident externality costs by R80 million (3% saving) and cut CO2 emissions by 400 000 tonnes (1.2% saving).
- Although greater levels of adoption are difficult to achieve, improved law enforcement would have the same or comparable effect. Furthermore, it is important to note that certification is not necessarily needed for transport operators to adopt RTMS principles and capatalise on its efficiency improvements.

[1] *Road Transport Management System* (RTMS). 2022. [Online]. Available: https://rtms-sa.org/

[2] Heavy load vehicles with a gross vehicle mass of over 3 500 kg (eNaTIS,2020)

[3] Statistics presented by Dr Paul Nordengen at the RTMS workshop in October 2021 (Nordengen, 2021)

[4] An on-going investigation of the RTMS quarterly submission data as part of a study to be completed by the end of 2022

[5] These assumptions are based on comparisons between various cases of improvements reported by RTMS certified operators to inform conservative estimates. The reported cases used to do this were found in:

- historic RTMS workshop presentations
- confidential information shared during interviews as part of the study mentioned in the previous footnote, and
- the following publication: Steenkamp AJ, Nordengen PA, Berman R, Kemp L. (2017) *Investigation into the smart truck pilot project: Progress made and way forward.*

GAIN GROUP Insight drives growth

Scenario 3: Bitterfontein hinterland terminal

Scenarios

The WC FDM™ enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies, and spatial planning. Pressing policy issues were identified and high-level scenarios were developed to estimate the potential annual impact on freight transport costs and Gross Domestic Product (GDP) in the Western Cape. The current results are indicative, with the purpose of encouraging discussions to increase the accuracy of the scenario development inputs. Once agreement is reached on the high-level scope and outcomes of these scenarios, priorities will be set to guide the implementation process for these scenarios.

Bitterfontein hinterland terminal

Utilising the terminal at Bitterfontein for freight to/from the Namaqualand region and Namibia border, and to/from the extended Cape Town metropolitan region was considered. This scenario considers the transfer of road freight at the Bitterfontein terminal and utilising the Bitterfontein rail line (approximately 490km from Bitterfontein to Cape Town).

Currently, no freight beyond Bitterfontein and towards Namaqualand or Nambia is transported on rail. The volumes and modal split of commodities related to the Bitterfontein catchment area are shown in Figure 1. The Bitterfontein catchment area includes rail freight from the Vanrhynsdorp district to the Port of Saldanha, Hopefield and Malmesbury. The road freight movement is along the N7 across the Piekenierskloof Pass towards Bitterfontein, Springbok and Vioolsdrif. Most of the commodities can be palletised and containerised, and are, therefore, suitable for rail transport.

The branch line is in relatively good condition, with enough available capacity for all freight along this route. Currently, there is only a small rail station handling granite at Bitterfontein, but a large terminal will not be required for these volumes. While ample land space is available, the development of a hinterland port concept will require private sector involvement and a different approach to intermodal transport by Transnet.

The advantage of a terminal at Bitterfontein would be the elimination of truck travel over the Piekenierskloof Pass and the congestion experienced and created by these trucks[1], especially in the CBD of Cape Town and the Port. In 2016, the average number of trucks travelling over the Piekenierskloof Pass were 686 trucks per day, representing 20.9% of the daily vehicle traffic. By 2019, that number grew to 759 trucks, with trucks' contribution towards daily vehicle traffic also rising to 22.1%. It will also allow trucks travelling to and from Namibia a quicker turnaround time between trips.

The annual volume of this freight is currently only around 79 098 tonnes per annum, which is approximately one train every week. This volume, however, is forecasted to increase to around 92 363 and 155 973 tonnes by the years 2026 and 2051 respectively. Currently, the freight transportation cost and externality cost savings per annum could be R33.4 million and R10.3 million, respectively, if all road freight is shifted to rail.

The Bitterfontein rail line to Cape Town is indicated in Figure 2, with the Namaqualand/Namibia border and the extended metropolitan region considered as potential catchment areas.

[1] Based on SANRAL's Integrated Transportation Information System (ITIS) data, which is available online at https://itis.nra.co.za/Portal/

