SUPPLY CHAIN COST IMPROVEMENT OPPORTUNITIES THROUGH STREAMLINING CROSS-BORDER OPERATIONS

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Abstract

The Cross-Border Road Transport Agency (CBRTA) in South Africa aims to encourage and facilitate trade between South Africa and its neighbouring countries. The CBRTA sponsored a study by Stellenbosch University (SU) to determine the logistics cost impact of cross-border delays between South Africa and its major neighbouring trading partners, and prioritise opportunities for improvement. SU is the proprietor of both a comprehensive freight demand model and a logistics cost model for South Africa, which enable extractions and extensions of freight flows and related costs for specific purposes. Through the application of these models, the following information is identified and presented in this paper: South Africa's most important border posts (based on traffic flows); a product profile for imports and exports through these border posts; the modal split (road and rail); the annual logistics costs incurred on the corridors feeding the border posts, as well as the additional costs incurred due to border delays.

The research has proved that the streamlining of border-post operations that take a total supply chain view (i.e. of both border operations and those that could be moved from the border) is beneficial.

Keywords: Cross-border Operations; Road Freight Transport; Supply Chain Cost; South Africa

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1 Introduction

In the European Union, intraregional trade accounts for almost 80% of total trade, while in Africa it accounts for only 12% (Lazenby, 2012). The low intraregional trade is partly attributable to delays, high congestion and inefficient service delivery at border posts which, in the case of South Africa's cross-border trade, translate into waiting times of 33 to 45 hours, and estimated annual transaction costs of US$29m to US$35m (Neethling, 2012). According to Teravaninthorn (2010), cargo dwell time may account for up to two-thirds of the total transport time to landlocked countries in sub-Saharan Africa, with border delays accounting for up to a third of the total transport time from Durban (South Africa's largest port) to Lusaka (in Zambia). Border delays could also lead to increased requirements for safety stock to offset the unreliability of deliveries, add to transport cost due to stationary transport equipment at the border controls, and increased stock holding costs due to pipeline inventory stuck in the border control system.

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- South Africa's most important border posts (based on traffic flows);
- A product profile for imports and exports through these border posts;
- The modal split (road and rail);
- The annual logistics costs incurred on the corridors feeding the border posts, as well as the additional costs incurred due to border delays.

2 Literature Review

In an analysis of World Bank statistics of the mean time required to export from 18 economic communities around the world, Djankov, Freund and Pham (2010) demonstrate that the South African Development Community (SADC) is at the 13th position with 36 days, compared to the shortest export time of 10 days from the CER (Australia and New Zealand), and 13 days from the European Union, with only the former Soviet Union countries (the CIS) and the four other African economic communities performing worse. The problems are magnified for landlocked African countries, whose exporters need to comply with different requirements at each border. The authors demonstrate that these trade delays hamper exports more than foreign tariffs do.

The duration of trade delays is influenced by three distinct components: bureaucratic requirements (bank and export documentation), transit time (packing and arranging transportation, inland transportation, additional clearance and waiting time at borders), and port handling and customs clearance. In sub-Saharan Africa, bureaucratic delays are the longest, taking 19 days on average, followed by customs and ports delays (nine days on average), and transit delays (seven days on average) (Freund and Rocha, 2010). The authors, however, highlight that, in the African context, transit delays have the most economically and statistically significant effect on exports. A one-day reduction in inland travel time leads to a 7% increase in exports, or translates into a 1.5% decrease in all importing-country tariffs. In contrast, improvements in bureaucratic requirements or port handling and customs clearance times have a far smaller impact on trade. The key reason put forward for this is uncertainty – delays that cannot be pre-empted (such as the length of border-crossing holdups) impact negatively on the demand for exports.

The physical nodes (ports and border posts) in trade supply chains are responsible for a considerable percentage of delays because of the way they fulfil their role as the administrative focal points to enforce the administration associated with the flow of freight across borders.

