POTENTIAL IMPACT OF TRAFFIC DENSIFICATION ON RAIL FREIGHT TRANSPORT COST IN SUB-SAHARAN AFRICA

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Abstract

This article highlights the significant cost-reduction opportunities possible through the densification of rail freight traffic, especially over longer distances, and the concomitant implications for increased profitability for railway organisations in sub-Saharan Africa (SSA). Densification opportunities should also focus on the development of transport corridors throughout the region. SSA countries themselves can play a critical role in unlocking this potential by, inter alia, simplifying regional economic agreements. As with most other initiatives in SSA, unlocking this potential will require efficient cross-country collaboration.

Keywords: Economies of Density, Rail Freight Transport, Sub-Saharan Africa, Transport Cost

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INTRODUCTION

Sub-Saharan Africa faces numerous economic challenges – from basic human needs to capacity for innovation (Madavo, 2005; Taylor, 2006; Moyo, 2009). The key challenges of relevance to this article are discussed below.

Firstly, heavy dependence on primary commodity exports remains a common feature of most countries in SSA. This exposes the region to external cyclical economic shocks. Therefore, economic diversification is a top priority for growth policies on the continent (UNECA, 2007).

Secondly, the poor world ranking of most SSA countries in terms of property rights and freedom from corruption is indicative of the remaining governance challenges. Addressing these challenges is one of the keys to unlocking an environment that would allow an ethical cycle of entrepreneurship, innovation, investment, and sustained economic growth and development to flourish under the principles of good governance (Holmes, Feulner & O'Grady, 2008).

Thirdly, transport infrastructure in SSA is limited, generally in a poor condition and operates well below design capacity, which impedes economic development. Cross-border corridor transport in most of SSA is costly, slow and unreliable. This exacerbates transport challenges for landlocked countries in SSA with export potential (De Bod, 2008).

Fourthly, although all the regional economic communities recognise the importance of improving trade facilitation to foster economic growth and eradicate poverty, the complex web of regional integration agreements in Africa leads to inefficiency (Ndulu, Kritzinger-van Niekerk & Reinikka, 2005).

There is increasing debate over the effectiveness of foreign aid to countries in SSA (see, for example, Chowdhury & Garonna, 2007; Easterly, 2008; Moyo, 2009). Alternative approaches are frequently proposed. Moyo (2009) is in favour of an approach whereby African nations take charge of their own growth by learning to tap into international financial markets by encouraging foreign investment; China is granting resource-backed loans which seem to result in the building of much needed infrastructure (Brautigam, 2010). Easterly (2008) warns against continuous fallback on 'big-push' transformational aid programmes, and suggests that there is more evidence of the success of small, targeted interventions in Africa. Chowdhury and Garonna (2007) reiterate the importance of 'political thrust, strategic purpose, institutional support, bold reform initiatives' and successful integration into the global economic system.

While the debate continues on the many approaches to addressing SSA's development challenges, the fact remains that for SSA to achieve the estimated minimum 7% gross domestic product (GDP) growth rate needed to reduce poverty, infrastructure investment requirements amount to around US$20 billion per year. This is twice as much as the region invested historically (World Bank, 2005). Providing efficient, effective and reliable freight transport infrastructure is a key component of this investment (Njini, 2010).

Research prepared by the Organization for Economic Cooperation and Development (OECD) confirms the need for this focused investment, as

transport cost in SSA is considerably higher than elsewhere in the world, severely hampering the region's competitiveness (Santiso, 2006).

Research results of the World Bank (2006) on SSA railway concessions indicated that rail transport is still the most cost-effective method for carrying non-time-sensitive bulk freight on distances longer than 500 km. Drew (2006), Havenga (2007) and Pittman (2007), among others, highlight the importance of traffic density in leveraging rail's cost-effectiveness over longer distances due to rail's high fixed infrastructure component. However, the density of railway transport in Africa has decreased since the 1970s as a result of the increasing shift of freight traffic from rail to road (Simuyemba, 2007).
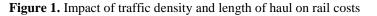
The objective of this article is to illustrate the need to reverse this trend of traffic volume erosion in order to gain from the considerable economies of density attainable in rail freight transport in SSA. This could form the backbone of more targeted investment planning in the region. In the following section the impact of density economies on rail freight transport is discussed. This is followed by a summary of the research methodology, a discussion of the research results and, finally, conclusions.
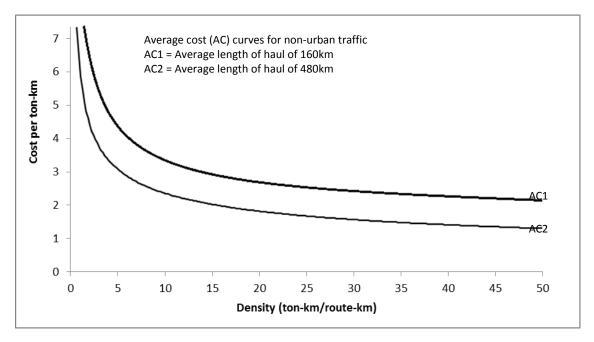
IMPACT OF ECONOMIES OF DENSITY ON RAIL FREIGHT TRANSPORT

In the context of rail freight transport, economies of density describe the relationship between inputs and outputs with a fixed rail network (Graham et al., 2003), or the phenomenon that an 'increase in traffic over a given infrastructure will be met by a less than proportionate increase in costs' (Joy, 1989).