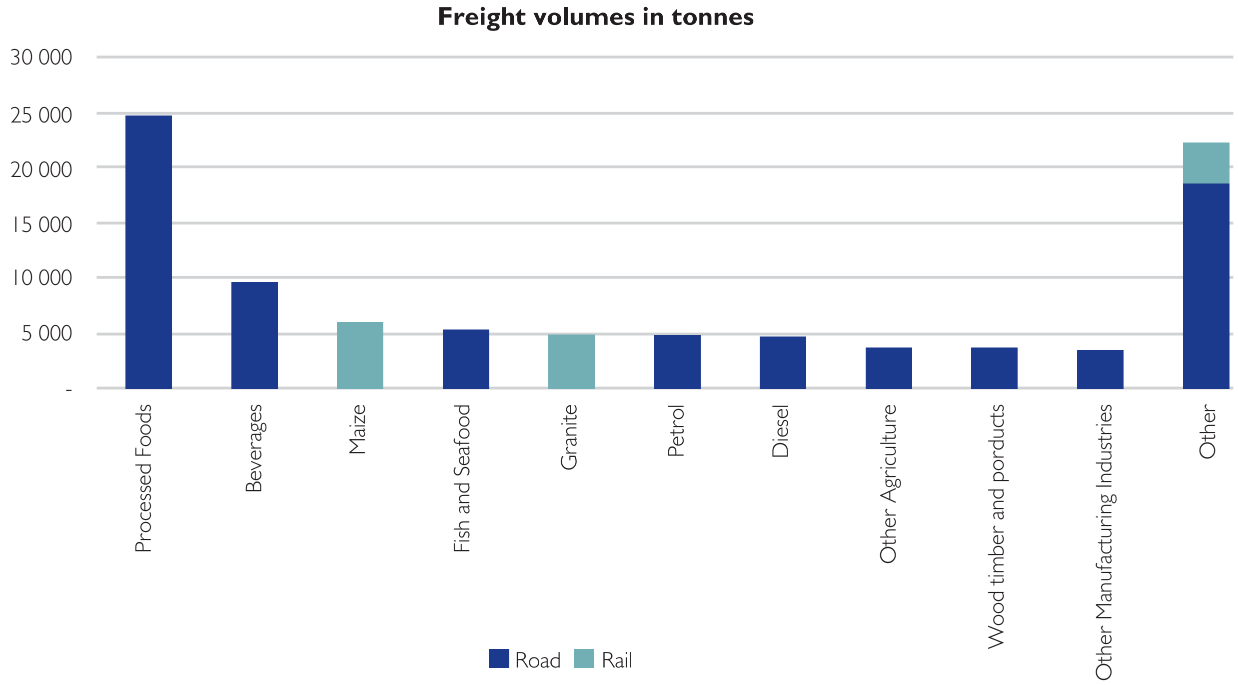


Figure 1: Modal split for the Bitterfontein catchment area

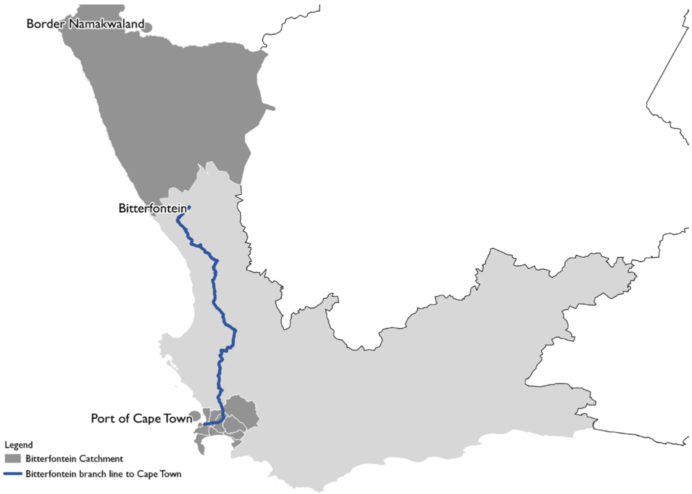


Figure 2: Bitterfontein line to Cape Town and potential catchment areas (the circles indicate the port and border)

Highlights

- Bitterfontein as a hinterland terminal could be a road to rail strategy to address road safety, while reducing congestion and turnaround times of road freight vehicles.
- The freight transportation cost and externality cost savings per annum will be R33.4 million and R10.3 million, respectively, if all road freight is shifted to rail.
- The branch line is in relatively good condition, with enough available capacity for all freight along this route. The development of a hinterland port concept will require private sector involvement and a different approach to intermodal transport by Transnet.

Western Cape Freight Demand Model (WC FDM™)
Scenario 4: Fruit container consolidation terminal Vredendal and Elgin

Scenarios

The WC FDM™ enables the development of data-driven scenarios to inform inter alia industrial and freight transport policies, and spatial planning. Pressing policy issues were identified and high-level scenarios were developed to estimate the potential annual impact on freight transport costs and Gross Domestic Product (GDP) in the Western Cape. The current results are indicative, with the purpose of encouraging discussions to increase the accuracy of the scenario development inputs. Once agreement is reached on the high-level scope and outcomes of these scenarios, priorities will be set to guide the implementation process for these scenarios.

Fruit container consolidation terminal

The Western Cape is responsible for more than half of South Africa's total agricultural exports and showed growth during a COVID-19 stricken 2020[1]. In recent years, various media reports[2] have highlighted road congestion to the Port of Cape Town, pressure on efficiency, and lowering of the cost of doing business. The consolidation of freight could make the logistics costs cheaper and more effective[3]. By investing in the correct infrastructure configuration that ensures the lowest overall total logistics costs at the highest possible GDP output, South Africa can gain a major international competitive advantage.

This scenario considers the development of two fruit consolidation terminals in Vredendal and Elgin by using the Bitterfontein rail line (Vredendal to Port of Cape Town) and Caledon rail line (Elgin to Port of Cape Town). As mentioned in the previous scenario, the Bitterfontein rail line is in a relatively good condition and has sufficient capacity for all freight along this route. Similarly, the Caledon rail line is in a good condition and operational. This scenario proposes the transfer of road freight from the catchment areas around Vredendal and Elgin to fruit consolidation terminals in Vredendal and Elgin.

This scenario does not consider any other initiatives to consolidate freight and the use of rail. Such activities will have a compound effect and result in a reduction of rail rates. The potential of future volumes will also further increase density.

