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GATEWAY PORT SELECTION BASED ON INLAND TRANSPORT COST AND PERFORMANCE METRICS IN WEST AFRICA

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Abstract

Geography can directly influence the economic development of a country and this is particularly true for landlocked countries that, by nature, do not have direct access to the sea to facilitate international trade. Landlocked countries (LLCs) are mostly dependent on the infrastructure of their transit neighbours to transport their goods to ports. Burkina Faso, Mali and Niger, the three landlocked Sahelian countries in West Africa, have traditionally used ports of coastal countries to the south including the Ports of Abidjan, Tema, Lomé and Cotonou. Combined, about 9 million tons of cargo (imports and exports) was moved in 2016 between the three LLCs. In this regard, the study sought to compare inland transport costs and performance metrics of various transit corridors in West Africa. Inland transport costs are a much larger share of total import/export transport costs for LLCs. The analyses involved determining the best gateway according the level of transport cost per corridor, as well as determining a single load centre for inbound and outbound cargo flows from the landlocked hinterland of West Africa according to the total cost of transportation. Using forecasted demand, the study found that the Port of Abidjan offered the lowest transport costs in the medium to long term. However, using historical data, the Port of Tema offered the lowest inland transport costs to shippers in landlocked West Africa. In addition, with the Port of Tema as gateway to landlocked West Africa, the logistics performance across its corridors is better than its competitors.

Keywords: Transport Cost, Transport Corridor, Landlocked, Hinterland, Gateway Port, West Africa

INTRODUCTION

Transport is indispensable for economic and social growth and the importance of transport to trade and development is widely recognised. Therefore, transport infrastructure development is important because transport facilitates trade and the general movement of goods and people (UNECA, 2009). Gateway ports are important transport nodes as they facilitate the movement of goods originating from and destined for landlocked countries. Gateways are generally characterized as ports with good intermodal connections that facilitate cargo concentration and distribution by different transport modes, and thereby offer transit or transhipment services to hinterlands that generate high volumes of commercial cargo (Fageda, 2000).

In West Africa, these hinterlands are landlocked countries (LLCs). A country termed as landlocked is one without direct access to the sea (Glassner, 1970) . There are sixteen countries in West Africa and out of these, 13 have direct access to the sea whiles 3 are landlocked and they include Niger, Burkina Faso, and Mali. These LLCs are noted to face difficulties in trade, and therefore grow more slowly (economically) than their coastal counterparts. The United Nations Convention on the Law of the Sea (UNCLOS) gives LLCs the legal right to access the sea by utilizing the seaports of coastal countries and therefore coastal countries are obliged to open their ports to LLCs (Luguje., 2004). LLCs in West Africa utilize the ports of coastal countries to their south which include Abidjan (Ivory Coast), Tema (Ghana), Lomé (Togo) and Cotonou (Benin). Historically, shippers in Burkina Faso and Mali have mostly used the Port of Abidjan due to a variety of reasons including a common language (French), dedicated facilities at those ports for Malian and Burkinabe shippers, and the existence of a rail connection between Ivory Coast and Burkina Faso (Luguje., 2004). Civil unrest in Ivory Coast in 1999 forced shippers to find alternative transit ports in Tema and Lomé.

Other ports in West Africa also handle LLC cargo. The Port of Dakar in Senegal handles some Malian cargo but is not considered in the scope of this study due to the limited tonnage and long distance from other landlocked countries. The Port of Lagos in Nigeria has also handled some Nigerien cargo even though Lagos traditionally handles domestic-bound cargo. Recently the Nigerian government introduced additional plans to compete for Nigerien tonnage. However, the Niamey-Cotonou rail project agreement between Bolloré Group and the governments of Niger and Benin has threatened to derail these plans. The project involves massive rehabilitation works on the Cotonou-Parakou line and a 574 kilometre extension of the line. This will enable a smooth flow of cargo between Benin and Niger, and ultimately offering steep competition to Lagos.

