BRANCH LINE CLOSURES: STREAMLINING OR DESTROYING CAPACITY

Havenga, Jan: University of Stellenbosch (janh@sun.ac.za)

Simpson, Zane: University of Stellenbosch (zane@sun.ac.za)

ABSTRACT

The purpose of this research is to inform infrastructure owners on the viability and especially future potential of South Africa's branch lines, and to position logistics practitioners' service offering in this context. A quantitative approach is followed in the research juxtaposing current and future freight transport demand in remote (and/or feeder) areas against the current density and achievable density of a railway.

The research revealed that South Africa's state-owned freight logistics provider (the railroad) is currently in a process of rationalising the rail network, which *inter alia* includes the closing of branch lines – a process that started a few years ago and is currently accelerated in spite of vehement public opposition. This drive is not popular with regional developers due to the further alienation of regional areas from the main economy. Logisticians however seem to have taken an indifferent attitude to this issue, mainly driven by the decline of the railway infrastructure (especially in these remote areas) and different objectives. Logisticians are not expecting railway service levels to improve soon, but cognisance of current increased investments in corridor rail freight infrastructure and its network effects are ignored. Regional freight's low return further contributes to this indifference. Understandably, rural branch lines are easily overlooked in an economy where extremely densified corridors already demand significant attention from role players. The research however warns against a myopic approach to branch lines - while the operation of these lines is not currently economically viable, both from a regional development and logistics cost savings perspective, branch lines can be a viable business in the future, alone, but especially also as part of an integrated network.

A core table that enables extraction of a wealth of information on all potential traffic was first constructed for each identified branch line in the country. It is an extensive table with all the normal identifiers, i.e. current rail traffic volumes, current road traffic volumes from which modal shift potential scenarios could be developed, commodity characteristic classification, commodity, tons, tonkilometres and 30 year forecast on each separate line level.

The results show that some traffic would utilise only specific branch lines, whilst others also play a role on core lines. The question then is how big a role is this, and is the branch lines nothing more than feeders into essentially core line traffic? In some cases traffic even utilises more than one branch line and even more than one branch line as well as the core line. Also, when certain questions such as maintenance and viability are considered it is sometimes necessary to think of the density of just the line (irrespective of where the traffic eventually terminates or originates). The only solution was to develop a classification system and classify all traffic with all the dimensions of commodity, tons, tonkilometres, forecasts, etc. according to this classification system. The research illustrated the integrated and "single network" characteristic of South Africa's railway system. Very few branch lines operate in "separate" economic pockets or development areas. The concessioning of the lines to different operators is therefore questioned or at least areas that required deeper thinking highlighted.

INTRODUCTION

South Africa is currently in a process of rationalising the rail network and closing branch lines. These events are not popular with regional developers, but logisticians has taken a "don't care" attitude, driven by the decline of the railway and different objectives. Rural branch lines, in an economy with hugely densified corridors, are easily overlooked. The research suggests that the current trend is correct, given current circumstances, but that both from a development and logistics cost savings perspective, branch lines can be a viable business in the future when higher densities are expected.

In global terms a renaissance in rail is experienced.[1] This rejuvenation does not always have density issues as driver, but externalities, such as harm to the environment. These issues should also be considered, as it means that density requirements could be viewed in a different way.

An important reaction in this regard emanated from South Africa's Department of Transport (DoT), when it considered the condition of rural roads. The DoT announced intentions to change axle limits on rural roads in a bid to relieve the burden on the secondary road infrastructure. Involvement in national transport departments in this way is not uncommon. Funding is often provided specifically (even in a vertically integrated environment)[2] and are often pressurised by society in reconsidering disinvestment events.[3]

Core network and regional railways also need to consider short lines where these lines provide access for rural traffic to main lines.[4] This is also a major focus of this study.

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[1] Friends of the earth, 2000, p. 5
[2] McCoy, 2001, p. 9
[3] Friends of the earth, 2000, p.5
[4] Beichtel, 2006, p. 8

Globally many lessons in this regard have been learned. Blainey[5] calls for freight demand modelling to understand economic viability, Erickson[6] illustrate how higher densities can make railways more economical than trucking even over shorter distances and Landry and Ozment[7] site case studies where innovation and customer service alone made short lines viable concerns. In South Africa a major branch line network were developed between 1910 and 1950 to serve remote communities and provide access to markets for farming communities. With the deregulation of the transport market in 1990 and the subsequent immediate focus on profitability a seemingly easy target for densification were the gradual abandoning of these low density lines. But in the absence of a clear understanding of long term future demand and the future effect of regulation these actions are questioned. This analysis attempts to develop a long term view of branch line viability.

In 1963 Hondelink reports on the reshaping of British Railways[8] and claims that the Government's approach is one-sided and that different approaches could make seemingly unprofitable services viable. He claims that "railway executives, both management and staff have been imbued with the doctrine that branch lines and intermediate stations are uneconomic in operation by nature".[9] Communities next to many of the branch lines closed over the last 50 years in the United Kingdom are attempting the reopening of these lines today and begin to understand that maybe these lines should not have been abandoned in the first place. This research's objective is to develop a long term view of the problem, based on long term future demand modelling in order to guide current decision making.

IDENTIFICATION OF BRANCH LINES IN SOUTH AFRICA

The branch lines that were considered for this analysis is depicted in figure 1:

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[5] Blainey, 2008, p. 1
[6] Erickson, 2001, p. 11
[7] Landry and Ozment, 2009, p. 39
[8] Hondelink, 1963, p. 1
[9] Op. cit. p. 2

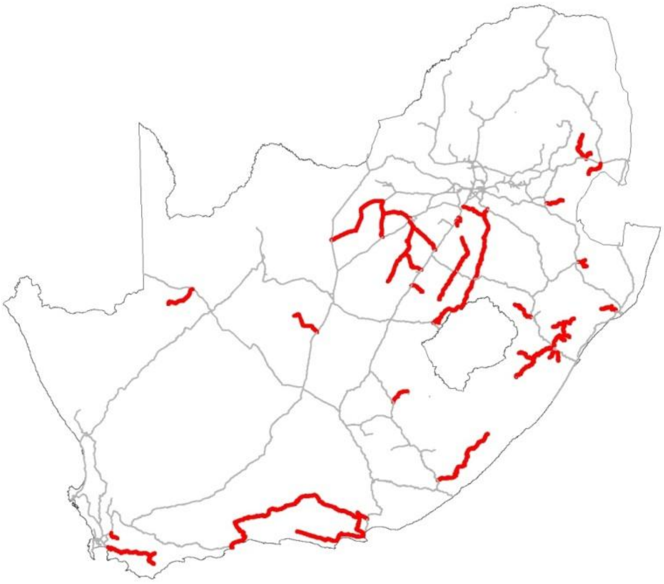

Figure 1: Branch lines

The analysis was not only complex, but is difficult to present as a single summary with a single set of metrics. The question is essentially a network question, but with many different parts that are sometimes related and sometimes not.