The Chirundu border post between Zimbabwe and Zambia is an example of the positive impact of reducing cross-border delays. In 2009 it took 39 hours on average for a truck to transit northbound through the border post, and 14 hours southbound (Curtis, 2009). The introduction of a one-stop border post (OSBP) in 2010, with concomitant infrastructure upgrades (for example a double-lane bridge and state-of-the-art scanner) has led to a reduction in transit times of 36% over the past two years, enabling truck flow to increase by 65% (*FESARTA*, 2013). That is a growth from an average of 1 800 to 2 000 trucks per month in 2009 to 12 000 to 14 000 a month in 2012, increasing revenues for the Zambian government by 30% (Tran, 2012).

The intention is to replicate this success at border crossings between South Africa and its major neighbouring trading partners. According to Curtis (2009), Beit Bridge (the border between South Africa and Zimbabwe) is the busiest border crossing in east- and southern Africa. In 2009, delays at the Beit Bridge border were 33.5 hours for northbound and 12.2 hours for southbound traffic. The long wait is mainly due to traffic having to pass through two identical controls on either side of the border. TradeMark SA (2010) postulates that the most effective way to reduce costs in the trade supply chain is to reduce waiting times at borders through an OSBP, addressing:

- Physical facilities – a common control zone (CCZ) with a fenced perimeter, as well as common facilities such as scanners, weighbridges and inspection bays;
- Operations improvement and training of personnel in order to streamline cross-border movement through simplified aligned processes and knowledgeable personnel; and
- Extraterritorial legal jurisdiction for border-control officers, which would move non-critical activities away from the border post and thus reduce time spent there.

In addition, the World Customs Organization (WCO) (2009) points out that intelligence is vital in the enforcement of customs regulations, and allows customs to execute targeted and selective controls to avoid disrupting legitimate trade based on a global network for gathering data and information, called the Customs Enforcement Network (CEN). All SADC countries belong to the WCO.

Curtis (2007) estimated that the potential savings in transport costs by reducing the standing time at Beit Bridge by 18 hours would be equal to ZAR128 million. This excluded other costs such as inventory cost, insurance and other cost elements. Fitzmaurice (2009) is even more ambitious, inferring that an OSBP at Beit Bridge that could transit a vehicle in three hours would save US$29 million northbound and US$35 million southbound. These savings related to reduced transport- and time-related costs; more predictable transport times; and improved logistical efficiency and trade competitiveness of the countries involved.

3 Research approach

Two SU proprietary models were used for the results presented in this paper:

- The freight demand model (FDM) is based on gravity modelling, and provides a bottom-up measure of freight flows between all magisterial districts (including borders) in South Africa, for all commodities, on all modes. It provides granular origin-destination data, as well as commodity data.
- The logistics cost model (LCM) measures all costs on all modes together with ancillary logistics expenditures such as warehousing, management and administration as well as inventory carrying costs. (A small portion of the LCM is published in South Africa's annual State of Logistics Survey.)

3.1 Determining freight flows

The FDM for South Africa is driven by an exhaustive geographically disaggregated sectoral supply–demand model of the economy, culminating in a gravity model to determine freight flows. The modelling of supply (production and imports) and demand (intermediate demand, final demand, exports and inventory investments) on a geographical basis per commodity is based on the input-output table (I-O table) of the economy. By its nature, the I-O table gives detailed information on the intermediate and final demand components of each commodity in the economy.

The geographical units are 356 magisterial districts (MDs), the smallest area for which some economic data is available. The estimation of flows per commodity is based on a gravity modelling approach using the volumetric magisterial district supply and demand data from the I-O process. Gravity models are the most widely used approaches internationally to distribute freight flows between origins and destinations. Gravity-based approaches are grounded on the premise that freight flows between origins and destinations are determined by supply and demand, and a measure of transport resistance. The amount of interaction – freight flows – between two areas is presumed to be directly related to the attraction of the areas, and inversely to the transport resistance measure between the two. For the purposes of this research, the transport resistance measure used was a distance decay function. While the I-O model provides data for the 356 MDs in South Africa, the gravity model expands this to 372 regions by distinguishing the eight border posts between South Africa and neighbouring countries, South Africa's seven ocean ports, and the largest freight airport (in Gauteng).