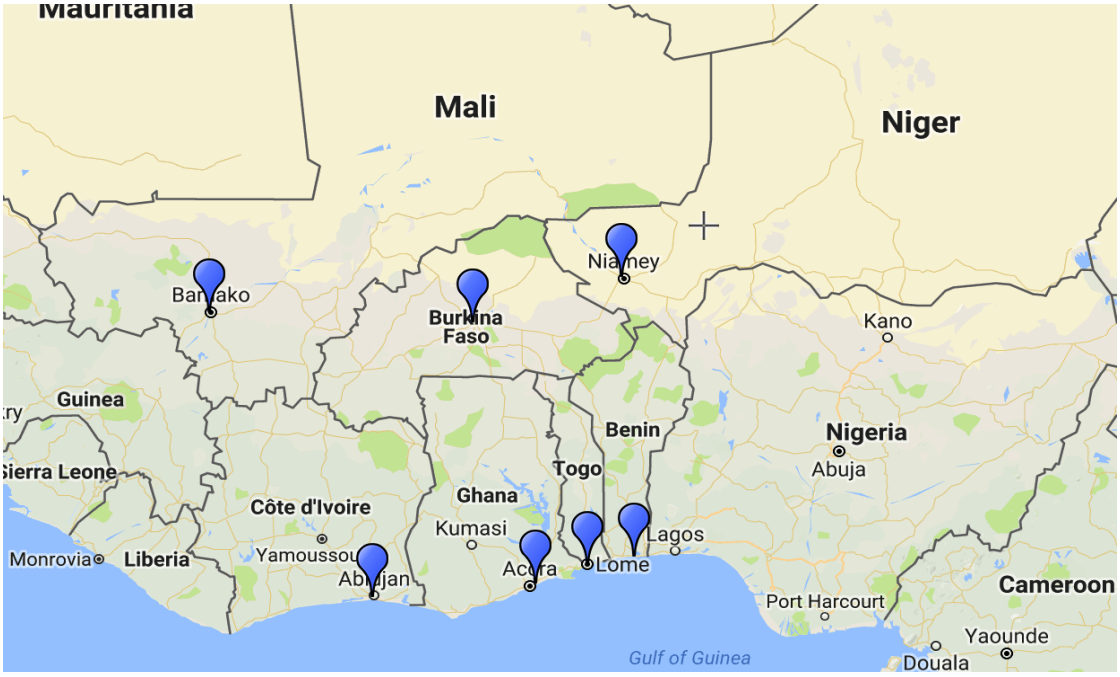

Figure 1: Specific locations of gateway ports and LLCs in West Africa

LLCs in West Africa suffer from relatively high cost of road transport for a variety of reasons including long haulage distances to ports, bad sections of road networks across corridors in West Africa, old and poorly maintained haulage trucks, poorly maintained transport facilities, trade imbalances causing limited backhauls and cumbersome government regulations. These high costs limit the competitiveness of their transit trade through West Africa's ports. Goods destined for LLCs sometimes take longer periods in gateway/transit ports as opposed to domestically bound goods. LLC tonnage also goes through a series of lengthy clearance procedures in some ports.

LLC shippers have to choose between at least four transit ports for their international trade. The selection of these ports is usually done based on the level of cost and the level of service, or a combination of both variables. Therefore, in selecting a gateway port to serve a specific LLC or as a primary load centre for all LLCs in West Africa, this research seeks to ascertain the levels of inland transport cost with respect to tonnage across each transit corridor and determine the logistics performance of each corridor used in the movement of LLC tonnage.

Transportation Landscape and Cost of Transport in West Africa

The transport market of West Africa's inland transit corridors can be said to be fairly competitive. The market actors can be characterized into three groups; the first comprises individual truck owners who may own between one and a few trucks and compete for cargo directly. The

second involves individual truck owners that own one to a few trucks and belong to a trucking union that regulates the activities of members and may be restricted to particular areas of operation. The last major group involves large trucking companies with fleets of vehicles that haul tonnage across multiple corridors. There is competition between transport corridors in West Africa, particularly emanating from the competitiveness of gateway ports. From a supply chain perspective, a port's competitiveness is also heavily reliant on the quality and flow of land transport networks connected to it (in most cases these are rail networks and regional interstate road networks). Therefore, in addition to internal port logistics and sea-side access facilities, more competitive ports will be connected to transport corridors with first-class infrastructure and facilities (Harding, Pálsson, & Raballand, 2007).

The two most important modes of transport in West Africa are road and rail. Road is the most dominant mode in the region especially for the transport of freight through transit corridors. Road transport is however one of the most challenging modes as the general condition of roads often hinders safe and expeditious transport of cargo. Rail transport in West Africa is limited and links only two capital cities with ports for the movement of freight; Abidjan (Côte d'Ivoire) to Ouagadougou (Burkina Faso) and Dakar (Senegal) to Bamako (Mali). The only other rail link in West Africa can only be used in combination with road for the movement of goods from a seaport to a commercial capital in the hinterland (Cotonou–Niamey rail-and road corridor). With water transport, although the Niger River offers great potential for inland water transport in West Africa, it has not been developed and many West African countries rarely use water transport for transit of cargo. However, in Ghana for instance, plans are underway to develop landing sites and other transport infrastructure along the Volta Lake (the largest man-made lake in the world) for the transportation of cargo in larger volumes from the south of Ghana to the North. There are major issues to address before this can become a reality. For example, the water level at certain portions of the lake recedes during the dry season such that it becomes unnavigable, sometimes for up to six months in a year.

Generally, the level of transport costs in West Africa is relatively higher than in other parts of Africa. The cost of a transport service goes beyond its price but may also include costs such as possible inefficiencies, risks and delays which negatively affect supply chain efficiency. Moreover, there are many factors that influence the price of a particular transport service for the movement of cargo from one location to another in the supply chain. Rodrigues (2017) outlines seven broad factors that influence the cost of transport including geography, product type, economies of scale, empty backhauls, infrastructure, mode, taxes, tolls and energy. The study asserts that geography is fundamental to transport cost as transport rates correlate with

distance, time and the efficiency of service routes. It is for this particular reason that landlocked countries traditionally incur higher transport costs than coastal neighbors.

