SUSTAINABLE FREIGHT TRANSPORT IN SOUTH AFRICA: DOMESTIC INTERMODAL SOLUTIONS

JAN H. HAVENGA
ZANE SIMPSON
PIETER F. FOURIE
ANNEKE DE BOD
janh@sun.ac.za
Centre for Supply Chain Management, Department of Logistics
University of Stellenbosch

ABSTRACT

Due to the rapid deregulation of freight transport in South Africa two decades ago, and low historical investment in rail (with resultant poor service delivery), an integrated alternative to road and rail competition was never developed. High national freight logistics costs, significant road infrastructure challenges and environmental impact concerns of a road-dominated freight transport market have, however, fuelled renewed interest in intermodal transport solutions. In this article, a high-level business case for domestic intermodal solutions in South Africa is presented. The results demonstrate that building three intermodal terminals to connect the three major industrial hubs (i.e. Gauteng, Durban and Cape Town) through an intermodal solution could reduce transport costs (including externalities) for the identified 11.5 million tons of intermodal-friendly freight flows on the Cape and Natal corridors by 42% (including externalities).

INTRODUCTION

Domestic intermodal solutions have been proposed as a key element to address South Africa's freight logistics challenges with specific reference to improving economies of density and size, increasing access for marginalised rural economies and sustainably lowering logistics costs (DoT, 1998, 2005; CSIR, Imperial Logistics and University of Stellenbosch, 2009; Van Eeden and Havenga, 2010).

Intermodal services in South Africa are, however, still commonly understood to denote the movement of import and export containers – the concept of 'domestic' intermodal services does not really exist. As such, the development of intermodal technology has kept pace with the demands of shipping companies, but developments in domestic intermodal services have been neglected.

According to De Witt and Clinger (1999), domestic intermodal services are 'a significant and critical factor in the execution of supply chains'. Peetermans and Sellnick (2010) confirm that in Europe there is an increasing trend towards companies delivering both domestic and international services, with the number of companies providing both services increasing from 45% to 57% of total intermodal service providers between 2005 and 2009, and their TEU (twenty-foot equivalent unit) weighted market share increasing from 68% to 80%. Over the same period, intermodal operators providing only domestic services have on average grown their businesses; the opposite occurred with companies providing only cross-border intermodal services.

A regional study (in North Dakota, USA) conducted by Berwick (2001) demonstrated the benefits of domestic intermodal transport, including a reduction in overall transport costs, an increase in economic productivity, a reduced burden on highway infrastructure, higher returns from public and private infrastructure investments, reduced energy consumption, and increased safety. Brown and Hatch (2002) highlight the potential for intermodal freight transport to become the core of America's long-distance freight transport market, and even foresee a role for intermodal in middle- and short-distance markets. Strong growth in domestic intermodal freight is also reported for other countries, such as Italy and Germany (Silborn, 2008:42), which is significant as Germany holds a dominant position (almost half) in the European domestic intermodal market (Woxenius and Bärthel, 2008:27). One of the key driving forces behind this growth in intermodal freight transport is that intermodality allows each transport mode to utilise its core strength in building supply chains that are on the whole more efficient, cost-effective and sustainable.

The European Union's confidence in an optimal balance between road and rail freight transport is evidenced by its budget of €450 million for the period 2007–2013 for the Marco Polo programme. New projects that shift freight from road to rail, sea or inland waterways are co-funded during the start-up phase before the projects become profitable. The programme aims to free Europe's roads of an annual volume of 20 billion tonkilometres (tonkm) of freight, the equivalent of more than 700 000 trucks a year travelling between Paris and Berlin (European Commission, 2011).

Similarly, in South Africa policymakers have expressed the desire for a modal shift and a domestic intermodal solution (DoT, 2005 and 2011:7-8; The Presidency, 2011). Private partners have also expressed an interest in participating in such a solution through both direct investment (Naidoo, 2011) and co-operation using licensed technology such as RoadRailer (Grove, 2005: 19). In fact, as far back as 1995 in a survey conducted by Havenga (1995), 70% of 46 road hauliers indicated a willingness to explore piggybacking further with the railway. The road hauliers believed that the service would benefit insurance companies due to lower claims, reduce road maintenance expenditure and save transport costs; and that a joint venture with the railway could benefit all parties. The respondents were asked to provide numbers of specific trailers that they were willing to ring-fence and commit to a service, and 1 298 trailers were identified. However, four years later, Jorgensen (1999) reports that 'this potential, already successfully implemented in the Americas, Europe and Australasia, has unfortunately, not been realised in Southern Africa'. A contributing factor is that, in order to enable this shift, freight flows must be identified that exploit the core strengths of both rail and road, yet the case for domestic intermodal solutions has never been clearly and unequivocally made. The research presented in this article aims to rectify this situation.

In the next section, intermodal freight transport is defined. This is followed by observations from the intermodal freight transport experience in the USA and Europe to distil key guiding principles for South Africa. A description of the research strategy to build the case for domestic intermodal freight solutions is provided, followed by a discussion of the research results. The last section concludes and recommends a way forward.

DEFINITION OF INTERMODAL FREIGHT TRANSPORT

To ensure a common understanding of the concept of intermodal freight transport the following definition for intermodal is accepted:
'Intermodality is a characteristic of a transport system that allows at least two different modes to be used in an integrated manner in a 'door-to-door' transport chain. In addition, it is a quality indicator of the level of integration between different transport modes' (European Commission, 1997).

Integration requires the promotion of efficient interconnection and interoperability between networks and modes. 'Interoperability' refers to harmonised interfaces between transport systems and a high level of service. 'Interconnection' refers to the physical interconnection of networks through new design and expansion of the transport infrastructure and interchanges (Keller, Tsavachidis & Hecht, 2000).

In the case of domestic intermodal freight transport in South Africa, the transport modes specifically refer to road and rail freight transport. The process of intermodal transport consists of short-distance road feeder services to an intermodal terminal in a logistics hub where freight is consolidated into main-line block trains running the length of the corridor to a destination terminal. From the destination terminal, it is transported to distribution centres or end destinations via road transport.