The input data for the flow modelling is created by subtracting the origin and destination data of known flows (rail, pipeline, conveyor and coastal shipping) from the supply (origin) and demand (destination) values. The balance of flows is modelled as origins and destinations. The decay factor is added for each commodity. The FDM then estimates road freight flows in South Africa (summarised into 64 commodity groups) between the 372 regions in tons and ton-kilometres, with 30-year forecasts and for three growth scenarios, and results in more than one million records of freight-flow data between defined origin and destination pairs. Known rail flows are utilised to conduct detailed modal analysis.

The availability of this data allows for the identification of South Africa's major border posts based on freight flow volumes, as well as the commodities transported through the borders. Once all flows have been identified, logistics costs are calculated. (Refer to Havenga (2007) for further details.)

3.2 Determining logistics costs

The LCM employs both a bottom-up and top-down approach for the computation of logistics costs by relating the total supply of a specific commodity to the costs of performing logistical functions with respect to that commodity. The logistics cost elements measured are transport; storage and port handling costs; management and administration costs; and inventory carrying costs. The total transport cost is measured by calculating the cost of transport by road (both distribution and line haul), rail, air, coastal shipping and pipeline.

Total road transport costs are calculated using the road freight flow outputs from the FDM. The approach involves the summation of all the different cost elements of road transport within a typology on a specific route (overhead costs are left out of the equation since these are calculated as separate cost elements in the model). These different cost elements of road transport in the model are determined by the vehicle type, which in turn is determined by the commodity type, typology and route of travel. The commodity's 'preferred' vehicle type will change with changes in each of these variables. Once the vehicle type and volume are known, the cost elements can be assigned. The model also extends to secondary road traffic (i.e. local distribution from the final warehouse to the retailer).

Actual rail transport costs are received from the national rail transport operator (Transnet Freight Rail) per commodity per origin-destination station, and therefore rail transport costs do not have to be modelled.

Storage and handling rates are used to calculate the warehousing costs for the entire country. Storage costs take the static storage delay in inventory into account and use the change in inventory costs from the previous year (per sector of the economy) to adjust the static delay. A separate handling charge (for picking and stuffing) is calculated per distinct commodity, based on industry tariffs and applied to all tons stored.

The inventory carrying cost is calculated by researching the rand value of inventory levels for different industries in the economy, and then multiplying that value by the weighted average prime rate for the year.

The cost of management and administration is calculated by taking the average number of employees in the logistics sector (excluding truck drivers), multiplied by their average annual earnings, and adding management costs of truck drivers (this is for in-house transport, which is calculated at average salary contribution to cost, applied to truck driver cost).

3.3 Additional logistics costs due to cross-border delays

In calculating the transport costs, a specific vehicle type is allocated to each commodity on each route of travel (such as long-distance corridor or short-distance rural movements). A more detailed understanding of this process is necessary in order to clarify the process followed to add cross-border-related transport cost. Each vehicle allocated to these specific freight movements have specific aspects used in determining costs. These are:

- the annual estimated kilometres travelled;
- the average payload;
- the percentage of the time the vehicle travels without cargo;
- the licence fees in the province allocated;
- the replacement value to determine depreciation;
- the value to determine carrying cost and insurance;
- wages for the driver;
- business overheads;
- toll fees required on the route of travel;
- maintenance and repair costs of the vehicle;
- costs of tyre usage; and
- fuel costs.

Of these costs, the licence fees, depreciation costs, capital carrying cost, insurance and wages will be incurred even for a vehicle standing at the border posts. Owing to standing time, more vehicles will be required to move the same volume of freight, and reduced utilisation is achieved, and thus fixed costs will increase the transport cost overall. These standing costs differ for each commodity and each vehicle type. The calculated costs for the various commodity groups are indicated in Table 1.