According to the Arvis, Carruthers, Smith, & Willoughby (2011) administrative procedures that apply to goods in transit and the inadequacy of key ancillary services are major factors that determine the cost and performance of transport corridors. In addition, for the movement of tonnage across transport corridors in West Africa, border crossing issues and cargo transport-sharing arrangements between truckers from countries on particular corridors have resulted in additional charges which have significantly increased the cost of transport for shippers.

Gateway Ports and Transport Corridors

Fleming & Hayuth (1994) explain that Gateways are nodes in the supply chain where international trade flows are being transshipped onto mainland areas and vice versa. Therefore, gateways serve the purpose of linking geographical areas by providing a system of multimodal infrastructure of national and regional importance for international trade. As facilities for the interchange of trade inflows and outflows, gateways achieve their purpose by providing a smooth, cost-effective, timely service through the integration of their internal activities with the external logistics activities and infrastructure of the other supply chain actors. Gateways, by virtue of their functions, are directly connected to transport/transit corridors. Transport corridors are primarily major transport routes on which cargo and people are moved between specific countries or regions. Therefore, a good transport corridor is one that consists of excellent transport and logistics infrastructure, and services that ensure that the movement of goods and people between major economic areas is seamless. A corridor therefore has the ability to reduce transportation costs by providing effective and efficient transport systems and services (Kunaka & Carruthers, 2014).

A study in 2007 on gateway logistics outlines some key determinants of gateway ports. The study explains that gateways should be centrally located, efficient, connected to major ports around the world and have adequate infrastructure to support cargo handling and onward transport of cargo (Tongzon & Oum, 2007). Gateway ports are usually located in areas that a close to major economic/growth centres and close to major intermodal transport corridors. UNCTAD (1992) defines a strategically located port as one that is located on a major maritime route, near major areas of economic activity, and physically possessing deep draft, breakwater and enough area for sea-side and land-side future developments. Fleming & Hayuth (1994) assertion that location is key to load centering also gives credence to the importance of the strategic location of a gateway port.

Additionally, the speed and reliability of services at gateways must be such that there is expeditious onward transport of cargo to its final destination. Efficiency offers ports a competitive edge over their neighbors although efficiency does come with some cost implications. With respect to competitiveness and gateway ports, the penetration capacity of the port in order to service the hinterland is considered very important for gateways (Ferrari, Parola, & Gattorna, 2011). A gateway must have good links with other international ports through frequent and regular ship calls.

To handle frequent and regular ship calls, adequate infrastructure is vital to gateways. This includes enough berthing space, appropriate and sufficient handling equipment and a well-motivated work force ready to ensure the required service levels are met. However, infrastructure goes beyond the actual port infrastructure but extends to first class intermodal transport infrastructure of transport corridors which is vital for moving cargo through the port and connecting it to the hinterland.

RESEARCH METHODOLOGY

Inland Transport Cost Analysis Approach

The method used in this study is meant to determine the attractiveness of each prospective gateway location with regards to inland transport cost minimization on transport corridors. The method takes into account the location of the gateway ports, the location of commercial markets/major cities of LLCs, actual road/rail distances from ports to markets, current and projected volumes of tonnage (imports and exports) in tons and haulage costs in US$ per ton-kilometre. Total transportation cost can be represented mathematically as:

TC= $D_n x\ d_n x\ F_n$

Where:

TC = Transport Cost in US$;

D_n = quantity in millions of tons;

d_n = distance between two locations;

F_n = transportation cost in ton-kilometres.

The model makes the assumption that the cost per ton-kilometre for rail transport is utilized instead of road where direct rail transport from a port location to a commercial centre is available, as rail transport cost is cheaper in line with the cost minimization objective. Abidjan's rail distance to Ouagadougou is longer than the road route. However, the transport cost per ton-kilometre is cheaper and the transit time shorter.

ANALYSIS

The demand for each location is the sum of imports and exports in million tons.

Table 1: D_n - Tonnage (Imports and Exports) for each location (million tons)

Year	Niger	Burkina Faso	Mali	Total tonnage per annum (mt)
2006	1.52	0.42	1.58	3.52
2007	1.85	0.54	1.34	3.73
2008	2.19	0.57	1.42	4.18
2009	2.77	0.54	1.76	5.07
2010	2.45	0.56	1.84	4.85
2011	2.98	0.72	2.11	5.81
2012	2.82	1.02	2.27	6.11
2013	2.9	1.04	2.55	6.49
2014	2.99	1.07	4.99	9.05
2015	3.37	1.15	3.82	8.34
2016	3.55	1.24	4.14	8.93

Source: World Bank (2017)

Mali records the highest tonnage of cargo in 2016 with about 4 million tons. This is followed by Niger and Burkina Faso with 3.55 and 1.24 million tons of cargo respectively in 2016. Burkina Faso records the lowest tonnage throughout the 11 year period under study.