The distance to the Port of Cape Town from Vredendal and Elgin is 303km and 70km respectively. The freight will utilise the rail line from Elgin to the Port of Cape Town and Vredendal to the Port of Cape Town as depicted in Figure 1. The benefit of these consolidation terminals is to reduce road and port congestion at the Port of Cape Town but also to improve the turnaround time of road vehicles.

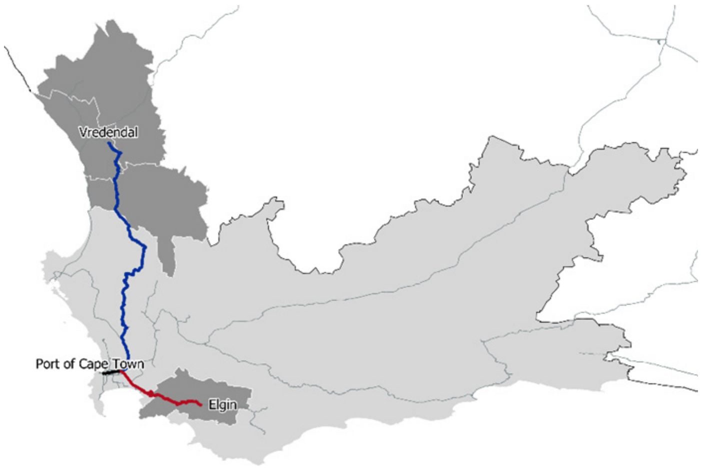


Figure 1: Rail lines and catchment areas for fruit consolidation terminals

Table 1 shows the current and expected fruit export volumes through the Port of Cape Town from the Elgin and Vredendal areas. All this freight is currently moving on road, with the N2 and N7 predominantly used for Elgin and Vredendal, respectively. Elgin's biggest fruit exports are that of deciduous fruit, with 294 300 tonnes in 2020 – which is expected to increase to 651 521 tonnes by 2051. Vredendal's biggest fruit exports are that of citrus, with 181 603 tonnes in 2020 – which is expected to increase to 664 428 tonnes by 2051.

Table 1: Fruit export volumes through the Port of Cape Town from the Vredendal and Elgin catchment areas in tonnes

Fruit terminal	Commodity	2020	2026	2051
Elgin	Deciduous Fruit	294 300	341 298	651 521
Elgin	Grapes	4 747	5 668	12 825
Elgin	Citrus	4 392	5 942	16 069
Elgin	Subtropical Fruit	42	50	105
Vredendal	Citrus	181 603	245 678	664 428
Vredendal	Grapes	35 906	42 874	97 005
Vredendal	Deciduous Fruit	5 800	6 726	12 840
Vredendal	Subtropical Fruit	15	18	38
Total		526 805	648 252	1 454 831

Although fruit from the area is primarily exported, Vredendal and Elgin also produce fruit for domestic use and consumption. Most of the exports go through the Port of Cape Town, as shown in Figure 2. Table 2 provides a breakdown of other port use for fruit exports from the area.

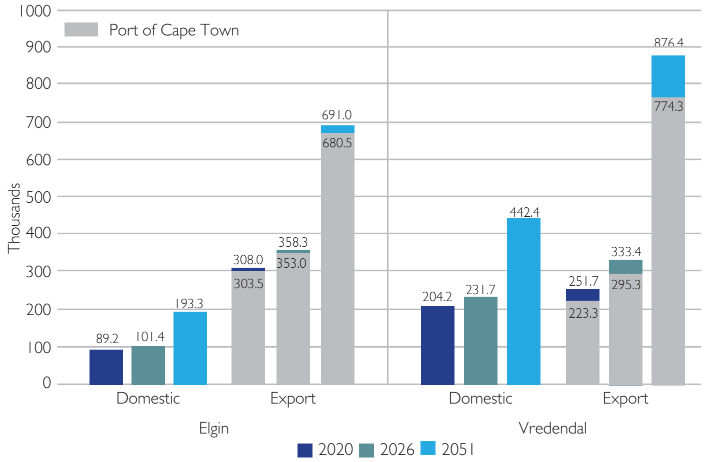


Figure 2: Vredendal and Elgin area fruit volumes

The fruit exports from Vredendal and Elgin to the Port of Cape Town generate an estimated 17 560 trips per annum. If all fruit exports from Vredendal and Elgin are considered, this number would represent 18 656 trips or 51 trucks per day.

Table 2: Current export ports for fruit from Vredendal and Elgin

Catchment area	Export port	Tonnes
Elgin	Port Cape	303 481
	Port Durban	945
	Port East London	1
	Port Port Elizabeth	3 595
Vredendal	Port Cape	223 324
	Port Durban	22 096
	Port Port Elizabeth	6 247
	Total	559 689

Terminal at Vredendal can be considered for fruit exports

Figure 3 shows the 2020 potential fruit volumes that can be directed to the Vredendal fruit consolidation terminal is 224 327 tonnes, with an expected growth to 777 115 tonnes in 2051. This is more than 50% of the current rail volumes on the rail line. The increased density on the rail line could result in a reduction of 20% of the rail rates.