Table 1. Standing costs per commodity group per day (FDM)

Commodity groups	Road fixed delay cost per ton (ZAR)
Chemicals	115
Construction & steel	88
Consumer	143
Equipment	135
Fuels & beverages	159
Minerals	165
Other	100
Paper & wood	98
Perishables	128
Tobacco & grains	112

These standing costs were calculated based on the fixed cost per day for each vehicle type used per commodity group, considering factors such as the average payload, annual kilometres travelled, and the percentage of time the vehicle travelled without cargo.

Additional inventory carrying cost is the additional cost of having freight standing at the border. This is determined by the average value of the cargo per commodity group and the opportunity cost of holding inventory. On a company-to-company basis, the opportunity cost of holding inventory can be represented by the hurdle rate, and will therefore differ slightly between companies. In the case of macro-economic calculations, the prime rate is used as a conservative proxy for holding inventory in the country.

Additional buffer stock cost is added to compensate for the unreliability due to the unknown length of border delays. This unpredictability causes inventory levels to rise on both sides of the shipment flows.

The critical assumption required in determining the effect of border procedures on border-related flows, therefore, are the current delay at the border and the targeted delay that can be achieved based on systemic improvements of the process.

In 2011, interviews and focus groups were performed with 29 cross-border freight owners and 25 logistics service providers (LSPs). The assumptions of the current delay times per border used in the above calculations are indicated in Table 2 for the original researched delay, and the expected reduced delay at the border for suggested improvements.

Table 2. Delay time assumptions per border

	Lebombo	Beit Bridge
Original researched delay at border	1.2 days	2 days
Expected reduced delay at border	0.5 days	0.5 days

The high-level estimate by the focus groups was that these measures would yield a net reduction of 0.5 days for both the Beit Bridge and Lebombo corridors.

4 Results

According to the 2009 data, 21% of South Africa's regional imports and 16% of regional exports were routed via Beit Bridge (the Zimbabwean border), while 71% of the imports and 59% of the related exports were routed via Lebombo (the Mozambican border). Imports and exports via the Namibian and Botswana border posts constitute the remainder of the regional trade to and from South Africa. For the purposes of this paper, the remainder of the discussion will focus on the two major border crossings.

Table 3 lists the cross-border commodity flows for South Africa's major border posts in 2009. Construction material dominates the traffic across the Mozambican border, comprising largely low-value commodities such as cement and lime imports to South Africa. Agricultural products and wood are the next most important imports to South Africa. The exports from South Africa are dominated by minerals (coal and chrome ore) and steel. Tobacco and grains, minerals (imports), tobacco and grains, and consumer goods (exports) are the major freight categories crossing the Beit Bridge border.

Table 3. Freight flow for South Africa-Lebombo and South Africa-Beit Bridge border posts (2009) (sorted according to imports)

LEBOMBO ('000 tons)				**BEIT BRIDGE ('000 tons)**		
Commodity group	**Imports**	**Exports**		**Commodity group**	**Imports**	**Exports**
Construction & steel	3 108	169		Minerals	781	47
Tobacco & grains	1 408	127		Tobacco & grains	688	202
Consumer	328	101		Consumer	87	201
Paper & wood	293	10		Construction & steel	70	10
Other	186	970		Paper & wood	29	1
Minerals	159	1 354		Other	21	207
Fuels & beverages	156	57		Perishables	16	28
Equipment	32	2		Equipment	5	33
Perishables	6	230		Fuels & beverages	2	95
Chemicals	1	21		Chemicals	1	5
Total	**5 678**	**3 041**		**Total**	**1 701**	**829**

Table 4 represents the annual logistics costs (2009) for the two border posts under discussion. The modelled costs for the Beit Bridge and Lebombo corridors under the current cross-border delay assumptions add up to ZAR1 039 million additional cross-border cost, which is also reflected in Table 4.