OBSERVATIONS FROM THE INTERMODAL FREIGHT TRANSPORT EXPERIENCE IN THE USA AND EUROPE

Intermodal rail transport is the fastest-growing rail traffic segment in the USA, increasing from 3 million trailers and containers in 1980 to 11 million in 2010 (a compound annual growth rate of 5%). Most intermodal rail traffic consists of consumer goods, and approximately 40% is contributed by domestic intermodal rail traffic, reflecting the vital role railroads play in the domestic economy (Association of American Railroads, 2011). Case (2009) states that intermodal traffic is 'holding its position (in the USA) in a falling transportation market' and that this is proof that 'such services are now structurally integrated in the transportation market'. In Europe (OECD member countries), the number of TEUs on rail tripled between 1980 and 2008 to 16 million TEUs (a compound annual growth rate of 4%) (OECD, 2010). Intermodal traffic in the USA surpassed coal traffic as far back as 2003, and is projected to be rail's best hope of recovery after the recession (Kolstad, 2009). Woodburn (2008:442) also cites the decline in 'traditional' rail transport industries and the concurrent development of consumer goods markets as a driver of the substantial intermodal freight growth in the United Kingdom.

Yevdokimov (2000:6-9) provides an extensive analysis of intermodal's advantages and echoes Berwick's (2001) regional findings (mentioned in the introduction) on a macroeconomic scale, i.e. increased volumes on the transport network resulting in economies of density, expansion of the network and resultant economies of size, reduction in logistics, and increased access to input and output markets. The European Intermodal Research Advisory Council (EIRAC, 2005) confirms that intermodal transport will enable Europe to cope with increasing transport demands, improve the environmental impact of transport, and enhance its competitiveness.

These advantages are better understood if intermodal transport is regarded as a general purpose technology (GPT) which is typically characterised by statistically significant spill-over effects to other areas of the economy (Laaksonen, 1999; Yevdokimov, 2000). Yevdokimov (2000) states that, in this view, intermodal transport is viewed as a two-way improvement of economic productivity, by improving both the current operational functions of the system and expanding these functions. He demonstrates that a once-off 10% increase both in the frequency of transport and transport network expansion due to intermodal transport resulted in a permanent increase in annual economic growth, gradually increasing and reaching a peak of 3% per annum after 15 years and settling over the long term at a 0.4% increase in economic growth per annum. The GPT nature of intermodal is also alluded to by Brown and Hatch (2002), who suggest that intermodal 'may be the most efficient and socially beneficial means of providing freight capacity'.

Positive environmental effects were not included in Yevdokimov's analysis (2000:18). The addition of this factor to future models should further illustrate the positive spin-offs from intermodal transport. In Europe, for example, rail-road intermodal solutions reduce carbon dioxide emissions by 55% (or by 1.8 million tons per year) and save 29% of energy usage compared to a road-only solution, with estimated annual environmental savings of about €180 million (European Commission, 2008). According to the Association of American Railroads (2011), railroads are on average four times more fuel efficient than trucks, with 7 gallons of fuel required to haul one ton of freight coast-to-coast in America via rail, compared with 28 gallons via road. This resulted in railroads, while almost doubling their freight volume between 1980 and 2010, using virtually the same amount of fuel as in 1980. The Association states that shifting 10% of long-distance road freight to rail would save more than a billion gallons of fuel per year, and annual greenhouse gas emissions would fall by more than 12 million tons.

Despite the benefits already being experienced, a number of areas that require attention in order to expand the use of intermodal transport have been identified internationally. The continuous development of optimal transport connections and interoperability standards among and between modes and logistics hubs are vital for the development of the logistics network of a region. Policymakers should also align regulations and infrastructure plans at all levels in order to enable efficient transport connections and stimulate integrated logistics strategies. Effective IT platforms and improved education and training on intermodality are critical, as is the requirement for all modes to operate at agreed levels of efficiency with concomitant shared liabilities (EIRAC, 2005; Site & Salucci, 2005; Vasiliauskas & Bazaras, 2006).

The fact that South Africa's national railroad has a historical infrastructure investment backlog and that the above-mentioned factors all require attention in South Africa, point to significant challenges locally. However, there is also the opportunity to learn from international experience and, through collaborative planning and development, to bypass many of the challenges caused by disjointed developments. The existence of long, dense, standardised flows between a few, highly concentrated origin and destination pairs also significantly enhances the prospects of success, as is illustrated in the research results.

RESEARCH METHODOLOGY

An initial approach to determining the target market for domestic intermodal solutions in South Africa was proposed by Van Eeden and Havenga (2010), identifying intermodal-friendly flows based on uniform, dense freight flows on long-distance corridors, derived from South Africa's national freight flow model (Havenga, 2007).

Subsequent to this analysis, more in-depth research and stakeholder consultations were conducted to develop a high-level business case for intermodal-friendly traffic. The research was also expanded to quantify the potential cost savings of an intermodal solution versus a road-only solution for the identified traffic. In addition, the potential impact of a domestic intermodal solution on externality costs and carbon dioxide emissions was also analysed. This subsequent research methodology is much more detailed and robust, reflecting the deeper analysis and segmentation principles required to initiate the process of building a business case for domestic intermodal, building on the strategic position put forward by Van Eeden and Havenga (2010: 263). The research methodology is depicted in Figure 1.

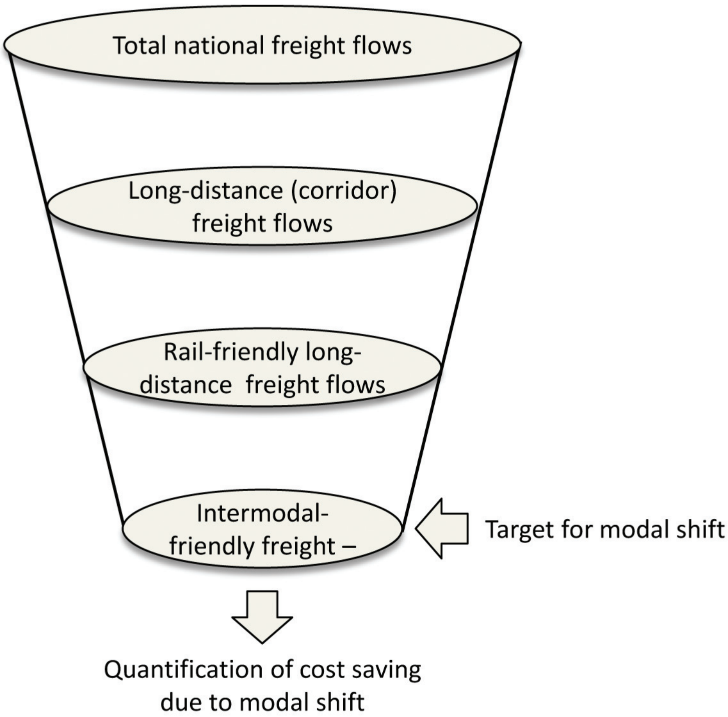

Figure 1: Research methodology

The first step in this process is to define total, national freight flows and long-distance (or corridor) flows as a subset thereof. The modelling of national freight flows in South Africa is driven by an exhaustive sectoral supply-demand model of the economy, culminating in a gravity model to determine freight flows. Corridor freight is long haul, typically comprising higher-value commodities, which originate at many points in cities, converge, flow to a divergence point within other cities, and are then distributed to consumption points. The approach to the national freight flow model and corridor freight flows has been well-documented and, as it is not the focus of this article, the reader is referred to Havenga (2007 and 2010) for a detailed description.