Some traffic would utilise only specific branch lines, whilst others also play a role on core lines. The question then is how big a role is this, and is the branch lines nothing more than feeders into essentially core line traffic? In some cases traffic even utilises more than one branch line and even more than one branch line as well as the core line. Also, when certain questions such as maintenance and viability are considered it is sometimes necessary to think of the density of just the line (irrespective of where the traffic eventually terminates or originates). The only solution was to develop a classification system and classify all traffic with all the dimensions of commodity, tons, tonkilometres, forecasts, etc. according to this classification system. The classification system was then applied to data obtained from a freight demand model for South Africa that were developed.[10]

Roughly speaking the chosen branch lines were classified for 66 million tons of total surface traffic (7% of all surface traffic in the country) which travels next to or on branch lines. Of this traffic, just 9 million tons currently travels on rail for all identified branch lines. Each of the identified lines was considered in order to determine potential, and the totals are classified into four network groups and two summary groups (where the descriptions describe traffic in one direction, but both directions are implied).

The proposed classification system is summarised in the following:

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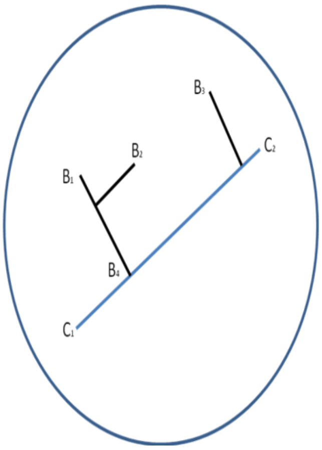
[10] Havenga, 2007, p. 160-179

Table 1: Branch line classification

Code	Description for potential traffic	Flow	Million Tons	% of all potential	% of all branch dependant traffic
B	originates and ends on the same line	B_1 to B_4	1.4	0.2%	6.5%
BB	utilise two branch lines, but not the core line	B_1 to B_2	0.5	neg	2.2%
BC	originates on a branch line and terminates on the core line	B_1 to C_1	17.9	2.3%	85.7%
BCB	originates on a branch line, travels some distance on the core line and then utilises a second branch line	B_1 to B_3	1.2	0.2%	5.6%



In order to make some sense out of the information two summary groupings were also created:

Table 2: Branch line summary classification

Code	Description for potential traffic	Sum of:
BD	All branch line dependant traffic	All traffic that would be lost whether on the core or branch lines, if the lines were closed
BP	The branch line portion of all branch line dependant traffic	Just the branch line portion of all branch line dependant traffic (thus excluding the tonkilometre for the corridor portion)

Some important exclusions from this potential were made. These are cases where the branch line is very short or where traffic would only need to use a short portion of the branch line before connecting to the core line. The assumption would be that any potential traffic of this nature would rather use road cartage to connect to the core line. This is a valid assumption, as traffic that is, for instance, 30km away from a core line and is close to a branch line, will still require road pick-up and delivery and therefore might as well be taken to the core line by road.

Traffic flows in South Africa is determined as flows between Magisterial Districts (MD's). For each magisterial district a centre point is determined. In order to analyse potential branch line flows these centre points are related to the network. This relationship is illustrated in figure 2:

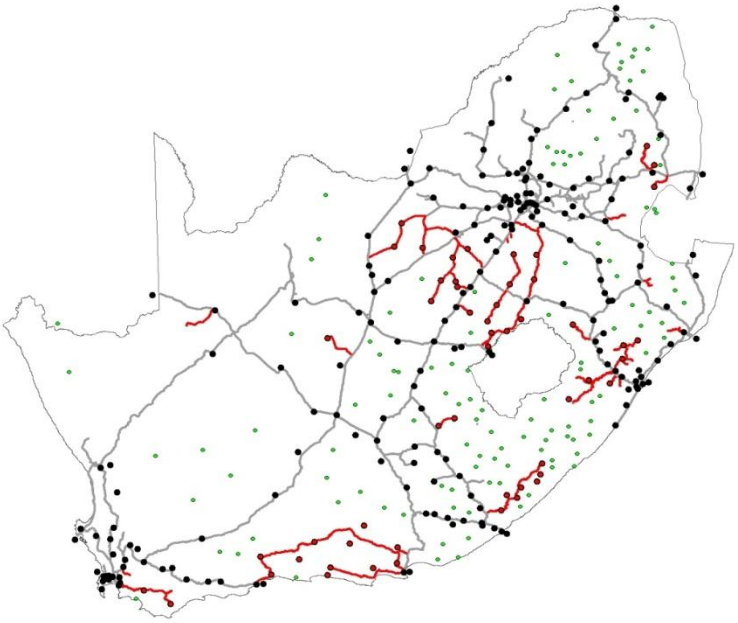


Figure 2: The relationship between magisterial districts and branch lines

(Red dots represent MD's close to branch lines, black dots represent MD's close to the core network, and green dots represent MD's with no rail connection)

From this classification of MD's relative to the total network the following possible flows (apart from flows that originate and terminate on the same line) can be determined if it is superimposed on the total network.

FLOW VOLUMES

Of South Africa's 934.7 million tons of total traffic, 7% could potentially use branch lines to some extent. The relationship between this traffic and total traffic in South Africa is depicted in table 3.