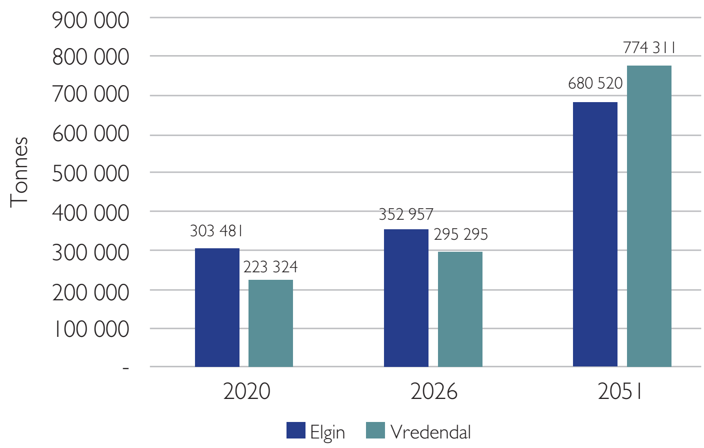


Figure 3: Fruit volumes and forecasts for Vredendal and Elgin catchment areas

Terminal at Elgin can be considered for fruit exports

In the catchment area of Elgin, 303 481 tonnes of 2020 fruit volumes could be directed to the Elgin fruit consolidation terminal which is about 6 times the current rail volumes. This increased density on the line should reduce the rail rate significantly. The forecast as shown in Figure 3 shows growth of 680 520 tonnes in 2051.

Cost saving implications for Vredendal and Elgin

Table 3 illustrates the potential cost saving implications for modal shift of fruit exports originating from the Vredendal and Elgin catchment areas. Given the current rail rate, moving the transport of fruit export volumes to the Port of Cape Town from road to rail is expected to result in a transport cost saving of R4.5 million (6.8%) and R7.8 million (15.2%) for Vredendal and Elgin, respectively. Similarly, a reduction in externality cost can also be realised through the proposed modal shift, with potential savings of R11.9 million and R8 million for Vredendal and Elgin, respectively.

Table 3: Potential cost saving implications of the establishment of fruit container consolidation terminals at Vredendal and Elgin

Fruit terminal	Road transport cost	Modal shift transport cost saving	Modal shift externality cost saving
Elgin	R51.1m	R7.8m (15.2 %)	R8.0m
Vredendal	R65.1m	R4.5m (6.8 %)	R11.9m
Elgin - Non-PoCT exports	R3.6m	R2.9m (81.8%)	R0.9m
Vredendal - Non-PoCT exports	R34.8m	R27.1m (77.9%)	R9.0m

Given that alleviation of (land or seaside) congestion at the Port of Cape Town is achieved, the fruit exports from Vredendal and Elgin that are currently destined for ports other then the Port of Cape Town will shift there. If this shifted freight is also transported by rail, the additional transport and externality cost saving will be R30.0 million and R9.9 million, respectively. Table 3 provides this information in further detail.

[1] Wesgro. 2022. *Agribusiness, agri-processing, furniture* [Online]. Available: https://www.wesgro.co.za/export/sector/agriculture- agro-processing-agribusiness [2022, March 15].

[2] Cape Town is the most congested city in South Africa and 29th most congested globally, with drivers spending an average of 124 hours a year in traffic. Operational inefficiencies at the Port of Cape Town leads to significant delays, which increased the number of teams required to operate the port's cranes and have led to citrus exports being redirected to the Eastern Cape ports to ensure supply chain continuity. These issues have delayed the processing of cargo severely, leading to frustrated importers and exporters and the fear of significant losses. The port efficiency is also hampered by the lack of sufficient equipment. COVID-19 has also had a severe effect on service levels, that nearly halved due to the impact of the virus.

- Githahu, M. 2020. *Businesses concerned over shippers by-passing Port of Cape Town* [Online]. Available: https://www.iol.co.za/capeargus/news/businesses-concerned-over-shippers-by-passing-port-of-cape-town-72da9741-3a64-452f-ba7a-c6c4281e66bd [2022, March 24].
- Magubane, K. 2020. *Western Cape government calls on Gordhan to rescue Cape Town Port from Covid-19 carnage* [Online]. Available: https://www.news24.com/fin24/economy/western-cape-government-calls-on-gordhan-to-rescue-cape-town-port-from-covid-carnage-20200630 [2022, March 23].
- Ngcobo, K. 2020. Cape Town among world's worst 30 cities for time wasted in traffic jams [Online]. Available: https://www.timeslive.co.za/sunday-times/lifestyle/2020-03-10-cape-town-among-worlds-worst-30-cities-for-time-wasted-in-traffic-jams/ [2022, March 24].
- Phakathi, B. 2020. *SA economy suffers as congestion at Cape Town's port worsens* [Online]. Available: https://www.businesslive.co.za/bd/economy/2020-06-29-sa-economy-suffers-as-congestion-at-cape-towns-port-worsens/#:~:text=The%20Covid%2D19%20pandemic%20has,of%20the%20subsectors%20worst%20affected. [2022, March 23].

[3] Havenga, J.H., Witthoft, I.E., De Bod, A. and Simpson, Z. 2020. *From Logistics Strategy to Macrologistics: Imperatives for developing World*. London. Kogan Page Publishers.

Highlights

- Due to congestion at the Port of Cape Town, a portion of the fruit exports from the Vredendal and Elgin catchment areas are being exported through other ports in the country.
- Fruit consolidation terminals for export fruit can assist in the road to rail strategy by directing fruit exports by rail from Elgin and Vredendal to the Port of Cape Town leading to:
  - A transport cost saving of R12.3 million and an externality cost saving of R19.9 million at current rail rates.
  - If the Port of Cape Town is congestion-free, an additional transport cost saving of R30.0 million and an additional externality cost saving of R9.9 million at current rail rates.