The next step is to identify rail-friendly freight, followed by extracting intermodal-friendly freight as a subset thereof. The potential cost savings of shifting freight to intermodal solutions are subsequently quantified. Next, the research approaches for each of these steps are discussed in turn.

Identification of rail-friendly freight

In South Africa, rail's core strength has traditionally been the transportation of bulk commodities, because this market segment enables the optimal utilisation of rail's **genetic technologies and economic fundamentals**.

Railways create and develop market opportunities by taking advantage of their **genetic technologies**, i.e. **bearing, guiding** and **coupling**. **Bearing** supports axle-loads of up to 40 tons (and therefore density) but at relatively low speed, while **guiding** refers to the wheel-on-track differentials (and therefore speed of movement) but with relatively low axle-load. When bearing and guiding are added to **coupling**, this translates into long trains with high volumes (Van der Meulen, 2007). Bearing, guiding and coupling in optimal combination therefore support heavy intermodal or double-stack container trains, attaining axle loads of up to 32 tons at 120 km/h. This provides volume throughput opportunities, but also slightly less price-sensitive markets.

The key **economic fundamentals** that apply to rail are **freight uniformity** and **long-distance line density**. **Freight uniformity** refers to the standardisation of freight to facilitate handling and transport, such as bulk and palletised commodities (hereafter referred to as unitisable commodities).

Line density refers to the volume of traffic per kilometre of railroad, expressed as 'tonkm per route kilometre'. 'Tonkm' is the standard unit for measuring freight transport, as it takes into account both tons and distance travelled (Chasomeris, 2003:133). Given rail's high fixed cost, higher density means that the cent per tonkm cost of a railroad will decrease with each additional tonkm of activity over the same track length. Dense corridors are ideal for rail or intermodal transport, as the density creates economies of scale because of the large volumes of tonkm generated (De Bod & Havenga, 2010:98; Havenga, 2010). For the purposes of this article, it is assumed that the core corridor network of the current rail system is in place and that an economic business case exists to keep it in place. (The current debate in South Africa is not about the corridor network, but revolves around the branch line network, and it has been shown that even in some of these cases, the lines could be profitable [Simpson & Havenga, 2010:252]). Flowing from this assumption, any additional freight will cause an improvement in density (i.e. tonkm per route kilometre, as discussed above), thereby reducing costs. Even so, for commercial purposes, a cut-off density of 100 000 tons per year (a train per week) is used to identify rail-friendly flows.

Distance is an important consideration in identifying intermodal freight ('d' in Figure 2) (Button 2010: 339), because of the low distance sensitivity of rail transport versus road transport.

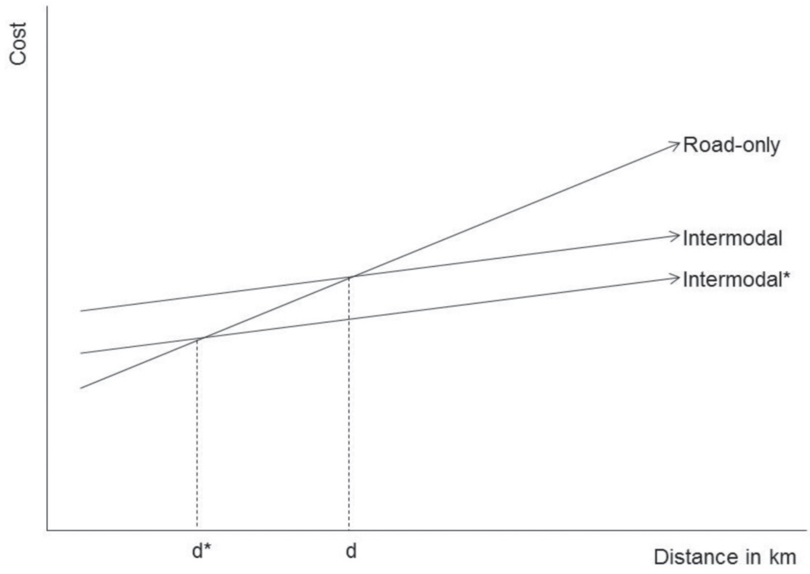

Figure 2: Distance trade-off in intermodal versus road-only cost (adapted from Button, 2010)

Button (2010:340) argues that efficient intermodal technology moves the intermodal line in Figure 2 horizontally downwards on the graph (to Intermodal*). This will cause 'd' to move to the left, decreasing the distance at which intermodal will become cheaper than road-only transport (to 'd*'). Determining 'd*' is, however, complex. As an extreme case study (due to the short distances involved), the United Kingdom Department for Transport (DfT) (2010: 3) analysed a 69 km intermodal route from Grangemouth across Central Glasgow to Paisley and a 116 km bulk cement powder route from East Lothian to North Lanarkshire. The DfT's case study confirms cost savings and environmental benefits for both routes, even over these short distances.

The results from South Africa's national freight flow model indicate that most long-distance transport of unitisable commodities in South Africa occurs over distances longer than 500 km (Figure 3). Therefore, an assumption of distances further than 500 km for rail-friendly unitisable commodities was deemed to be conservative and was adopted.

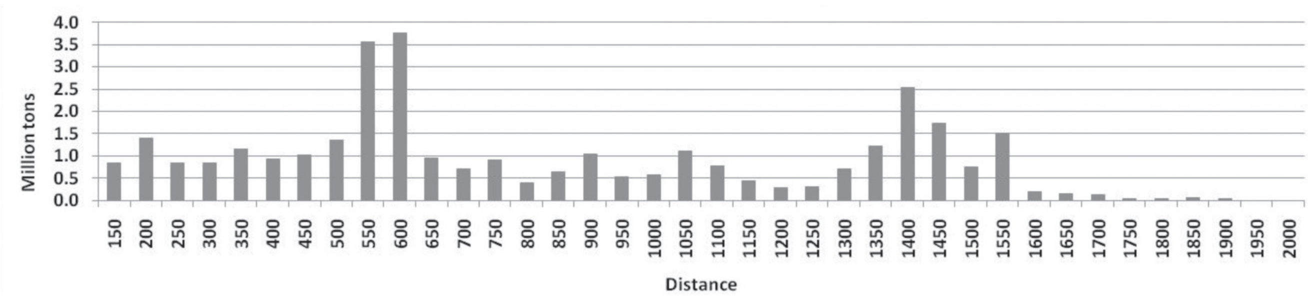

Figure 3: Transport distances of unitisable commodities >150 km (based on results from South Africa's national freight flow model as described in Havenga, 2007 and 2010)

Rail-friendly freight is, therefore, defined as freight flows between dense origin-destination pairs of 100 000 tons per annum (a minimum of a train per week) over distances greater than 500 km. The portion of this freight that is suitable for intermodal transport is subsequently identified.