Table 3: Relationship between core only and potential traffic requiring a proportion of branch line use

	Tons (million)	**Tonkilometres (billion)**	**ATD**
Total SA	934.7	315.2	337.2
Bulk mining SA	99.3	70.5	710.0
General freight currently on rail	98.7	30.9	313.1
General freight total available	835.4	244.7	292.9
3 core Corridors	101.0	81.0	802.0
Capecor (Gauteng to Cape Town	36.6	38.5	1 051.9
Natcor (Gauteng to Durban)	51.1	30.1	589.0
Gauteng-PE	13.3	12.3	924.8
Potential traffic that would require a proportion of branch line use	**66.4**	**26.4**	**397.6**

Of the 66.4 million tons of total surface traffic potential that would require branch line use, 9.1 million tons are currently on rail (Table 4). This usage (compared to total potential) is summarised below:

The summary of results is shown below:

Table 4: Rail market share of potential branch line traffic

	Total Tons (millions)	Rail Tons (millions)	Total Tonkilometres (billions)	Rail Tonkilometres (billions)	Road ATD	Rail ATD
BB	7.3	1.8	0.5	Neg	69.1	21.8
BC	23.4	4.1	10.5	1.3	449.1	324.5
CB	33.7	3.2	14.5	1.0	431.1	302.9
BCB	2.0	0.1	1.0	Neg	466.9	469.9
All B inclusive	**66.4**	**9.1**	**26.5**	**2.4**		

Only 11% of potential tons shipped are included in a single branch line system. As average transport distances are low for traffic that originates and terminates within the same system, only 1.9% of potential tonkilomters are enclosed within a system.

SWITCHING SCENARIOS

Two scenarios for the possible switching of traffic next to branch lines were conducted (Table5)

Table 5: Switching scenarios

S1 = ATD>100km	
Automotive	0%
Break Bulk	50%
Dry Bulk	75%
Liquid Bulk	25%
Perishables	0%

Scenario 1 (low switching scenario):

S2 = ATD>500km	
Automotive	0%
Break Bulk	10%
Dry Bulk	25%
Liquid Bulk	0%
Perishables	0%

Scenario 2 (high switching scenario)

Of the 66.4 million tons of potential traffic next to branch lines of which 9.1 (or 14%) million tons is currently on rail a maximum of at most another 29.3 million tons could move to rail. Of this new 29.3 million tons only 4.0 million tons will be within the same branch line system. The rest of the traffic will require the core network. If this traffic switches, total branch line related traffic will be 38.4 million tons (market share of 58%) of which 85% (32.6 million tons) will require the core network (table 6).

Table 6: Scenarios for switching traffic

	Total tons (millions)	Total rail tons (millions)	Switchable rail tons scenario 1 (millions)	Switchable rail tons scenario 2 (millions)	Total rail tons after scenario 1 (millions)	Total rail tons after scenario 2 (millions)
BB	7.3	1.8	4.0	1.3	5.8	3.1
BC	23.4	4.1	9.5	2.6	13.6	6.8
CB	33.7	3.2	14.7	3.4	17.9	6.6
BCB	2.0	0.1	1.0	0.3	1.1	0.4
All B inclusive	66.4	9.1	29.3	7.6	38.4	16.8

These scenarios can also be depicted for tonkilomters (table 7)

Table 7: Switching scenarios in tonkilomters

	Total tonkilometres (billions)	Total rail tonkilometres (billions)	Switchable rail tonkilometres scenario 1 (billions)	Switchable rail tonkilometres scenario 2 (billions)	Total rail tonkilometres after scenario 1 (billions)	Total rail tonkilometres after scenario 2 (billions)
BB	0.5	0.0	0.1	0.0	0.2	0.1
BC	10.5	1.3	3.3	0.9	4.6	2.2
CB	14.5	1.0	5.1	1.1	6.1	2.1
BCB	1.0	0.0	0.4	0.1	0.4	0.1
All B inclusive	26.5	2.3	8.9	2.1	11.3	4.5

Only 3% of tonkilometres can be delivered within the same branch line system. The rest will require the core network.

IMPACT ON COSTS

Of the 3.8 trillion rand worth of commodities that are shipped in South Africa only R412 billion of value is shipped in the vicinity of branch lines and of these only R21 billion worth is on rail. As can be seen in Figure 3, the huge majority of the value of commodities shipped in the vicinity of branch lines is CB flows, transported by road. The emerging pattern is quite clear, i.e. relatively more commodities flowing towards rural areas are beneficiated.

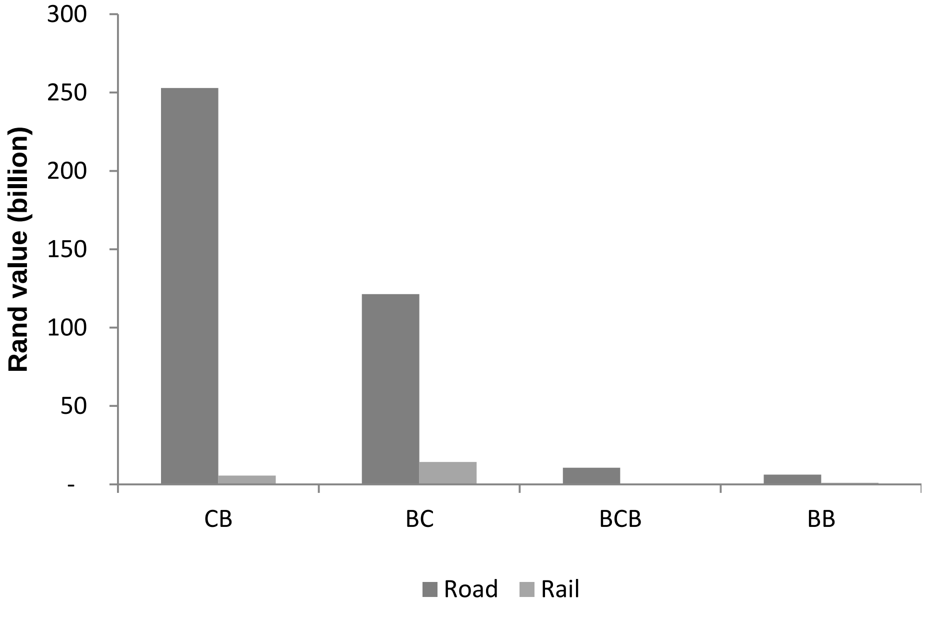


Figure 3: Rand values of commodity shipped, per flow type and transport mode

Where-as rail market share for branch lines currently is 14% in tons and 9% in tonkilometres it is only 5% in value (actual total value of commodities transported).