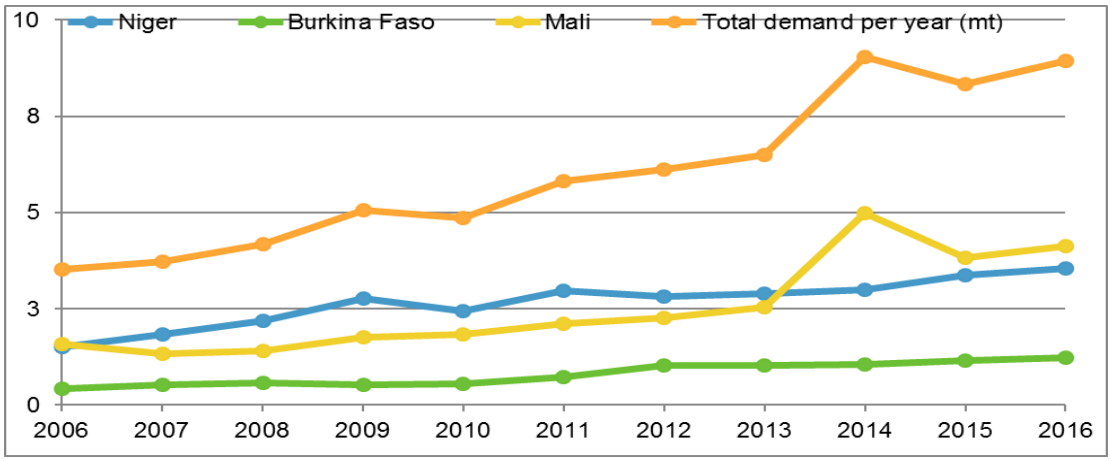

Figure 2: Tonnage trend for LLCs

From 2006-2016, landlocked West Africa experiences approximately 154% increase in tonnage at an average rate of 10% per year. Most LLCs find it difficult to balance their trade: imports exceed exports in aggregate value, as well as in volume. According to Arvis, Carruthers, Smith, & Willoughby (2011), raw materials represent the major quantity of exports from LLCs in sub-Saharan Africa, while manufactured goods and processed foods, which have higher value per ton are the primary imports.

Table 2: Characteristics of Corridors in West Africa

Corridor	Road distance (d_n) in km	Average Corridor Cost per ton/km (F_n)	Average Transit Time (days)	Round trip Duration (Days)
Tema – Ouagadougou	1057.0	0.14	22	40
Tema – Niamey	1121.0	0.14	36	45
Tema – Bamako	1973.0	0.14	35	46
Abidjan – Ouagadougou (Road)	1228.0	0.17	22	35
Abidjan – Ouagadougou (Rail)	1260.0	0.14	16	35
Abidjan – Niamey	1623.0	0.17	27	40
Abidjan – Bamako	1098.9	0.17	23	35
Lomé – Ouagadougou	945.8	0.18	25	40
Lomé – Niamey	1073.0	0.18	23	35
Lomé – Bamako	1790.4	0.18	33	42
Cotonou – Ouagadougou	1004.6	0.18	24	37
Cotonou – Niamey	1021.1	0.18	23	30
Cotonou - Bamako	1849.2	0.18	35	45

Source: Researchers' survey and computation.

Average transport costs in US$/ton/km are represented in table 2. The average distance across all corridors is 1311 kilometres. The average transport cost ranges from US$0.14 - US$0.18 per ton/km. The Tema-Sahel corridors are the cheapest at an average price of 0.14 US$ per ton/km with neighboring Lomé/Cotonou - Sahel corridors recording the average highest cost at 0.18 US$ per ton km. The pricing mechanism for such transport in West Africa is based on the cost of fuel along with road conditions, indirect and direct costs associated with inland transport.

Corridor road/rail distances were determined using Google maps which calculate actual physical distances between two points on a map. The distances range from between 945.8 km (Lomé - Ouagadougou corridor) to 1973 km (Tema - Bamako Corridor). The average transit time per corridor is also presented in table 2. The average transit time of all corridors is about 26 days, with the Tema-Niamey Corridor recording the highest time with 36 days. The shortest transit time is on the Abidjan-Ouagadougou rail corridor which takes about 16 days.

Figure 3 shows the transport layout for tonnage flows for landlocked West Africa. The four littoral ports at the south each receive tonnage from the hinterland (exports) and disperse tonnage through imports, to the hinterland of landlocked West Africa.