Identification of intermodal-friendly freight

Brown and Hatch (2002) assert that 'rail intermodal's economic value and contribution to the economy resides primarily in long-haul corridors' and highlight typical freight, mostly fast-moving consumer goods (FMCG). These are products that are sold quickly and generally consumed on a regular basis, as opposed to durable goods such as kitchen appliances, which are replaced over a period of years. FMCG product categories comprise food and dairy products, pharmaceuticals, consumer electronics, packaged food products, household products, beverages, and the like.

The key driver of density (one of rail's economic fundamentals described previously) is the unitisation of cargo. This requires a large storage footprint (e.g. iron ore is stockpiled, and containers are stacked while goods within containers are palletised). Distribution centre to distribution centre (DC-to-DC) traffic for redistribution is naturally densified around a few corridors, but has no intermodal potential if it cannot be unitised (through palletisation) and 'connected' from shelf to shelf between these DCs. For the purposes of isolating intermodal-friendly transport from rail-friendly freight flows, the concept of 'unitisable' was therefore narrowed to 'palletisable' in order to ensure that only freight that can be easily packed on pallets and stacked in containers was identified. In order to identify freight that could be described as 'palletisable', three workshops were conducted with industry experts and the commodities from the freight flow model (Havenga, 2007) were classified into two groups, i.e. 'palletisable' and 'non-palletisable'. This classification is reflected in Table 1.

Table 1: Classification of palletisable versus non-palletisable final consumption products

Palletisable FMCG	Non-palletisable FMCG
• Food & food processing	• Automotive
• Beverages	• Electrical machinery
• Tobacco products	• Furniture
• Pharmaceuticals & toiletries	• Metal products excluding machinery
• Motor vehicle parts & accessories	• Transport equipment
• Other chemicals	
• Non-metallic mineral products	
• Bricks	
• Non-ferrous metal basic industries	
• Machinery and equipment	
• Textiles & clothing	
• Printing and publishing	
• Other manufacturing industries	
• Rubber products	

Finally, the concept of **terminal density** was added as a special consideration for intermodal-friendly transport. Dense terminals lead to the standardisation of equipment and processes, which drives down costs (Kreutzberger 2008:153), and also moves 'd' (refer to Figure 2) to the left, i.e. reducing the distance at which intermodal transport becomes more cost-effective than road-only transport. In this case, two types of flows were considered: long-distance flows between metropolitan areas (as 'low hanging fruit', or traffic that can switch easily) and flows from large manufacturing installations in rural areas to metropolitan areas.

Cost analysis

The cost of road freight transport is obtained from South Africa's national logistics cost model. The logistics cost model research approach and 2008 results are detailed in Havenga (2010), and the 2009 results published in Havenga, Pienaar and Simpson (2011). The calculation of road transport costs is driven by weight in tons and distance travelled, and involves the summation of all the different cost elements of road transport on a specific route (including items such as licence fees and toll fees). The different cost elements of road transport are determined by the vehicle type. The vehicle type, in turn, is determined by the commodity type, network typology (i.e. whether it travels on corridors, in rural areas, or in metropoles) and route of travel.

To determine the current transport cost of palletisable freight, the total weighted cost of these flows between distribution centres was calculated. This was translated into cent per tonkm data and compared to the current actual cent per tonkm data for similar freight received from the national railroad. The potential cost savings experienced on rail due to the introduction of an intermodal solution can be attributed to an increase in density (i.e. a more favourable relationship between fixed and variable costs, where more freight is available to absorb fixed costs), i.e. a shift down the Harris (1977) curve, depicted in Figure 4. (System density savings represented by logistics service providers taking over some marketing, customer service and terminal handling costs have not yet been established).

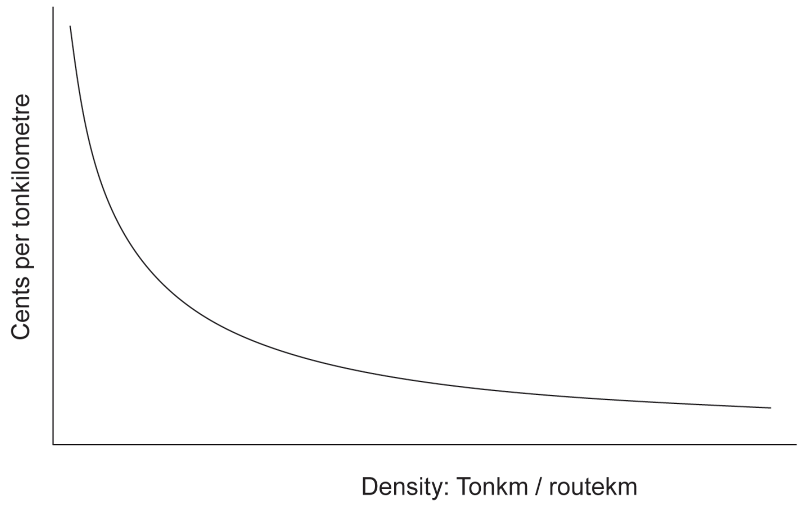

Figure 4: The economics of rail density (adapted from Harris, 1977)

Externality costs

Externality costs include all non-charged costs and encompass emissions, accidents, congestion, policing and noise pollution. Total road and rail freight externality costs were calculated for the first time in South Africa's sixth annual state of logistics survey (Havenga, Van Eeden & Simpson, 2009), and refined in the seventh survey (Havenga, Simpson, Van Eeden, Fourie, Hobbs & Braun, 2010).

Externality costs are calculated to depict the actual cost to the environment in monetary terms. Externality costs, with the exception of emissions, are based on a study done by Jorgensen (2009). Jorgensen (2009:6-12) calculates accident costs based on a 2006 survey on the N3 highway between Johannesburg and Durban, congestion costs based on studies in Australia and Europe, and noise and policing costs based on Australian research.