The most commodities transported in the vicinity of branch flows are, in order of magnitude: processed foods, maize, stone, fuel, wood, coal, other mining, sugar cane, beverages, bricks (all of which are above 2 million tons each)

The current cost (2008), to transport these commodities are around R19 billion (or 11% of the total transport bill for South Africa of R171 billion rand in 2008). The transport bill for railways is less than R1 billion (0.5%) which means 14% of tons, 9% of value, 5% of tonkilomters and 0.5% of costs is shipped on rail (figure 4).This mean the railway ships about one seventh of all potential freight in the vicinity of branch lines, but that the value of these commodities are less than a tenth of the total value transported. These rail shipments are over relatively shorter distances than road and the income for the railway is negligible when compared to the total transport cost in question.

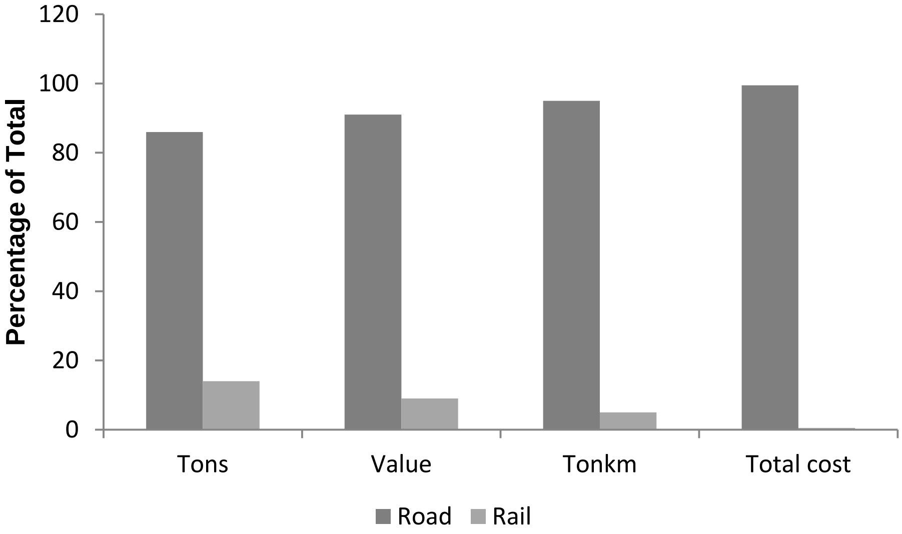


Figure 4: The diminishing role of rail

The costs can also be depicted per flow type (figure 5)

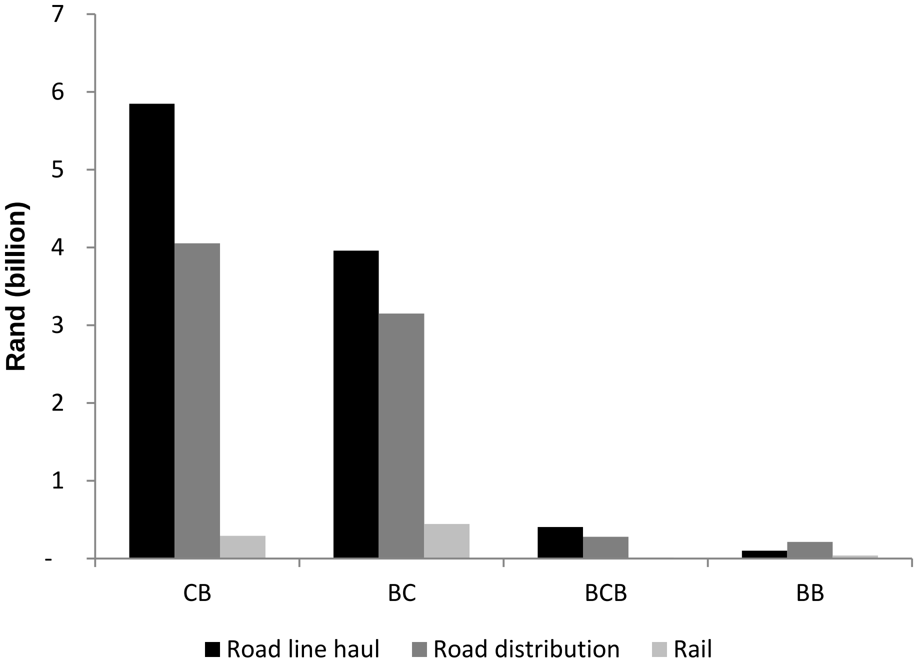


Figure 5: Transport cost split for rail and road per flow type

These costs can also be expressed in rand per ton and tonkilomters (Table 8)

Table 8: Costs per tonkilometre, for each flow type

	Line haul cost per tonkilometre (Rand)	**Distribution cost per tonkilometre (Rand)**	**Rail cost per tonkilometre (Rand)**
CB	0.52	1.76	0.31
BC	0.54	1.68	0.33
BCB	0.52	2.29	0.29
BB	0.50	0.80	1.00

AFTER PROPOSED AXLE LIMIT CHANGE

The axle limit change will have a considerable effect on transport costs. The transport cost split for road and rail if the axle limit proposal is implemented, is shown in figure 6.