Western Cape Freight Demand Model (WC FDM™)
Waste data gathering and analysis process

Waste Overview

The WCFDM freight flows are derived from economic activity, specifically activities that contribute to the transportable GDP[1]. Although waste does not contribute to the GDP, it still needs to be transported and disposed of. This results in additional transportation costs that must be accounted for.

Waste is generated during the extraction and manufacturing activities, as well as after the final consumption of goods. A portion of the transportable GDP will end up in landfill.

The WCFDM waste data is a combination of reported WC Department of Environmental Affairs and Development Planning (DEA&DP) and City of Cape Town waste data. The major waste streams are displayed on the right.

The City of Cape Town (CoCT) is the largest waste generating area in the Province and was responsible for 77% of the Province's municipal waste handling of 1.5m tonnes in 2020.

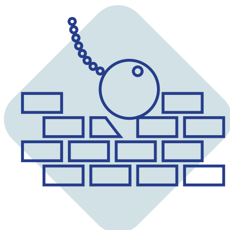
The data processing methodology for the three largest waste streams for the CoCT is discussed below.

1. GW01 – Municipal waste

Figure 1 shows the approximate catchment areas for each waste facility within the City of Cape Town Municipality and Figure 2 the waste collection and transfer process.

GW[2]01 Municipal waste
(also including GW99 other waste)

W20 Organic or garden waste



GW30 Construction and demolition waste

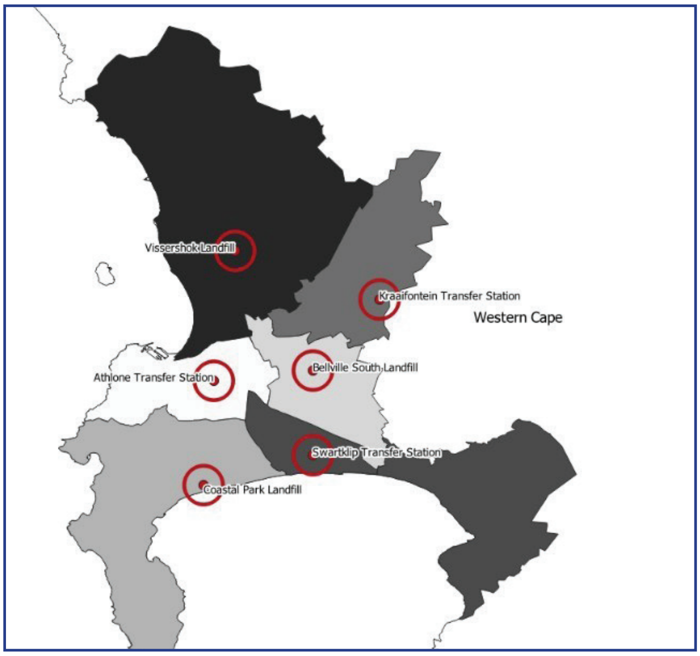


Figure 1: Catchment areas for the various refuse transfer stations and landfills in the CoCT Municipality.

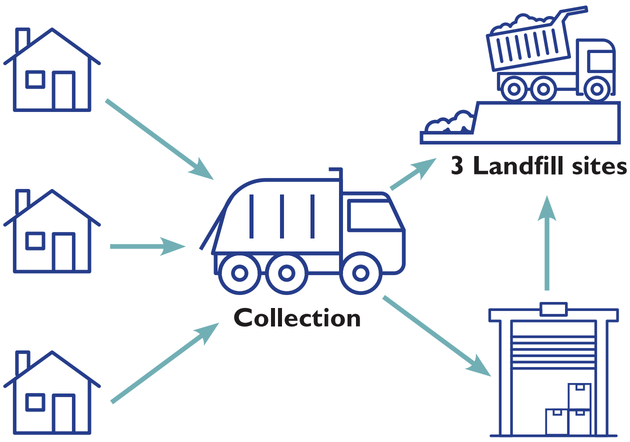


Figure 2: The waste collection and transfer process

[1] The transportable GDP consists of the extraction of raw materials and manufacturing, also referred to as the primary and secondary economic sectors, respectively.

[2] GW = General waste

Waste is not always taken directly to a landfill. There are three refuse transfer stations where waste gets dropped off and consolidated before being transported to one of the landfills.

For the WCFDM, waste OD flows were generated based on the intersection of each WCFDM district with each of the municipal waste facilities catchment area. For districts that fall into multiple catchment areas, the waste flows were split between the different waste facilities.

2. GW30 – Construction and demolition waste

Figure 3 shows the movement of construction and demolition waste. Residents, as well as companies, can drop off small quantities of builders' rubble at one of the city's drop-off sites. There are 37 drop-off sites in Cape Town for this type of waste. From these sites, the waste is primarily taken directly to landfill. The catchment areas for construction and demolition waste are shown in Figure 4.

3. GW20.01: Garden waste

There are various flows of organic waste. This waste has the same catchment as municipal waste. Some of it ends up in landfills (this is already included in municipal waste, sometimes separated as GW20.02 "food waste"). Most of this waste is GW20.01 (garden waste) that is separated at source (e.g. by being dropped off at drop-off points). Some of this garden waste is then composted by private companies and sold as compost material. Reliance Compost (Pty) Ltd is the principal composting company, and transports all the garden waste to its composting site just outside Paarl.