Harris (1977) stated that "(T)he extent of economies of traffic density in the rail freight industry is a matter of critical importance with respect to public investment in and the financial viability of the USA rail system. The evidence strongly supports the hypothesis that significant economies of density exist, and that many of the light-density lines, which comprise 40% of the rail system, should be eliminated".

The service lives of rail transport infrastructure and equipment last several decades. Therefore, asset-driven fixed costs (a significant proportion of total costs) cannot be reduced rapidly in the event of traffic loss. Given this high level of fixed costs, the average cost per ton-kilometre and profitability are directly related to the degree of traffic density, i.e. the volume of traffic per kilometre of rail, expressed as ton-kilometre per route-kilometre (ton-km/route-km). This means that the cost per ton-km of a railway will decrease with each additional ton-km of activity over the same track length. This decreasing cost function is hyperbolic, as illustrated in Figure 1.

Figure 1. Impact of traffic density and length of haul on rail costs

Source: De Bod, 2008

A study conducted by Mercer Management Consulting (2002) on Class I and regional railways in the US confirmed this decreasing cost function. The study also emphasised that adequate traffic density is essential to meet the efficiency levels required to be competitive and to provide the economic returns

necessary to justify investment. Pittman (2007) shows that econometric studies indicate that existing freight railways are operating at levels where there are still economies of density to be achieved.

RESEARCH METHODOLOGY

A freight demand model for South Africa was developed in 2006 (and is updated annually) to establish a database for all South African freight flows as input for long-term infrastructure planning (Havenga, 2007). The modelling of total freight flows is based on gravity modelling of the supply and demand for 354 magisterial districts and 64 commodity groups.

For the research presented in this article, actual freight flows for Botswana and Zambia were recorded in the two countries, and gaps were modelled on similar principles as the South African freight demand model (although at a more consolidated level due to the lack of detailed data). Owing to monetary constraints, this approach was not possible for all SSA countries in. Due to the onerous task of gathering the detailed information discussed below, the sample was limited to Southern African Development Community (SADC) countries. The extension of the model to other countries further north into SSA is important in the light of the economic interrelationship of the region and the SADC focus on development funding. By using indicators such as population, GDP and trade, an estimate of freight flows in the other countries is possible. Network length is also available, which enables the estimation of potential rail freight traffic density.

To enable freight-flow analysis for the SADC countries, the following economic factors were researched:

- GDP and population statistics
- Industry sector distribution patterns per country
- Preferred modes of transport used
- Installed and usable infrastructure for different modes – route-km and road quality index
- Spatial indices per country (size of country, coastal development and metropolitan placement)
- Company sizes per industry

Using the known freight flow volumes for South Africa, Botswana and Zambia, and the six factors given above, the freight flows for the remaining SADC countries were modelled. The modelled results were then compared to established international research results (Harris, 1977; Ordover & Pittman, 1994; Mercer Management Consulting, 2002; Pietrantonio & Pelkmans, 2004). In these studies, figures for ton-km achieved were compared to available route-km in order to illustrate the impact of the potential density on rail costs in the various countries. The magnitude of this relation is deemed to be a reliable indicator of the profitability of both the railway organisations and the freight transported. The significance of the potential density in terms of the focus on corridor development is subsequently illustrated.

DISCUSSION OF RESULTS

The road and rail ton-km estimate and the network length required to deliver this transport output are summarised in Table 1.

Table 1. SADC rail and road ton-km and network length in km (2006)

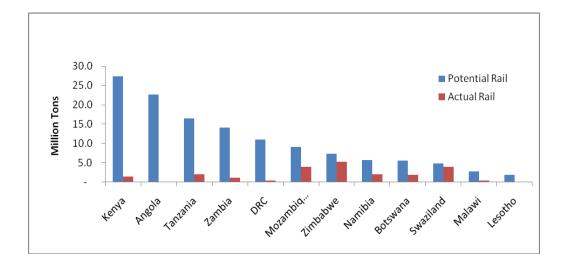| Country	Length of (km)			Tons (million)			Ton-km (millions)	
	Rail	Road	Paved Roads	Rail	Road	Total	Rail	Road
RSA	20 070	358 596	59 753	178.00	553.0	731.0	108 000	170 000
Kenya	2 100	63 265	8 933	1.48	59.3	60.8	1 200	4 332
Angola	2 515	51 429	5 348	0.04	50.4	50.5	21	7 912
Tanzania	4 460	88 200	3 704	2.01	34.7	36.7	2 562	4 126
Zambia	916	91 440	6 779	1.15	30.1	31.2	625	2 851
DRC	3 256	17 250	2 250	0.5	14.1	24.4	465	2 084
Botswana	888	10 217	5 620	1.85	18.8	20.7	647	1 378
Mozambique	2 593	30 400	5 685	4.00	13.4	17.4	500	1 351
Zimbabwe	2 583	18 338	8 692	5.30	9.0	14.3	2 400	444
Namibia	2 382	64 808	5 378	2.07	10.8	12.8	1 262	1 119
Swaziland	301	14 597	1 064	3.90	3.6	7.5	710	8
Malawi	789	14 597	2 773	0.40	5.9	6.3	75	88
Lesotho	3	4 955	887	0.00	4.3	4.3	0	16