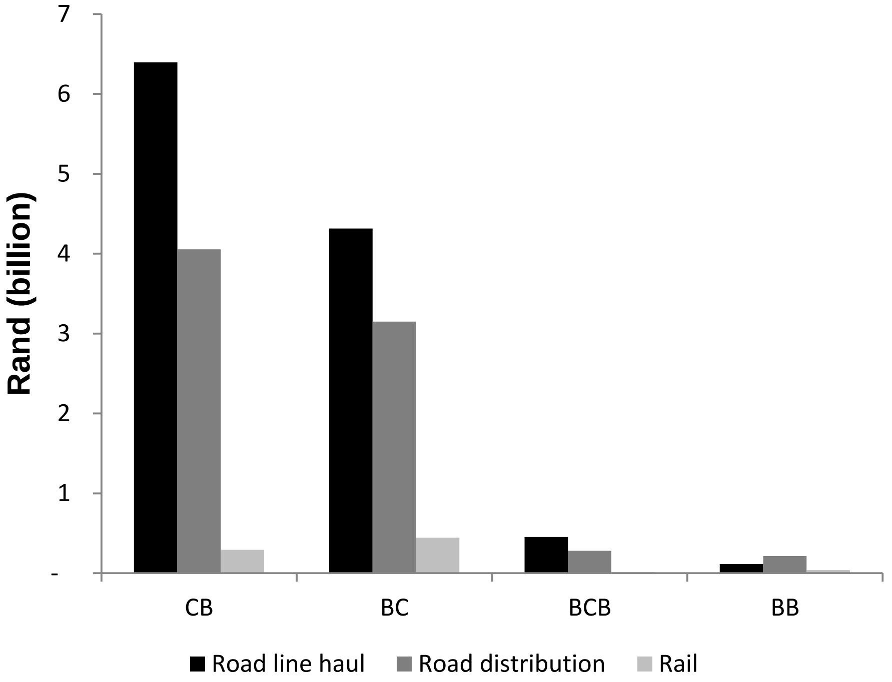


Figure 6: Transport cost split for road and rail per flow type if axel limit is implemented

These costs can also be expressed in rand per ton and tonkilomters (Table 9)

Table 9: Costs per tonkilometre, per flow type if axel limit is implemented

	Line haul cost per tonkilometre (Rand)	**Distribution cost per tonkilometre (Rand)**	**Rail cost per tonkilometre (Rand)**
CB	0.57	1.76	0.31
BC	0.59	1.68	0.33
BCB	0.57	2.29	0.29
BB	0.57	0.80	1.00

Axle load limit effect on road line haul traffic on branch lines will increase road transport costs, as can be seen for road transport costs per flow type, in figure 7.

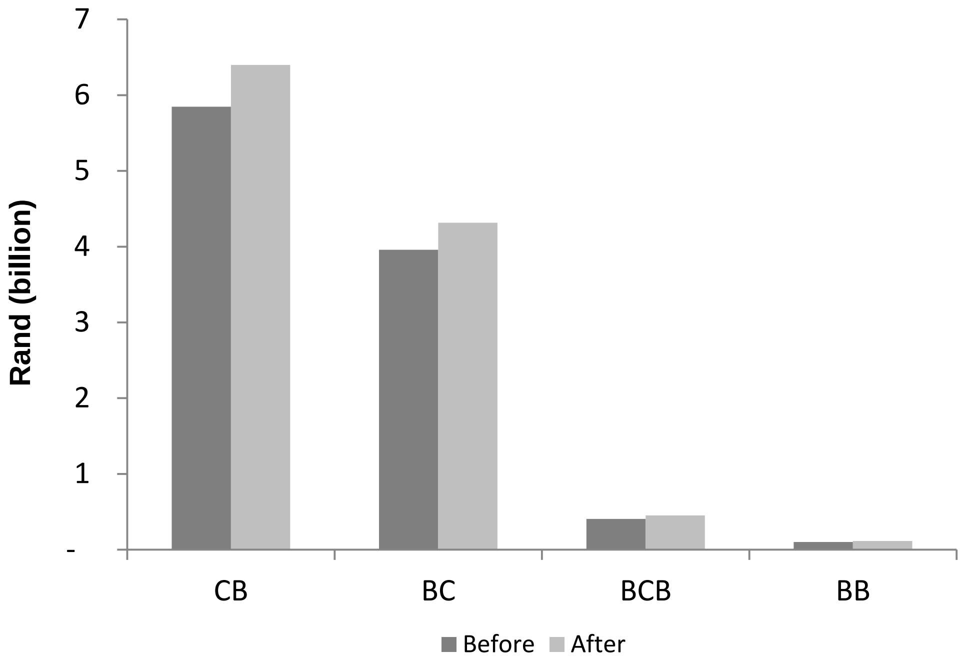


Figure 7: Road transport cost increases per flow type if axel limit is implemented

These costs can also be expressed in rand per ton and tonkilometres (Table 10)

Table 10: Costs per tonkilometer, per flow type if axel limit is implemented

	Rand per tonkilometre before	**Rand per tonkilometre after**
CB	0.52	0.57
BC	0.54	0.59
BCB	0.52	0.57
BB	0.50	0.57

Road costs in total for traffic in the vicinity of branch lines will increase by a billion rand from R10.3 billion, to R11.3 billion (figure 8).

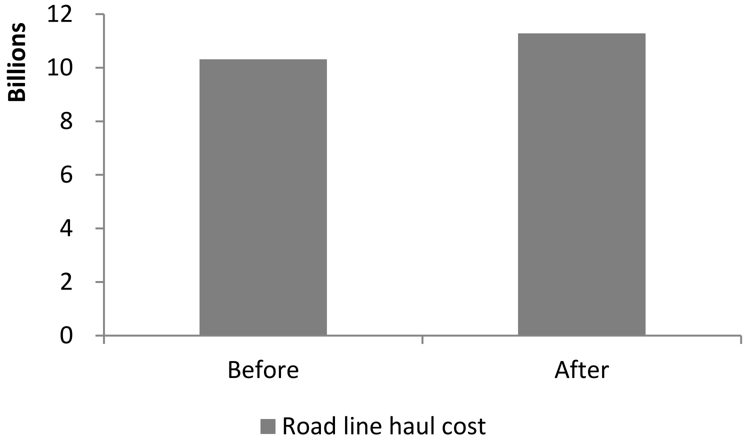


Figure 8: Road line haul transport cost increases if type if axel limit is implemented

Although road transport costs will rise, total transport costs, given the scenarios and assuming that commodities can be transported at current rail tariffs, will be lower. Current total transport costs are 18.8 billion, whilst with the proposed scenarios 1 and 2; it would be 17.6 billion and 18.5 billion respectively.