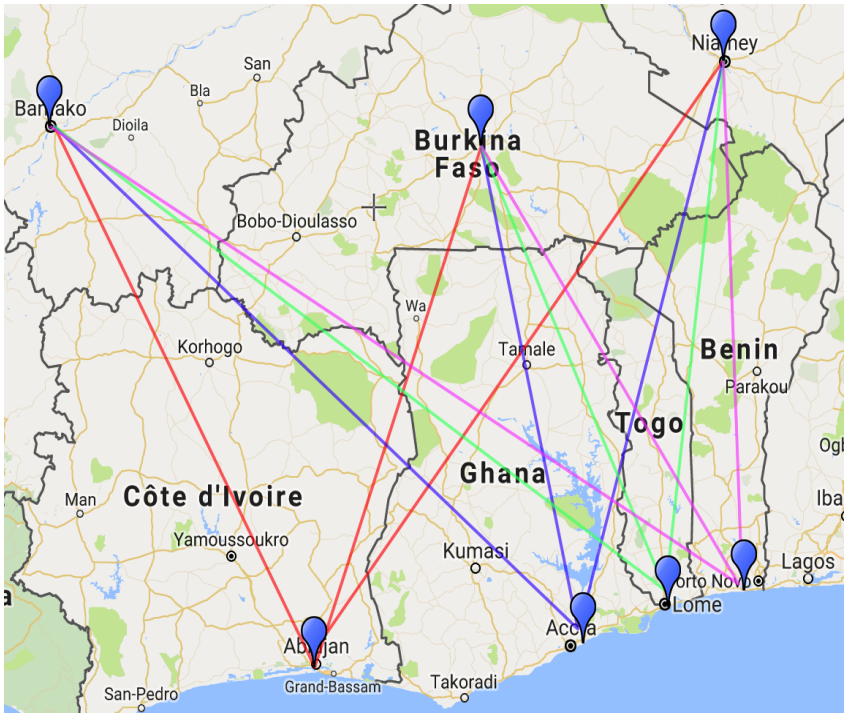

Figure 3: Current transport layout for inbound and outbound flows of transit cargo

Table 3 analyses the total cost of transport per corridor taking the distance, tonnage and cost into consideration. Each corridor transport cost in addition to the total transport cost associated with a single gateway port is calculated and compared. In total, four scenarios have been developed per gateway port. The data used is for the year 2016. In terms of Nigerien tonnage, the cheapest corridor transport cost was the Tema-Niamey Corridor (US$ 602 million), as compared to the Abidjan, Lomé and Cotonou-Niamey corridors. Tema-Ouagadougou corridor (US$ 183 million) was the cheapest transport cost corridor for Burkina Faso tonnage. With regards to tonnage for Mali, the cheapest corridor alternative was the Abidjan-Bamako Corridor (US$ 773 million) which was more than US$300 million cheaper than the next alternative.

Table 3: Corridor cost analyses for West Africa based on 2016 data

Scenario 1: Assuming Port of Abidjan, Ivory Coast as Gateway					
Port	Destination	Distance - d_n (km)	Quantity - D_n (million t)	Cost - F_n (US$/tkm)	Total cost - TC (US$ million)
Abidjan	Niamey	1623	3.55	0.17	979.4805
	Ouagadougou*	1260	1.24	0.14	218.736
	Bamako	1098.9	4.14	0.17	773.4058
Total transport cost (US$ million)					1,971.62
Scenario 2: Assuming Port of Tema, Ghana as Gateway					
Port	Destination	Distance - d_n (km)	Quantity - D_n (million t)	Cost - F_n (US$/tkm)	Total cost - TC (US$ million)
Tema	Niamey	1212.2	3.55	0.14	602.46
	Ouagadougou	1057	1.24	0.14	183.5
	Bamako	1973	4.14	0.14	1143.55
Total transport cost (US$ million)					1,929.51
Scenario 3: Assuming Port of Lomé, Togo as Gateway					
Port	Destination	Distance - d_n (km)	Quantity - D_n (million t)	Cost - F_n (US$/tkm)	Total cost - TC (US$ million)
Lomé	Niamey	1073	3.55	0.18	685.65
	Ouagadougou	945.8	1.24	0.18	211.1
	Bamako	1790.4	4.14	0.18	1334.21
Total transport cost (US$ million)					2,230.96
Scenario 4: Assuming Port of Cotonou, Benin as Gateway					
Port	Destination	Distance - d_n (km)	Quantity - D_n (million t)	Cost - F_n (US$/tkm)	Total cost - TC (US$ million)
Cotonou	Niamey	1021.1	3.55	0.18	652.48
	Ouagadougou	1004.6	1.24	0.18	224.23
	Bamako	1849.2	4.14	0.18	1378.02
Total transport cost (US$ million)					2,254.73

Overall, the Port of Tema as a single load centre offers the cheapest total inland transport cost for the supply chain of landlocked West Africa. In total, the transport cost with Tema as a load centre is approximately US$ 1.9 billion whereas the highest cost is Port of Cotonou with a total cost of US$ 2.25 billion. Tema records the cheapest total transport cost due to the following reasons; first, the average transport cost from Tema is the cheapest amongst all alternatives. Second, Tema lies in a central position to most markets and has the advantage of shorter transit distance to most markets except the Tema-Bamako corridor. This is in line with the studies of (Tongzon & Oum, 2007) and (Fleming & Hayuth, 1994).