4. Provincial waste

Apart from the CoCT, there are 24 other municipalities within the Western Cape that are served by 61 waste facilities, as can be seen in Figure 5, that report handling Municipal, Garden and Construction and Demolition Waste. The same methodology that was used for the City of Cape Town Municipal waste assignments to WCFDM districts was applied to the rest of the Province.

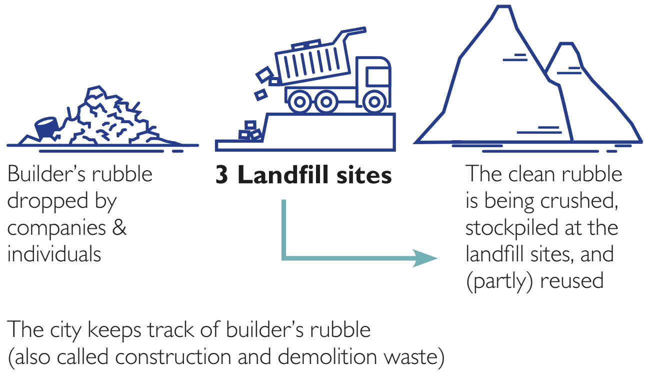


Figure 3: GW30 – Construction and demolition waste.

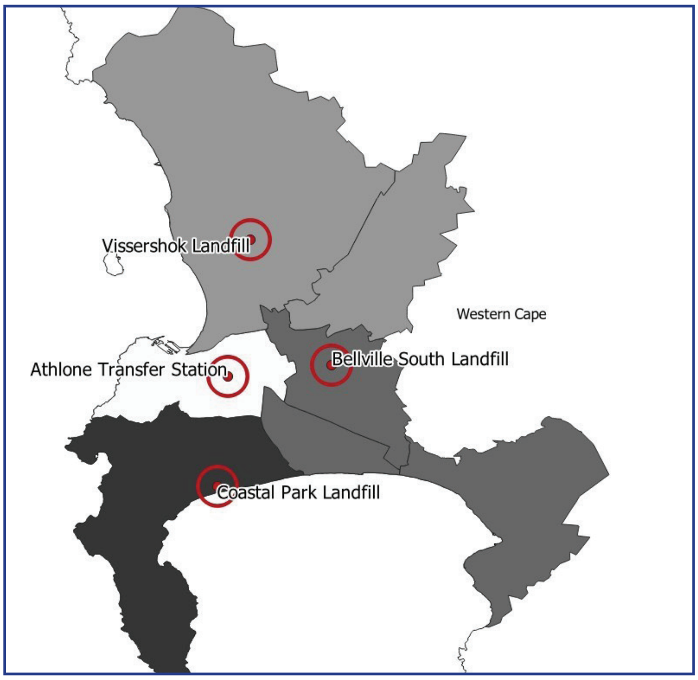


Figure 4: Catchment areas of industrial builder's rubble flow dropped off directly at landfill sites. This can come from anywhere in Cape Town, and it could go to any of the 3 landfill sites where it is stockpiled.

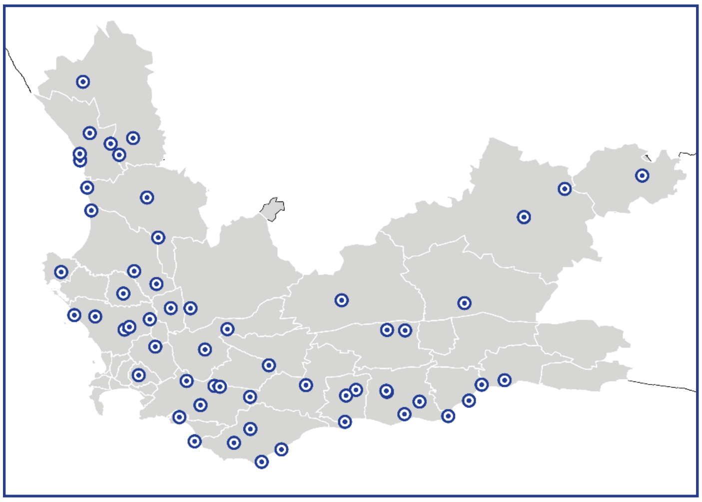


Figure 5: Provincial waste facilities, excluding city of Cape Town.

Western Cape Freight Demand Model (WC FDM™)
Detail on "Other manufacturing industries" and the grouping "Other commodities"

Table 1 below lists all the manufacturing freight flows that originate within the Western Cape (intra-provincial and outgoing traffic). The grouping 'Other commodities' is also detailed in Table 1.