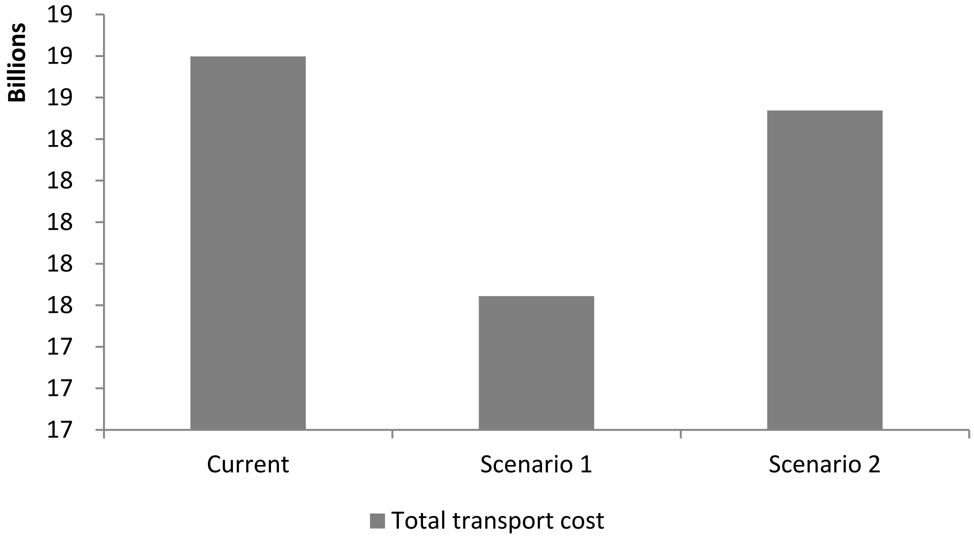


Figure 9: Comparative total transport costs for current and possible scenarios

This effect is demonstrated clearly by considering the components of cost (figure 10):

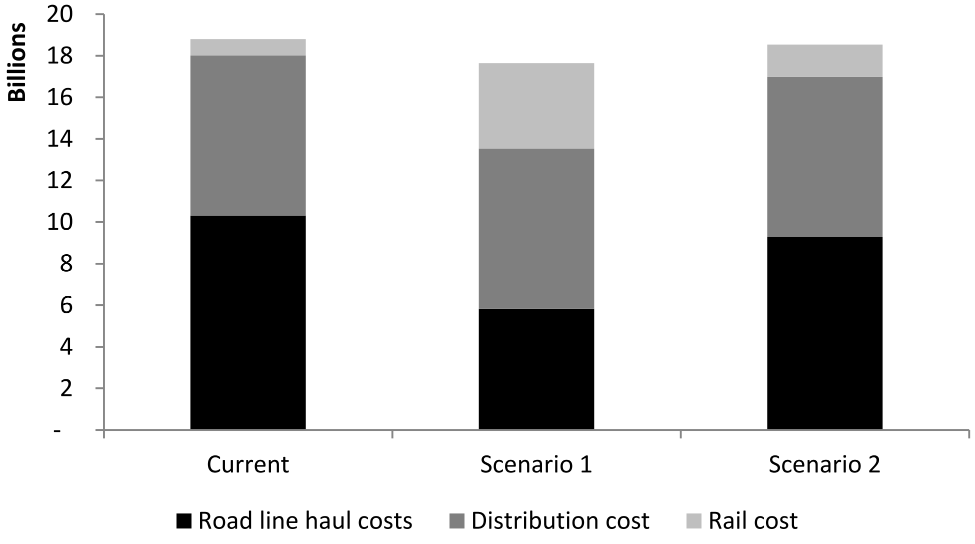


Figure 10: Comparative cost components for current and possible scenarios

Various externality costs should also be considered, such as accidents, congestion, emission, noise and policing, which can be quantified by using a rate per tonkilometer per mode (and per typology in some cases).

Total externality costs of 3.8 billion rand, are almost entirely on road compared to rail externality costs of a mere R38.6 million). This is due to the railway's significantly reduced accident cost, no congestion cost, and far lower emission costs. Road total externality costs are 14.6c per tonkilometre, while rail is a minimal 1,6c per tonkilometre (figure 11).

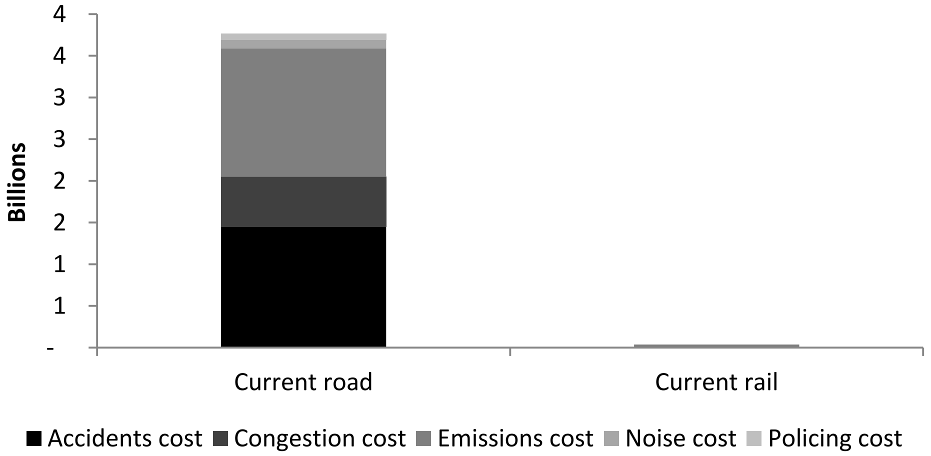


Figure 11: Externality cost components currently on road and rail

The externality costs for current and possible scenarios are shown in figure 12. The total externality costs for Scenarios 1 and 2 are 2.5 billion and 3.5 billion respectively.