Emission externality costs are determined by calculating emission generation per tonkm per mode. For road, fuel consumption is the critical variable when calculating the amount of carbon dioxide emissions per tonkm. For rail, a weighted combination of diesel consumption and electricity consumption is used to determine carbon dioxide emissions per tonkm. The externality cost of the emissions is based on a flat externality cost of $30 per ton of carbon dioxide emissions generated, which is based on the average cost of offsetting carbon dioxide emissions. (Calculating the average carbon dioxide emission offset cost is a topic of research in itself and has generated many debates in this and other industries. Values as low as $10 and as high as $90 have been observed. The fact that exact levels are unknown at this stage, and that tax levels are under debate, makes calculating carbon dioxide emissions a precarious subject. McCarl and Sands [2007] use three scenarios, with $30 as the average.)

With regard to the intermodal solution's emissions, the same approach is used as previously stated but only for intermodal-friendly freight. This is possible as the emissions calculated are mode specific and are calculated at a tonkm level. Savings are calculated as the amount of emissions not being produced by road freight due to the switching of all the potential intermodal freight to rail.

South Africa's National Treasury is seeking to implement a carbon tax by 2012 to reduce greenhouse gas emissions (National Treasury, 2010). A tax of R75 per ton (in 2005 terms) of carbon dioxide is proposed, increasing to around R200 per ton (in 2005 terms) of carbon dioxide (the timeframe is not clear from the National Treasury discussion document). In this article, the potential reduction in tonnage of carbon dioxide emitted is demonstrated through a R165 per ton of carbon dioxide tax (this was the value used by the National Treasury in their feasibility studies) (National Treasury, 2010). Calculating the amount of carbon dioxide tax savings that could be achieved by using an intermodal solution to transport freight was determined by using the emission savings calculated and multiplying this with the tax rate of R165 per ton of carbon dioxide.

DISCUSSION OF RESEARCH RESULTS

Total corridor freight in South Africa amounted to 192 million tons (or 100 billion tonkm) in 2009. Twenty-seven per cent of freight shipped on these corridors (51 million tons) and 28% of tonkm (28 billion tonkm) represented intermodal-friendly freight. (The discrepancy between the ton and tonkm contributions indicates that this freight tends to move over longer average transport distances than other freight.)

The majority of this intermodal-friendly freight moves on the Gauteng–Cape Town corridor (Cape corridor) and the Gauteng–KwaZulu-Natal corridor (Natal corridor) (47% of tons, 59% of tonkm), resulting in a narrow description of a highly densified, easily targetable market segment (Figure 5).

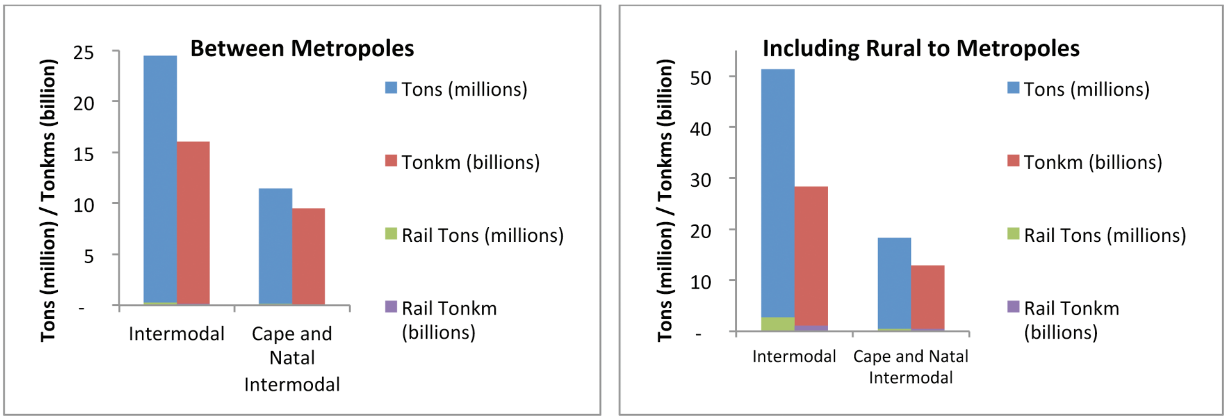

Figure 5: Relative size of the intermodal market for the Cape corridor and Natal corridor

The Cape corridor and Natal corridor contain a sizeable market for intermodal freight (relative to the current railway turnover and volumes), contributing a total of 11.5 million tons (9.5 billion tonkm) that travels an average distance of 829 km. A further 6.8 million tons (3.4 billion tonkm) could be added to the two corridors due to palletisable freight that originates in manufacturing facilities in rural areas and utilises a large portion of the corridors. This means that a total of 18.3 million tons (12.9 billion tonkm) can be classified as potential intermodal freight.

In 2009, the total transport cost of the 11.5 million tons of intermodal-friendly cargo between metropoles on road was R4 billion, i.e. 43 cents per tonkm. (The deterioration of the average fuel price between 2009 [the base year of the cost model] and June 2011 means this cost has increased to 47.3 cents per tonkm.) The 150 000 tons of comparable shipments, where the same type of cargo was transported over the same routes by rail, was charged at 34 cents per tonkm (including terminal charges). The total road transport costs when palletisable freight from manufacturing facilities in rural areas is added was R5.4 billion for the 17.8 million tons (46.6 cents per tonkm), compared with the 32.8 cents per tonkm it costs to rail similar freight on similar routes.

The potential cost reduction achieved through an intermodal solution is attributable to a shift on the Harris curve due to an increase in density. Figure 6 shows that potential intermodal-friendly freight on all corridors has a density of 1.2 million tonkm/routekm (at a cost of 34 cents per tonkm), while the Cape and Natal corridors have a slightly higher density at 1.3 million tonkm/routekm (at a cost of 32 cents per tonkm). If the potential intermodal freight on these two corridors were to shift to rail, the density would increase to 5 million tonkm/routekm (at a cost of 18 cents per tonkm). The increase in density would therefore cause a decrease in cost of 14 cents per tonkm, i.e. a 44% transport cost saving due to the change in density.