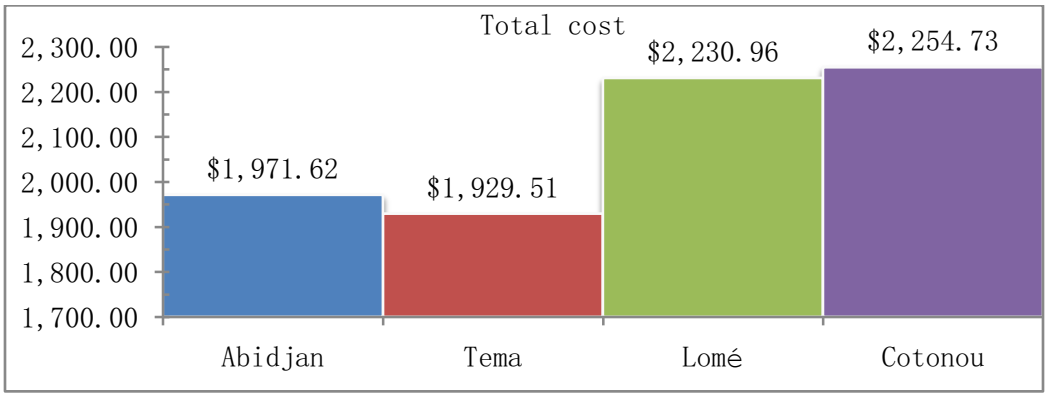

Figure 4: Gateway port ranking with regards to total inland transport cost.

Transport cost based on projected tonnage

A tonnage forecast for the landlocked countries is made, in order to analyze cost with changing levels of demand based on changing economic variables. The forecasted tonnage is based on changes in population.

Table 4: Forecasted demand based on economic variables (2017-2026)

	Niger	Burkina Faso	Mali
2017	3.70	1.26	4.65
2018	3.87	1.34	5.02
2019	4.04	1.43	5.38
2020	4.22	1.51	5.75
2021	4.39	1.60	6.12
2022	4.56	1.68	6.49
2023	4.73	1.76	6.85

2024	4.91	1.85	7.22
2025	5.08	1.93	7.59
2026	5.25	2.02	7.96

Table 4...

Source: Researcher's computation

Taking the year 2022 as a point of reference, forecasted tonnage was used to determine the attractiveness of gateway ports in terms of the transport cost. Certain assumptions were made: (1) Road distances will not alter within the period of forecast (2) the average cost of transport per ton-kilometre remains constant.

Table 5: Total Transport Cost based on Forecasted Tonnage

Scenario 1: Assuming Port of Abidjan, Ivory Coast as Gateway					
Port	Destination	Distance - d_n (km)	Quantity - D_n (million t)	Cost - F_n (US$/tkm)	Total cost - TC (US$ million)
Abidjan	Niamey	1623	4.56	0.17	1258.48
	Ouagadougou*	1260	1.68	0.14	296.33
	Bamako	1098.9	6.49	0.17	1211.68
Total transport cost (US$ million)					2,766.50
Scenario 2: Assuming Port of Tema, Ghana and Gateway					
Port	Destination	Distance - d_n (km)	Quantity - D_n (million t)	Cost - F_n (US$/tkm)	Total cost - TC (US$ million)
Tema	Niamey	1212.2	4.56	0.14	774.07
	Ouagadougou	1057	1.68	0.14	248.59
	Bamako	1973	6.49	0.14	1791.59
Total transport cost (US$ million)					2,814.25
Scenario 3: Assuming Port of Lomé, Togo as Gateway					
Port	Destination	Distance - d_n (km)	Quantity - D_n (million t)	Cost - F_n (US$/tkm)	Total cost - TC (US$ million)
Lome	Niamey	1073	4.56	0.18	880.95
	Ouagadougou	945.8	1.68	0.18	285.99
	Bamako	1790.4	6.49	0.18	2090.28
Total transport cost (US$ million)					3,257.23

Table 5...

Scenario 4: Assuming Port of Cotonou, Benin as Gateway					
Port	Destination	Distance - d_n (km)	Quantity - D_n (million t)	Cost - F_n (US$/tkm)	Total cost - TC (US$ million)
Cotonou	Niamey	1021.1	4.56	0.18	838.34
	Ouagadougou	1004.6	1.68	0.18	303.77
	Bamako	1849.2	6.49	0.18	2158.93
Total transport cost (US$ million)					3,301.04

With forecasted tonnage, there results for the individual gateway selection with respect to cost remain the same. The Tema-Niamey Corridor is the cheapest for Niger with a cost of US$ 774 million. Again, the Tema-Ouagadougou corridor remains the cheapest for Burkina Faso with a cost of US$ 248 million. For Mali, the Abidjan-Bamako Corridor is the cheapest with a cost of US$ 1.2 billion. However, in terms of cargo concentration at a single gateway, Abidjan becomes the cheapest option in 2022 taking the pole position from Tema. A single load centre could potentially lead to significant cost savings in taking advantage of economies of scale, more optimized cargo routing for shipping lines and inland haulers, and optimized handling in port.