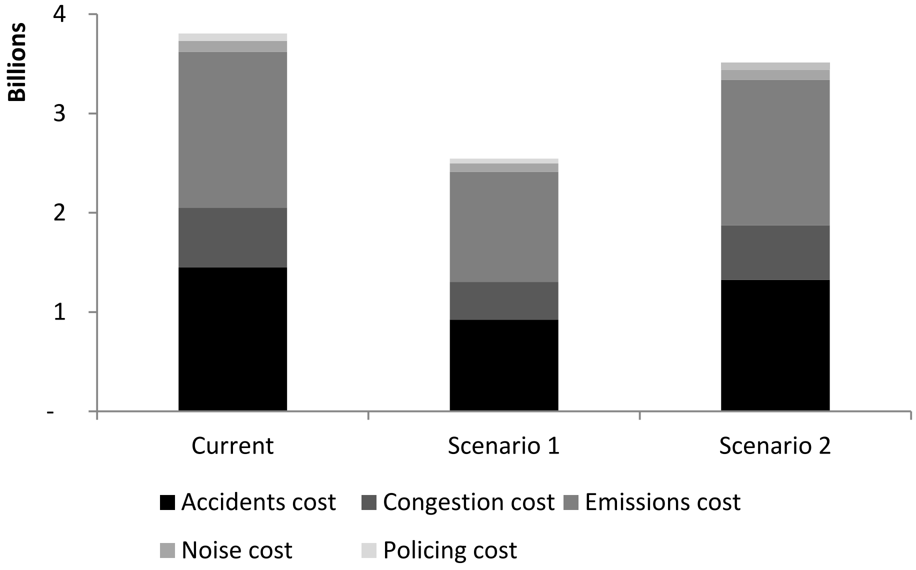


Figure 12: Comparative externality cost components for current and possible scenarios

Total transport costs for branch line traffic (with externalities included) will therefore reduce from R22.6 billion to R20.2 billion in Scenario 1 and R22.0 billion in scenario 2. That is an 11% reduction for scenario 1 and 3 % reduction for scenario 2. (figure 13).

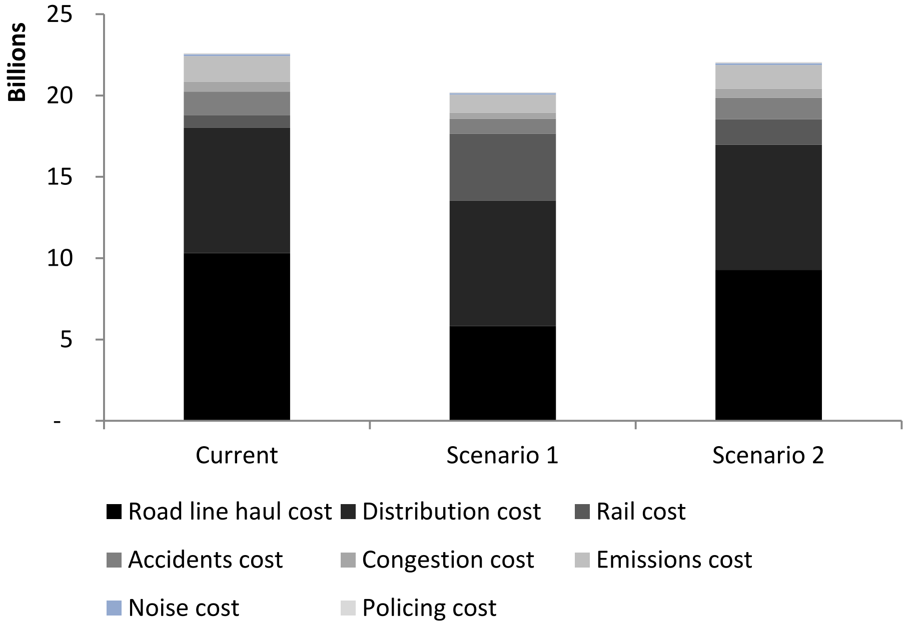


Figure 13: Comparative cost components for all associated costs for current and possible scenarios

Three further aspects have, however, not been considered. The one is consideration of user pay principles for road, it is assumed that road freight infrastructure costs (which is included in terms of licensing, toll and fuel levy charges) is not fully recovered. Secondly it should be taken into account that only freight in the vicinity of branch lines has been considered and thirdly rail tariffs were used (as opposed to real road costs).

BRANCH LINE DENSITIES – SUSTAINABILITY

Sustainability of specific lines is best described by the density concept.

A railroad's ability to earn sufficient revenues to cover the full costs of the business is critical given rail's high fixed costs. Because railroads invest in assets with useful lives measured in decades, asset-driven fixed costs (a significant proportion of total costs) cannot be quickly reduced in the face of declining traffic. In the United States, for example, the Uniform Rail Costing System (UCRS) used by the Surface Transportation Board (STB) treats nearly a third of total railroad operating expenses as fixed and fully 50 percent of infrastructure ownership costs as fixed.
The STB also has recognized that the remaining "variable costs" include a significant portion of joint and common costs that are difficult to attribute to specific traffic segments and are likely to be fixed as well. Many researchers postulate that, given these two observations, the fixed cost portion of railroad operations could be as high as 70%.

Because of the high level of fixed costs inherent in rail operations, the average cost per tonkilometre and profitability are directly related to the degree of traffic density (i.e., **volume of traffic per kilometre of railroad**). The higher the traffic density, the lower the average cost per tonkilometre and the greater the free cash flow available to support investment. The lower the density, the higher the proportion of fixed costs and the lower the returns. Adequate traffic density is essential to meet the efficiency levels required to be competitive in today's transportation markets and to provide the economic returns necessary to justify private investment.

The relationship was first described by Robert Harris[11] three decades ago that evaluated 55 railroads in terms of revenue tonmiles per mile of road (for South Africa expressed as tonkilometres) that can be generated for each route tonkilometre of network that requires to be deployed and compared these to the underlying cost structure of cent per tonmile.