Table 1: Manufacturing freight flows that originate within the Western Cape (2020)

Commodity	Million tonnes 2020	Percentage contribution
Processed Foods	9.10	33.4%
Beverages	2.85	10.5%
Diesel	2.31	8.5%
Petrol	1.88	6.9%
Cement	1.84	6.8%
Animal feed	1.73	6.4%
Other Manufacturing Industries	1.25	4.6%
Bricks	1.03	3.8%
Other commodities:		
Other Petroleum Products	0.92	3.4%
Iron & Steel	0.57	2.1%
Slaughtered animal meat	0.47	1.7%
Metal products, machinery and electronic equipment	0.38	1.4%
Fertilizer	0.36	1.3%
Chemicals	0.30	1.1%
Paper	0.29	1.1%
Textile Products	0.29	1.1%
Jet fuel	0.24	0.9%
Wood timber and products	0.23	0.9%
Soya bean products	0.23	0.8%
Scrap metals	0.19	0.7%
Pharmaceutical Products	0.19	0.7%
Gas in Pipes	0.14	0.5%
Recycled paper	0.12	0.4%
Non-Ferrous Metal Products	0.12	0.4%
Printing and Publishing	0.08	0.3%
Gas	0.05	0.2%
Motor Vehicle Parts & Accessories	0.03	0.1%
Transport Equipment	0.02	0.1%
Pulp of wood and paper	0.005	0.0%
Motor vehicles and trucks	0.002	0.0%
	27.22	100.0%

Other manufacturing industries consist of manufactured goods that can be classified by the following (HS2) codes: (36) Explosives; pyrotechnic products; matches; pyrophoric alloys: certain combustible preparations. (71) Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewellery; coin. (90) Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus: parts and accessories thereof. (91) Clocks and watches and parts thereof. (92) Musical instruments; parts and accessories of such articles. (93) Arms and ammunition; parts and accessories thereof. (95) Toys, games and sports requisites; parts and accessories thereof. (96) Miscellaneous manufactured articles. (97) Works of art, collectors' pieces and antiques.

Western Cape Freight Demand Model (WC FDM™)
Air data

Overview

In 2020 there were 32 241 tonnes of freight transported via Cape Town International Airport of which the most (54%) were exported. The largest trading partners for export air freight were the United Kingdom (3 191 tonnes) and the Netherlands (3 136 tonnes). Mauritius (1 027 tonnes), Germany (974 tonnes) and China (840 tonnes) were the largest sources of air freight imports. Almost 99% of cargo is transported by belly-freight as Cape Town has no scheduled international full freighter services[1].

Figure 1 and 2 show the extent of air freight arriving (import) and departing (export) from Cape Town International Airport.

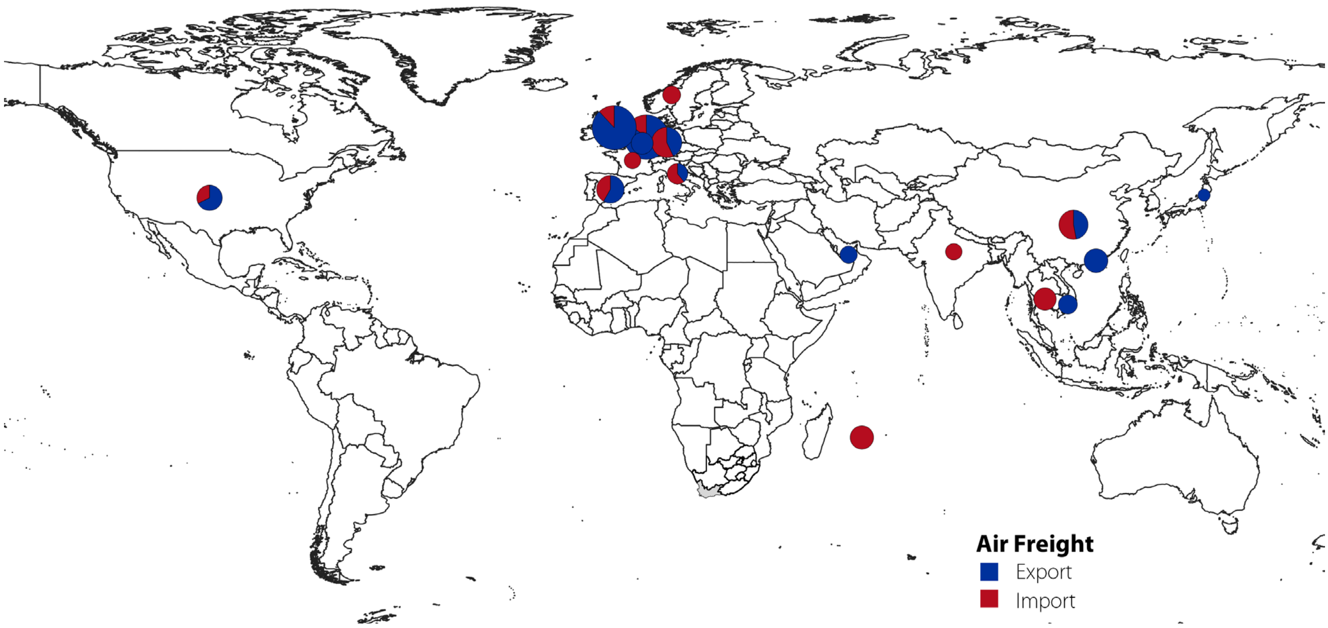


Figure 1: Map showing the import and export freight volumes for Cape Town International Airport in 2020