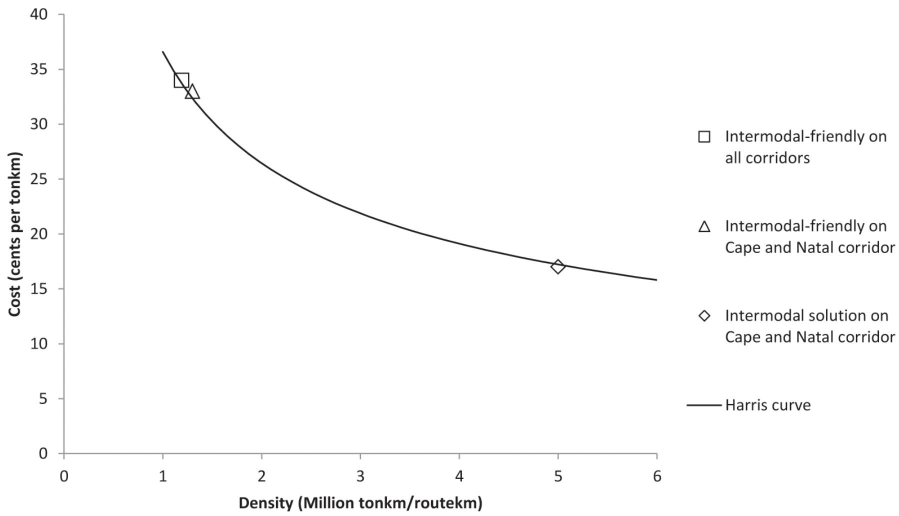

Figure 6: Intermodal density change on the Harris curve

Figure 7 compares the current costs per tonkm to the potential intermodal solution costs depicted in Figure 6. With the implementation of an intermodal solution, a cost decrease of between 16 and 18 cents per tonkm could be expected (depending on whether the rural-to-metropole palletisable freight is included or not) compared with the 2009 rail average cost for all corridors. By implementing an intermodal solution, the 11.5 million tons could be transported at a cost of only R1.6 billion, resulting in a R2 billion saving per annum based on 2009 values (R1.8 billion per annum based on 2011 values). If the rural-to-metropole palletisable freight is included, the transportation of the 18.3 million tons could be done at R2.5 billion, resulting in a saving of R3 billion per annum in 2009 terms (R3.3 billion in 2011 terms).

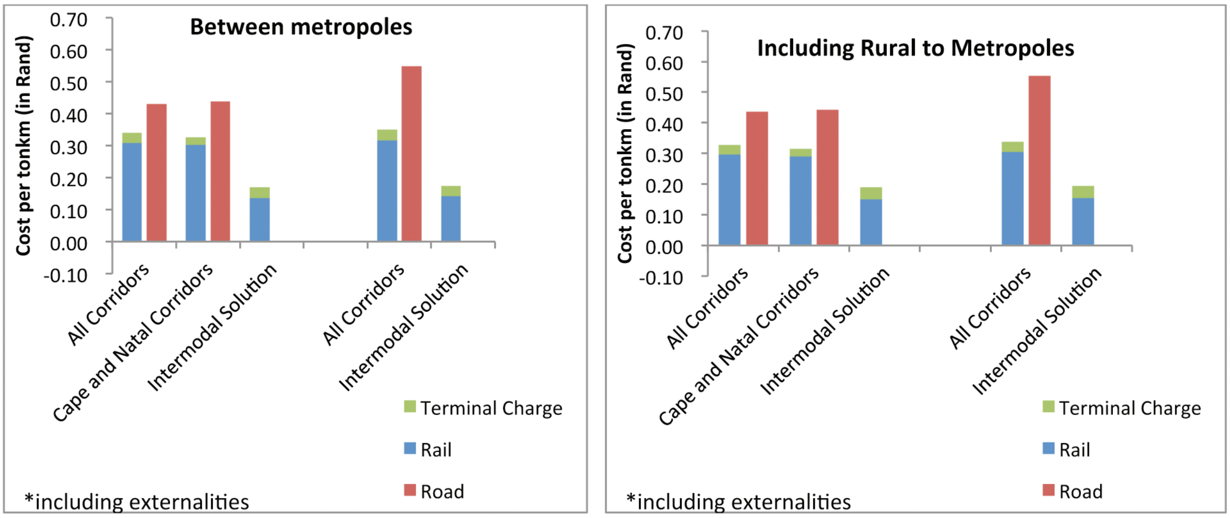

Figure 7: Current road cost versus potential intermodal cost for Cape and Natal corridor combined (per tonkm)

Externality costs have a much larger impact on road than on rail, thus contributing to the large price difference when comparing road and potential intermodal costs when externalities are included. The difference between road and an intermodal solution including externalities is 37 cents/tonkm in 2009 terms and 41 cents/tonkm in 2011 terms.

When externality costs are included for palletisable freight flowing between metropoles, the total potential saving increases to R2.2 billion a year based on 2009 values and R2.4 billion based on 2011 values. If rural-to-metropole palletisable freight is included, the saving increases to R2.9 billion in 2009 terms (R3.2 billion in 2011 terms). Figure 8 illustrates this relationship.

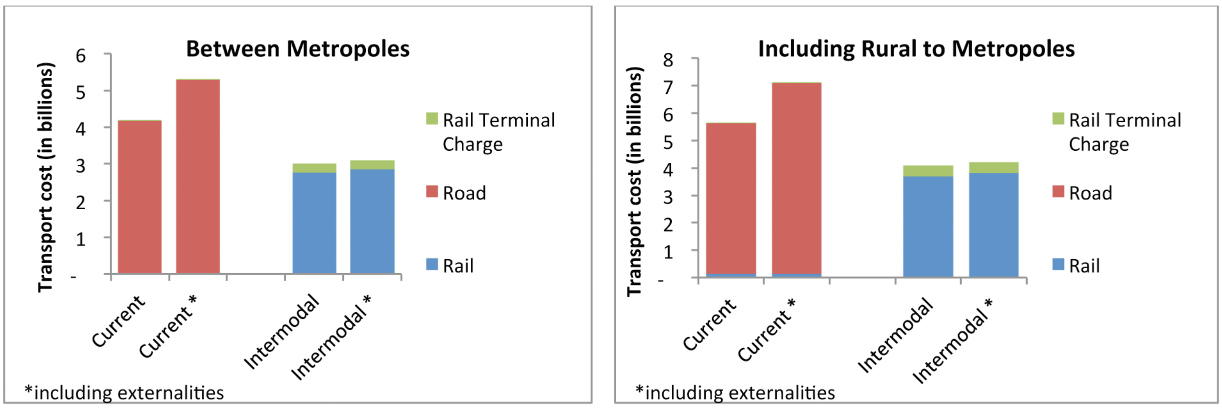

Figure 8: Current total road cost versus potential intermodal cost for Cape and Natal corridor combined

The introduction of a carbon tax will lead to a much greater focus on emission reduction to reduce logistics costs and carbon footprint. First-world markets already discriminate against high carbon-footprint commodities. Clavin (2010: 4) analysed ethical consumerism in the United Kingdom from 2007 to 2009 in various economic sectors. The highest growth in ethical product consumption is reported in the food and drink sector (27%) and the personal products sector (29%), the target industries for intermodal solutions proposed in this article. It will be important for freight owners to demonstrate lower carbon footprints in order to remain competitive. Figure 9 depicts the potential reduction in tonnage of carbon dioxide emissions if an intermodal solution is implemented in South Africa.