Harris plotted his result and illustrated an inverse exponential relationship between the two observations. The inflection point of Harris' relationship is between 1 and 3, i.e. a million tonmiles per route mile would indicate a less competitive railroad and more than 3 million tonmiles per route mile would indicate a highly competitive railroad. His original diagram is illustrated in figure 14:

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[11] Harris, 1977

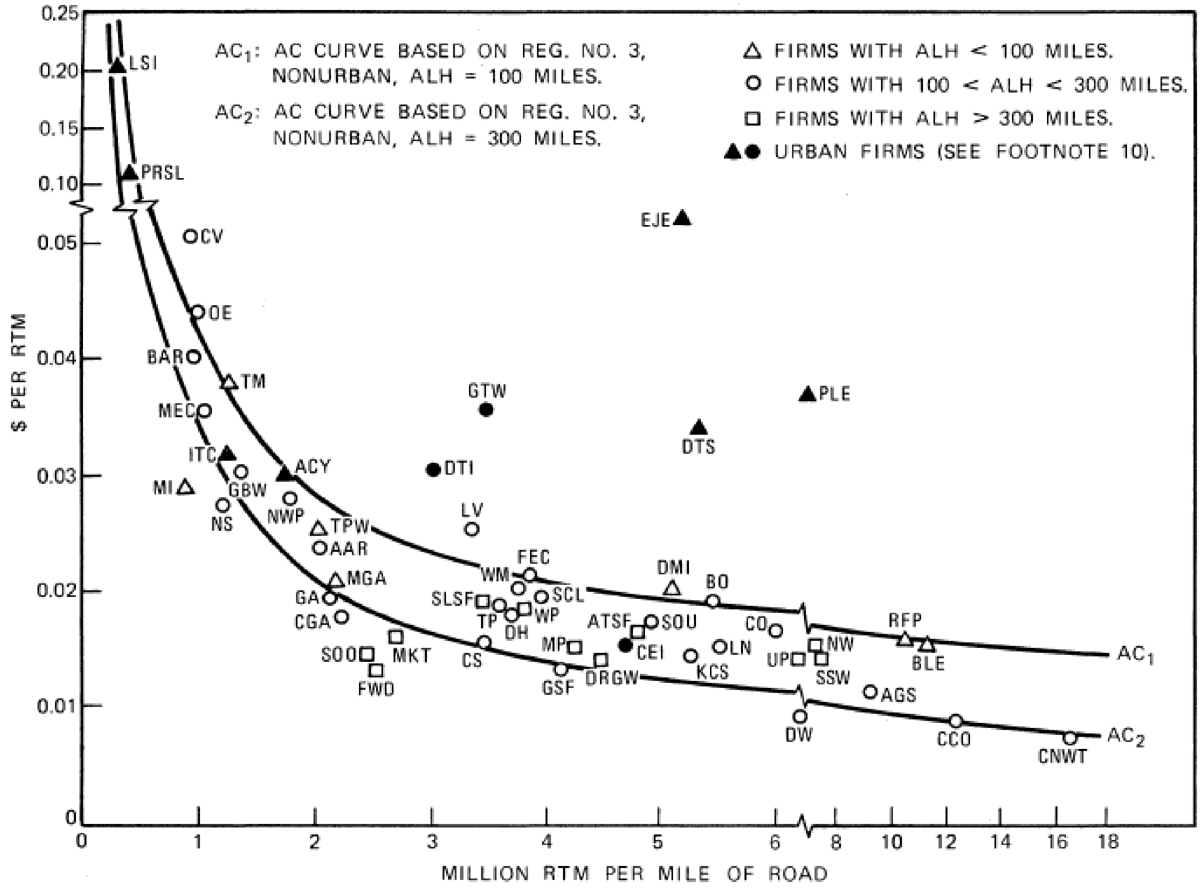

Figure 14: Harris' original density relationship

Harris' curve or at least the concept behind it is used globally to discuss, compare and benchmark rail economics. In order to explain it further a practical example is created.

These density calculations were applied to the freight demand model data.

This analysis is depicted in table 11.

Table 11: Density analysis

	Rail Actual density (tonkilometre/route km)	**100% potential density**
Total SA	5.3	13.7
Bulk mining SA	40.0	40.0
GFB	3.1	10.3
3 core Corridors	3.5	19.3
Capecor	2.4	23.1
Natcor	12.4	42.7
Gauteng-PE	0.3	3.1
BP	0.2	1.3

The analysis shows, by illustration, that current rail density is around 5.3 million tonkilometres per route kilometre. This is high, but it is 40 million for bulk mining and only 3.1 million for the rest of the business (still good, but approaching borderline). It also shows the upper limit (100% market share) for a more rail orientated economy of more than 10 million tonkilometres per route kilometre for a general freight business.

The three corridors' current density is slightly higher than the current for all GFB traffic (which is surprising – it should perhaps have been much higher), but the upper limit is double than what can be achieved for the total country, i.e. 19.3. **This confirms the corridor orientated strategy.** Within the three core corridors Natcor's current density is quite high, 12.4, with a maximum ceiling of 42.7.

Current rail density is low for branch lines, i.e. around 0.2 million tonkilometres per route kilometre and only has an upper limit of 1.3 million tonkilometres and as such is probably not a viable isolated business on its own.

Future densities for the branch line portion of all traffic, at 100% penetration, is depicted in table 12

Table 12: Density analysis

	100% potential density
BP 2007	1.3
BP 2037	4.4

To achieve a minimum density of 4.4 million tonkilometres per route kilometre all the branch lines together will have to acquire 100% market share. This does not seem feasible now, but 100% potential density in 30 years does.

CONCLUSION

As railroad investment has a long planning horizon and plays an important role in society. The current "haste" to abandon branch (or short) railway lines or at least reposition these lines in possibly tenuous concessioning arrangements does not take this fact into account. Long term forecasts clearly indicate that higher densities are possible in the future, but that the costs of reviving these lines could be prohibitive. In stead maintaining these lines at a slight loss right now might mean that viable options could exist in the future. Furthermore, emission charges, the lower possible limits on road axle loads and other changes in regulatory frameworks will mean that a breakeven point of viability will be reached even sooner than expected. The contribution of branch line traffic to densify the core network should also be taken into account. It is often ignored and the substantial contribution to network cost savings due to higher densities on the core not taken into account.

Many branch lines around the world have already been abandoned, but in those countries where further closures are considered the case for demand intensive long term demand modelling and sustainability must be considered.

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