More than 50% of the total cost relates to transportation. Line haul makes up the bulk of transportation cost (76%) and distribution represents 24%. The remaining cost is almost equally distributed among inventory carrying, warehousing, and management and administrative costs. Road fixed costs are the largest of the three added costs at the border. This emphasises the fact that the time delay at borders results in considerable added costs, which could signify a great advantage if minimised.

Table 4. Modelled costs for Beit Bridge and Lebombo corridors – total logistics costs and additional cross-border costs under current cross-border delay assumptions

Cost element	LEBOMBO			BEIT BRIDGE			Grand total
	Import	Export	Total	Impor	Export	Total	
Total transport cost – all modes	1 496	867	2362	814	389	1203	3 566
Total externality costs – all modes	417	77	494	169	60	229	723
Storage and ports	577	191	768	145	76	221	989
Management, admin & profit cost	473	228	701	178	87	265	966
Inventory carrying cost	467	343	810	159	185	344	1 154
Cross-border: Additional buffer stock cost	25	8	33	12	5	18	51
Cross-border: ICC in transit border	42	25	67	18	19	37	104
Cross-border: Road fixed delay cost	488	63	552	234	99	333	884
Total cost	**3 984**	**1 803**	**5 788**	**1 730**	**920**	**2 650**	**8 438**

Adjusting the supply chain metrics in line with the potential reduction in border delays, the 'could be' supply chain costing was calculated. The assumptions used for this calculation are based on the perceptions voiced during interviews and focus groups with 29 cross-border freight owners and 25 LSPs. Tabulated results for the two corridors in the 'could be' state are summarised Table 5, adding up to ZAR368 million, and yielding a reduction in the pre- and post-intervention cost of ZAR671 million, which represents the net gain per annum of the proposed improvements.

Table 5. 'Could be' supply chain costs for Beit Bridge and Lebombo corridors due to reduced cross-border delays

Cost element	LEBOMBO	BEIT BRIDGE	Total ZAR
Cross-border: Additional buffer stock cost	14	4	18
Cross-border: ICC in transit border	28	9	37
Cross-border: Road fixed delay cost	230	83	313

The savings due to a 12-hour reduction are significantly more than the ZAR128 million Curtis (2007) postulated as possible with an 18-hour reduction in border delays. The higher value could be ascribed to the total supply chain view that this research has taken by including the impact of the border-post delay on the cost of origin-to-destination transport cost.

During the focus group discussions, a number of border-post interventions were proposed. The key interventions to bring about a reduction in border delays are: integrated information systems and processes; scanners and weighbridges in key areas (scanning all freight at origin and pre-border); creating one-stop border posts; optimising border-post infrastructure; and streamlining processes across agencies. These interventions were estimated by the focus group participants to have an initial capital cost of ZAR750 million and an additional annual running cost of ZAR100 million. However, the savings to southern African trade partners would see a macro-view payback period of approximately two years for such an investment. This is a high-level estimate, and further detailed studies are required to improve the accuracy of estimates for intervention cost and savings.

5 Conclusion and recommendations

The research has proved that the streamlining of border-post operations that take a total supply chain view (i.e. of both border operations and those that could be moved from the border) is beneficial. In order to achieve this objective, all supply chain costs from origin to destination have to be considered and compared to the investment cost of creating a trans-frontier (ICT) investment view that extends beyond the physical border post.

This includes much more than modifying the physical infrastructure at the border, and includes ICT investments, and different procedures and legal frameworks. This conclusion is in line with Chirundu's OSBP findings (TradeMark SA, 2010). The savings that can be realised on a macro-economic level, however, seem to be much higher than those found by Curtis (2007), and the researchers conclude that this is because of the wider supply chain view that was taken.

A strong political will need to exist and be established in order to create the legal frameworks to make this work, but more than this, the culture change must receive attention. Streamlining processes across several agencies is not an easy task to aspire to, but this has to be addressed and resolved.

A complete solution will also require support from both the public and the private sector, and interconnectivity between these sectors on both sides of the border. Without wide collaboration and dedicated focus from senior management in both sectors, such an endeavour would not be possible.

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