Source: De Bod, 2008

Applying the methodology described above provides the first estimate of rail market share in SADC countries other than South Africa. The major

objective for developing this information was to guide further research. The research conducted on SADC countries indicates that there is significant potential
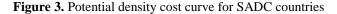
available for rail systems in this region. The results
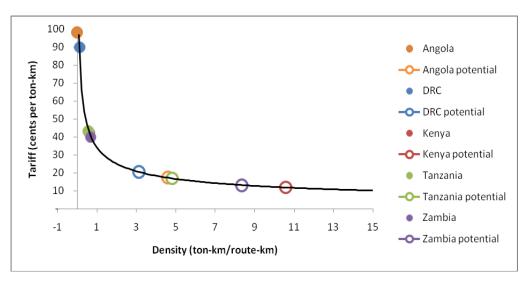
per country are summarised in Figure 2.

Figure 2. Actual and potential rail volumes

Source: De Bod, 2008

Actual and potential rail volumes can now be plotted on the density curve to determine the shift on the curve if the volumes, as indicated, were to shift. According to the principles of the density curve, the possible or potential savings in costs can therefore be modelled. This modelling indicates that significant

potential for cost reduction exists. Tons were converted into ton-km given the network length required for each flow in order to apply the density principle, as estimated by De Bod (2008) and displayed in Figure 3.

Figure 3. Potential density cost curve for SADC countries

Source: De Bod, 2008

Increases in density go hand-in-hand with upgrading rail infrastructure, and the potential for density should improve the business case for private investment in rail infrastructure. This is achievable because a reduction in the cost of transport (as indicated by the downward slope of the density cost curve) serves three major SSA economic growth objectives: firstly, businesses should become more

competitive and increase the scale of their business. Secondly, railway organisations should be able, through the resulting density gains, to negotiate more profitable rates. For example, if transport costs can be reduced by 30%, railway organisations could charge, say, 15% less and business shippers would save 15% on their transport bill, while the railway organisations would also be 15% better off. Thirdly, the investment

in infrastructure could, by itself, induce economic growth. Density cost savings are possible by decreasing fixed infrastructure cost per ton-km. As indicated in Figure 4, the fixed cost component tied in rail transport is high, hence, cost savings gained from density advantages are high too.
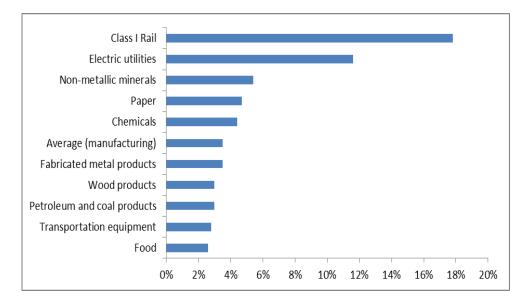
Figure 4. Capital expenditure as a percentage of revenue

Source: Rodrigue, 2009

Expenditure on railways has historically represented a drain on national budgets in SSA countries. An intention of the New Partnership for Africa's Development (NEPAD) is for the private sector to contribute towards building infrastructure, plug the funding gap and reverse the flow of public money towards railway operations. Furthermore, NEPAD has prioritised providing 'institutional support' for the concessioning of railways. Due to the quantum of finance required to finance railway infrastructure, government policy support is necessary (De Bod, 2008).

The corridor concept, already the focus of regional development initiatives (SADC, 2006), is ideally suited to taking advantage of this potential density. Initially based on making existing transport routes more efficient, corridors are critical to achieving the region's economic and political objectives. This becomes even more important when considering that 16 of the continent's 54 states are landlocked and require efficient regional transport links for access to ports. Furthermore, the transport distances for all these countries are long, over routes that can be densified, and, therefore, provide ideal opportunities for rail transport organisations to improve their efficiency.

CONCLUSION

Local specialisation, surplus production, and regional and international trade is central to economic growth, and efficient transport is at the heart of competitive trade. Most SSA countries are too small individually to generate the economies of scale required for international competitiveness. The international trade routes for these countries, especially the landlocked ones, are long. Over longer distances and with adequate density, rail transport is considerably more efficient than road transport. The research presented here confirms that the potential for densified rail transport in sub-Saharan Africa is available for rail transport organisations to improve their efficiency. The corridor concept, already the focus of regional development initiatives, is ideally suited to taking advantage of this potential density. Unlocking this potential will require efficient trans-national collaboration.

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