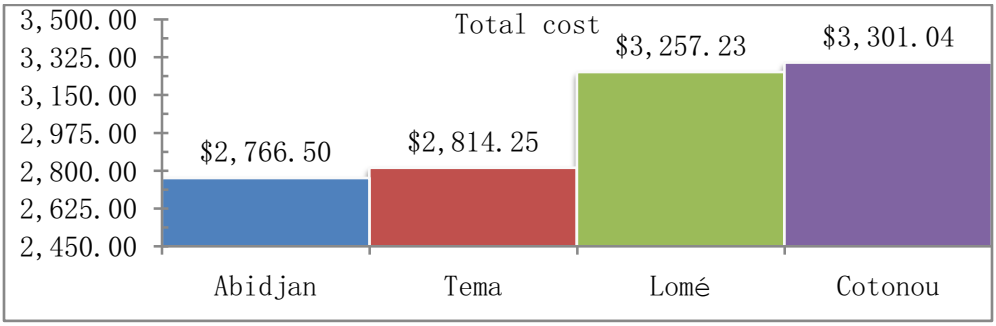

Figure 5: Gateway port ranking based on forecasted tonnage

Performance Metrics of Corridors

The importance of transport cost to the supply chains of landlocked economies cannot be overstated. However, the requisite conditions for the international movement of goods over land go beyond transport cost. It is for this very reason that it is important to evaluate the performance of transit corridors beyond cost. This includes the efficiency of customs and border management clearance, the quality of trade and transport infrastructure, the ease of arranging competitively priced shipments, the competence and quality of logistics services, the ability to track and trace consignments and the frequency with which shipments reach consignees within

scheduled or expected delivery times, as clearly outlined in the Logistics Performance Index (LPI) by the World Bank (2016). The LPI is calculated by analysing these six indicators. Independently, none of the indicators will ensure good logistics performance (Martí, Martín, & Puertas, 2017). All the indicators have been aggregated and duly weighted. Scores range from 1 to 5, the highest score representing the best logistics performance.

The performance metrics of corridors is evaluated in this study using the LPI. The LPI was developed as a benchmarking tool that comprehensively measures the efficiency of international supply chains (Gonzalez, 2016). Efficient logistics and supply chains on a macro-economic level have the capability of developing economies and connecting firms within those economies to domestic, regional and international markets.

Table 6: Logistics Performance Index ranking of countries concerned

Indicator	Score/ Rank	Burkina Faso	Ghana	Togo	Côte d'Ivoire	Niger	Mali	Benin	Mean
Overall LPI Score		2.73	2.66	2.62	2.6	2.56	2.5	2.43	2.59
Overall LPI Rank		81	88	92	95	100	109	115	97.14
Customs	score	2.55	2.46	2.49	2.67	2.59	2.45	2.2	2.49
	rank	84	93	89	70	81	94	130	91.57
Infrastructure	score	2.67	2.48	2.24	2.46	2.22	2.3	2.39	2.39
	rank	71	86	117	89	121	109	97	98.57
International shipments	score	2.73	2.71	2.62	2.54	2.63	2.48	2.55	2.61
	rank	83	85	93	105	91	112	104	96.14
Logistics quality and competence	score	2.78	2.54	2.46	2.62	2.5	2.46	2.47	2.55
	rank	71	98	106	87	100	105	104	95.86
Tracking and tracing	score	2.49	2.52	2.6	2.62	2.35	2.36	2.23	2.45
	rank	103	101	91	89	121	120	129	107.71
Timeliness	score	3.13	3.21	3.24	2.71	3.02	2.93	2.69	2.99
	rank	88	82	76	128	98	106	130	101.14

Source: Extracted from *Logistics Performance Index*, (World Bank, 2016)

Table 6 shows the LPI ranking for the different countries under study. Overall, Burkina Faso ranks highest among the countries under study followed by Ghana, Togo, Ivory Coast, Niger, Mali and Benin. With regards to the customs index, which measures the ease of clearance in terms of processes and time spent, Ivory Coast scored the highest followed by Niger and

Burkina Faso respectively. Benin had the lowest score. Burkina Faso scored highest with regards to the quality of logistics and transport infrastructure (rail, road, water and air), followed by Ghana and Ivory Coast respectively.

The composite corridor LPI in table 7 takes into account each country involved in moving goods across the corridor. The composite corridor LPI is the arithmetic mean of the overall LPIs for each country that is a part of a particular corridor. For instance, for the Cotonou-Bamako corridor, the route is Benin-Niger-Burkina Faso-Mali. Therefore, the mean of the overall LPIs for these countries is computed to give the composite corridor LPI which can be compared to other corridors under study. For all landlocked destinations, the analyses reveal that the Port of Tema in Ghana would be the best gateway to use taking the various indicators of logistics performance into account. For Niger and Mali, trucks would have to transit through Burkina Faso which has the highest index score relative to the other countries under study. An alternative gateway for the landlocked countries would be the Port of Lomé, which comes second in the ranking for all corridors with regards to logistics performance.