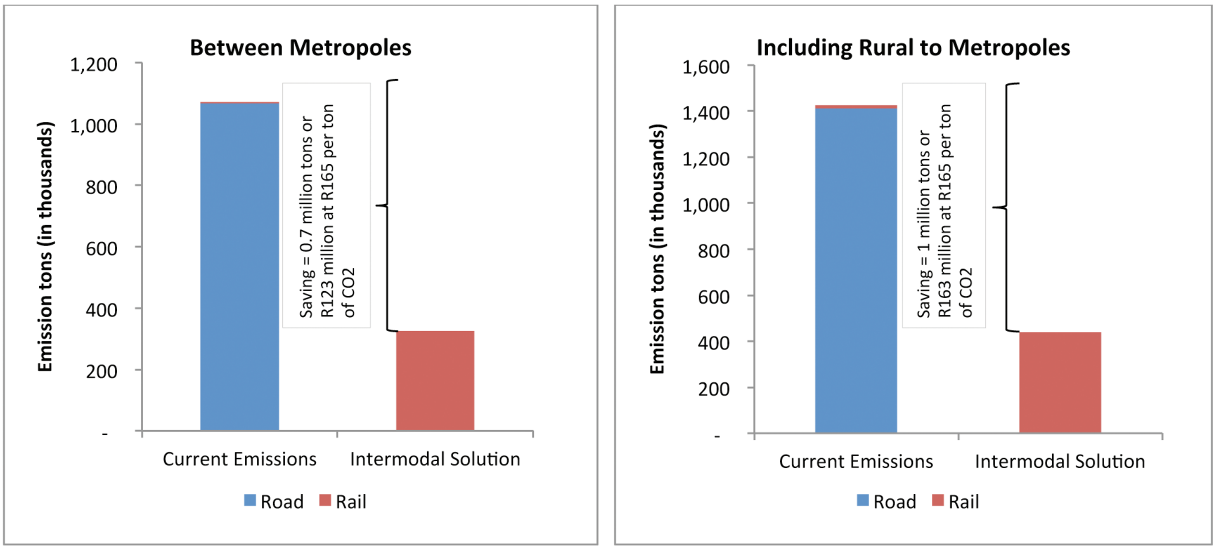

Figure 9: Reduction in tonnage carbon dioxide emissions due to an intermodal solution on the Cape and Natal corridors

CONCLUSION AND NEXT STEPS

The challenges in developing and implementing successful domestic intermodal freight solutions are manifold, as highlighted by international experiences, and should be approached realistically. However, as illustrated, the potential benefits of domestic intermodal solutions to the South African economy are clear – significant cost and emissions reductions in an uncertain energy and carbon offset world. The economic realities of the future and increased demand for freight transport also leave players little choice but to galvanise solutions in this area. Stone's (2008:246) view that domestic intermodal 'will be a significant part of the expectations of a new invigorated rail freight activity' is therefore supported by the findings presented in this article.

The stakeholders in the potential domestic intermodal freight market in South Africa are highly concentrated and consist of three core groups, namely, Transnet, logistics service providers and shippers or freight owners, with the market concentration spread over a limited number of large freight owners.

The political and corporate will to develop domestic intermodal solutions does exist. The high-level business case points to the feasibility of such a solution. Stakeholders are challenged to take the initiative, and set aside myopic interests and paradigms based on the past, to address this challenge. As with the development of key national roads projects (McKenzie 2011a and 2011b) and bulk export rail expansions (Creamer, 2011), the establishment, fast-tracking and collaborative funding of a domestic intermodal freight programme must be a macroeconomic priority. In the absence of a national body to drive this, stakeholders who are eager to take up the challenge are urged to contact the author. The scope of the interaction could be limited, initially, to the joint conduct of a pre-feasibility study with interested parties.

REFERENCES

Association of American Railroads. 2011. *Rail intermodal keeps America moving*. Available from: http://www.aar.org/Economy/~/media/aar/Background-Papers/Rail-Intermodal.ashx (Accessed 13 June 2011).

Berwick, M. 2001. *North Dakota strategic freight analysis: Item I. Intermodal highway/rail/ container transportation and North Dakota*. Fargo: North Dakota State University.

Brown, T.R. & Hatch, A.B. 2002. *The value of rail intermodal to the US economy*. The American Association of State Highway and Transportation Officials: Special Committee on Intermodal Transportation and Economic Expansion. Available from: http://intermodal.transportation.org/Documents/brown.pdf (Accessed 4 July 2011).

Button, K. 2010. *Transport Economics*. 3rd edition, Cheltenham: Edward Elgar.

Case, R. 2009. The complex future of the North American rail network. *Transport and Logistics*. Spring 2009. Toronto: Oliver Wyman.

Chasomeris, M.G. 2003. South Africa's sea transport costs and port policy in a global context. *Africana Bulletin*. 51:133-63.

Clavin, B. 2010. *Ethical Consumerism Report 2010: Ethical shopping through the downturn*. Manchester: The Co-operative Bank.

CSIR, Imperial Logistics & University of Stellenbosch. 2009. Logistics value and costs: driving macro and micro-economic change towards global competitiveness and sustainability. *6th Annual State of Logistics Survey for South Africa*. Available from: http://www.csir.co.za/sol/ (Accessed 10 June 2011).

Creamer, T. 2011. Transnet opens door to private participation in big rail, ports projects. *Engineering News*. 17 June 2011.

De Bod, A. & Havenga, J.H. 2010. Sub-Saharan Africa's rail freight transport system: Potential impact of densification on cost. *Journal of Transport and Supply Chain Management*. November 2010:89-101.

De Witt, W. & Clinger, J. 1999. *Intermodal Freight Transportation*. Committee on Intermodal Freight Transport. US Transportation Research Board. Available from: http://onlinepubs.trb.org/onlinepubs/millennium/00061.pdf (Accessed 21 June 2011).

DoT (National Department of Transport, South Africa). 1998. *Moving South Africa: A Transport Strategy for 2020*. Chapter 9: Strategy Recommendations: Freight Customers. Pretoria: Department of Transport.

—. 2005. *National freight logistics strategy*. Pretoria: Department of Transport.

—. 2011. *Road Freight Strategy for South Africa: Final draft*. Pretoria: Department of Transport.

EIRAC (European Intermodal Research Advisory Council). 2005. *Strategic Intermodal Research Agenda 2020*. Brussels.

European Commission. 1997. *Communication from the Commission to the European Parliament and the Council: Intermodality and intermodal freight transport in the European Union*. Brussels.

—. 2008. *ICT and e-Business Impact in the Transport and Logistics Services Industry*. Study report No. 05/2008. Brussels.