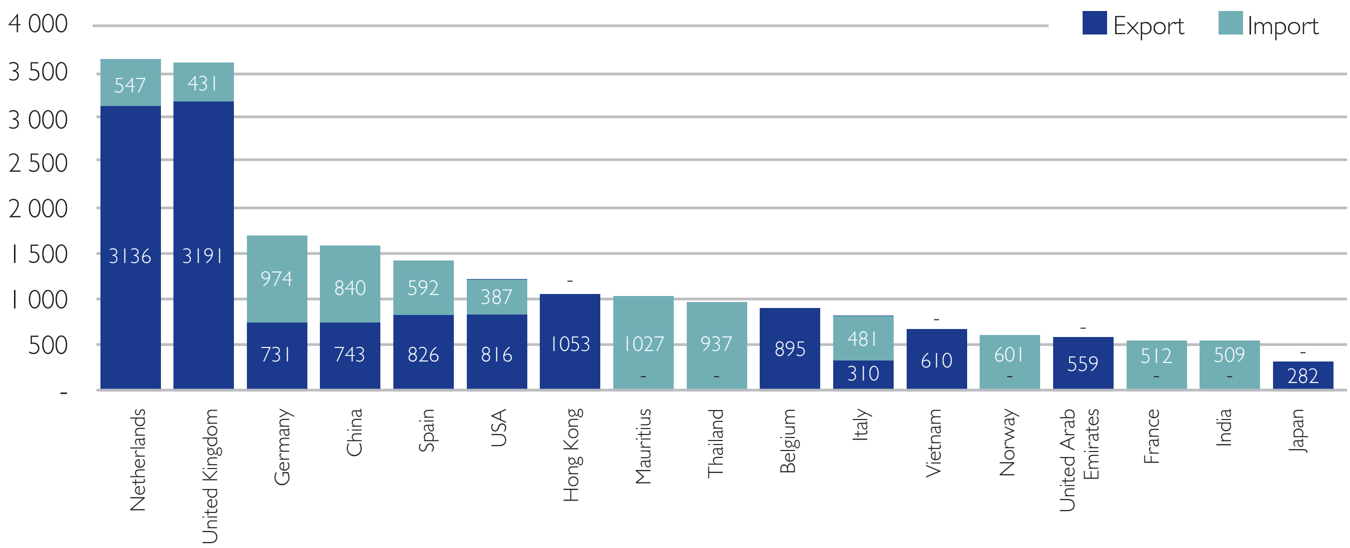


Figure 2: Import and export freight volumes for the major air freight trading partners facilitated by Cape Town International Airport in 2020

[1] Email correspondence with David King (Wesgro) on 25 October 2021 regarding Air freight data in the Western Cape.

Food makes up 29% of all air freight, of which the majority is fresh food (7 972 tonnes). Figure 3 shows the top 10 commodities in terms of total volume traded, that is both imports and exports combined.

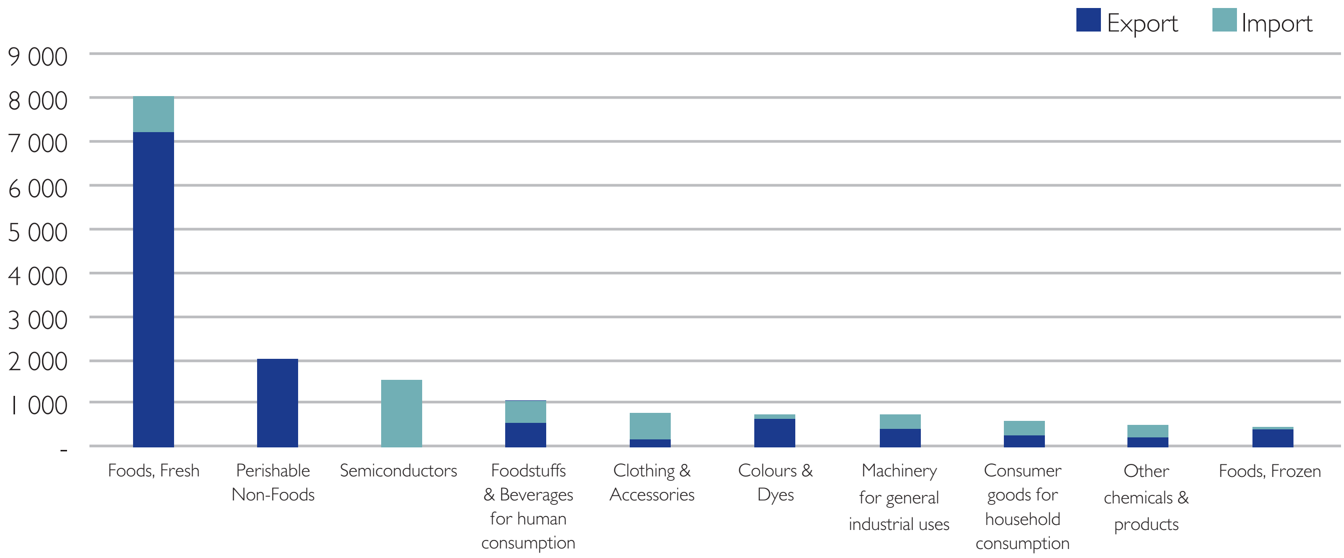


Figure 3: The most significant Cape Town air freight commodities based on trade volumes (exports and imports)

As a facilitator of international trade, the Cape Town International Airport is a net exporter of food. The largest trade volumes facilitated through CTIA by country are the United Kingdom (2 724 tonnes), the Netherlands (1 832 tonnes) and Hong Kong (1 020 tonnes). Of all the countries that trade through Cape Town International Airport, Thailand is the only country wherewith no food is traded in either direction.