—. 2011. *Marco Polo - New ways to a green horizon*. Available from: http://ec.europa.eu/transport/marcopolo/ (Accessed 21 June 2011).

Grove, J. 2005. Chief Executive's Report, *Unitrans Limited Annual Report*. Johannesburg: Unitrans Limited.

Harris, R.G. 1977. Economies of traffic density in the rail freight industry. *The Bell Journal of Economics*. 8(2):556-64.

Havenga, J.H. 1995. *Intermodal transport within Transnet: a Spoornet perspective*. Unpublished research report of the Piggyback Study Group. Johannesburg: Transnet.

—. 2007. *The development and application of a freight transport flow model for South Africa*. Unpublished doctoral thesis. Stellenbosch: University of Stellenbosch.

—. 2010. Logistics costs in South Africa – The case for macroeconomic measurement. *South African Journal of Economics*. 78(4):460-78.

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

Havenga, J.H., Simpson, Z.P., Van Eeden, J., Fourie, P.F., Hobbs, I. & Braun, M. 2010. Logistics costs – Volatility, agility and future shock. *7th Annual State of Logistics Survey for South Africa*. Available from: http://www.csir.co.za/sol/docs/7th_SoL_2010_March.pdf (Accessed 15 May 2011).

Havenga, J.H., Van Eeden, J. & Simpson, Z.P. 2009. The state of logistics in South Africa – sustainable improvements or continued exposure to risk. *6th Annual State of Logistics Survey for South Africa*. Available from: http://www.csir.co.za/sol/docs/6th_SoL_survey_web_final.pdf (Accessed 4 July 2011).

Jorgensen, A.A. 1999. Intermodal transport options for international and domestic freight requirements in Southern Africa. *Council of Logistics Management Conference*. Johannesburg, April 1999.

—. 2009. Transport costs and the relevance of externalities: A discussion paper. *Africa Rail*, 25 June 2009.

Keller, H., Tsavachidis, M. & Hecht, C. 2000. *Interconnection of trans-European networks (long-distance) and regional/local networks of cities and regions*. Final report for CARISMA (Concerted action for the interconnection of transport systems in the member states in association with the European Commission). Available from: http://www.transman.hu/Projektek/carisma.pdf (Accessed 21 June 2011).

Kolstad, T. 2009. *Domestic intermodal traffic is the best hope for railroad recovery*. Available from: http://www.glgroup.com/News/Domestic-intermodal-traffic-is-best-hope-for-railroad-recovery-42619.html (Accessed 23 June 2011).

Kreutzberger, E. 2008. The impacts of innovative technical concepts for load unit exchange on the design of intermodal freight bundling networks. In: Konings, R., Priemus, H. & Nijkamp, P., eds. *The Future of Intermodal Freight Transport*. Cheltenham: Edward Elgar.

Laaksonen, S. 1999. Employment and technology: Results of recent econometric research. In: Lievonen, J. & Císcar, J.C., eds. *IPTS-ESTO Techno-Economic Analysis Report*. June 1999. European Commission.

McCarl, B.A. & Sands, R.D. 2007. Competitiveness of terrestrial greenhouse gas offsets: are they a bridge to the future? *Climatic Change*. 80(1):109-26.

McKenzie, J. 2011a. SA stresses partnerships, local content as it meets transport investors. *Engineering News*. 13 June 2011.

— 2011b. Four major SA roads projects presented to potential investors. *Engineering News*. 14 June 2011.

Naidoo, B. 2011. Moving freight to rail could offset higher costs due to carbon taxing. *Engineering News*. 3 June 2011.

National Treasury. 2010. *Discussion paper for public comment - Reducing Greenhouse Gas Emissions: The Carbon Tax Option*. December 2010.

OECD. 2010. *Trends in the Transport Sector 1970-2008: Container transport dataset*. International Transport Forum, OECD. Available from: http://www.internationaltransportforum.org/statistics/trends/index.html (Accessed 4 July 2010).

Peetermans, E. & Sellnick, O. 2010. *Report on combined transport in Europe*. International Union of Railways. Paris. December 2010.

The Presidency. 2011. *Diagnostic: Transport infrastructure – roads, rail, ports and air*. National Planning Commission, 8 June 2011. Available from: http://www.npconline.co.za/pebble.asp?relid=184 (Accessed 4 July 2011).

Silborn, H. 2008. Measures promoting intermodal transport as an alternative to pure road transport. *International Conference on Heavy Vehicles*. Paris. 19-22 May 2008.

Simpson, Z. & Havenga J.H. 2010. Revitalisation of branch lines in South Africa: A long-term view for sustainability. *Journal of Transport and Supply Chain Management*. November 2010:243-54.

Site, P.D. & Salucci, M.V. 2005. *Freight transport thematic research summary*. Transport Research Knowledge Centre. Brussels: European Commission.

Stone, B. 2008. Critical success factors: interconnectivity and interoperability. *The future of intermodal freight transport*. Cheltenham: Edward Elgar.

United Kingdom Department for Transport. 2010. *Short Haul Rail Freight on Track for Profits in Scotland*. London.

Van der Meulen, D. 2007. Leveraging the competitive strengths of railways in South Africa. *Proceedings of Transport Infrastructure and Development Conference*. Sandton, Johannesburg. 30-31 May 2007.

Van Eeden, J. & Havenga, J.H. 2010. Identification of key target markets for intermodal freight transport solutions in South Africa. *Journal of Transport and Supply Chain Management*. November 2010:255-67.

Vasiliauskas, A.V. & Bazaras, D. 2006. Analysis of problems with containers as intermodal loading unit. *Transport and Telecommunication - Proceedings of the 5th International Conference RelStat'05*, 7(2): 232-239. Riga. 13-14 October 2005.

Woodburn, A. 2008. Intermodal freight in Britain: A terminal problem? *Planning, Practice and Research*. 23(3), August 2008.

Woxenius, J. & Bärthel, F. 2008. Intermodal road-rail transport in the European Union. In Konings, R., Priemus, H. & Nijkamp, P., eds. *The Future of Intermodal Freight Transport*. Cheltenham: Edward Elgar.

Yevdokimov, Y.V. 2000. Measuring economic benefits of intermodal transportation. *Transportation Law Journal*. June 2000.

Table of acronyms

CSIR	Council for Scientific and Industrial Research
DC-to-DC	Distribution Centre to Distribution Centre
DfT	Department for Transport
DoT	Department of Transport
EIRAC	European Intermodal Research Advisory Council
FMCG	Fast Moving Consumer Goods
GPT	General Purpose Technology
OECD	Organisation for Economic Co-operation and Development
TEU	Twenty-foot Equivalent Unit