Table 7: Composite LPI according to Transport Route

Corridor Origin	Transit countries	Final destination	Composite Corridor LPI
Abidjan	Burkina Faso	Niamey	2.63
	N/A	Ouagadougou	2.67
	N/A	Bamako	2.55
Tema	Burkina Faso	Niamey	2.65
	N/A	Ouagadougou	2.70
	Burkina Faso	Bamako	2.63
Lomé	Burkina Faso	Niamey	2.64
	N/A	Ouagadougou	2.68
	Burkina Faso	Bamako	2.61
Cotonou	N/A	Niamey	2.50
	Niger	Ouagadougou	2.58
	Niger + Burkina Faso	Bamako	2.56

SUMMARY AND CONCLUSION

Landlocked countries have always had huge challenges to surmount in terms of trade. In West Africa especially, they have had to rely on the infrastructure of their coastal neighbors and the

efficiency of their services, in addition to their own, to facilitate the movement of goods to and from their market centres.

The major objective of the study was to select gateway ports based on corridor transport cost and corridor performance metrics. Different scenarios were developed by considering a single load-centre gateway option based on cost, single gateway options per landlocked country based on cost and gateway selection based on corridor performance according a Composite Corridor Logistics Performance Index.

The research revealed that most of the cross border transit routes were road. Only the Abidjan-Ouagadougou corridor had rail service from port to market. This is unfortunate as rail usually is the cheaper option and in terms of cargo integrity, the safer option. However, the Abidjan-Ouagadougou corridor recorded a longer rail distance than road and a cheaper cost per ton kilometre. Thus, rail was the cheaper option and was therefore used in the analysis.

The corridor transport cost was based on the cost per ton kilometre, the tonnage per market (total annual imports and exports in tons) and the distances of each corridor. Tonnage was forecasted and using the year 2020 as target year, cost iterations were made. With the aim of total cost transport minimization to the supply chain of landlocked countries using a single gateway, the Port of Tema in Ghana was adjudged to offer the least cost for inland transport within the maritime supply chain for landlocked West Africa based on 2016 data. The differences in cost between the gateways were relatively moderate under current conditions. However, between the first and last ranked singe gateway (Tema and Cotonou), total transport cost difference was almost US$ 325 million. With forecasted tonnage, and taking the year 2020 as the reference point, the Port of Abidjan becomes the cheapest option as singe gateway for landlocked West Africa with a total cost of US$ 2.77 billion. In terms of multiple gateway options according to the cheapest corridor for a landlocked country, the research revealed the following options to be best:

Table 8: Summary of Total Transport Costs for each Corridor

2016			2022		
Landlocked country	**Corridor**	**Cost (US$ million)**	**Landlocked country**	**Corridor**	**Cost (US$ million)**
Niger	Tema-Niamey	602	Niger	Tema-Niamey	774
Burkina Faso	Tema-Ouagadougou	183	Burkina Faso	Tema-Ouagadougou	248
Mali	Abidjan-Bamako	773	Mali	Abidjan-Bamako	1200

On the other hand, from a logistics performance precept, the various gateways were analyzed. A Composite Corridor LPI (CCLPI) was developed simply by averaging the LPI scores of the

various countries involved in moving cargo through a particular transit corridor. The results revealed that the Port of Tema was the dominant gateway to serve all three landlocked countries based on the LPI scores of the corridors. Apart from Mali which should use the Port of Abidjan for its shipments, Burkina Faso and Niger should use the Port of Tema for their shipments as the cost of inland transport and corridor performance are justifiably better than competing ports.

The different transport corridors in West Africa are quite competitive. However, transport cost is relatively quite high in West Africa. In addition, the transit times as evidenced in table x are too long for the distances involved. This greatly affects the fluidity of the supply chains of firms in landlocked countries. Additionally, the logistics performance of countries along transit corridors is low, as compared with countries in Europe and Asia. For instance, the average LPI score for the countries in the study in West Africa is 2.59 whiles the LPI scores of Germany, Luxembourg and Sweden are 4.23, 4.22 and 4.20 respectively.

Further studies could be conducted to redesign the supply chain for inflows and outflows of goods for landlocked countries in West Africa. Specifically, a study could be conducted to optimize the flow of goods by determining appropriate location(s) for dry ports within the sub-region that could help improve distribution of cargo between landlocked areas and seaports. This would address the issue of high inland transportation costs that affect landlocked countries.

REFERENCES

Arvis, J., Carruthers, R., Smith, G., & Willoughby, C. (2011). Connecting Landlocked Countries to Markets: Trade Corridors in the 21st Century. . Washington DC: The World Bank.

Fageda, X. (2000). Load Centers In the Mediterranean Port Range: Port Hubs and Port Gateways. 40th congress of the European Social Science Association. Bacelona.

Ferrari, C., Parola, F., & Gattorna, E. (2011). Measuring the Quality of Port Hinterland Accessibility: The Ligurian Case. Transport Policy, 18, 382-391.

Fleming, D., & Hayuth, Y. (1994). Special Characteristics of Transport hubs: Centrally and Intermediary. Journal of Transport Geography, 2(1).

Glassner, M. (1970). Access tothe Sea for Devoloping Land-locked states. Netherlands: Springer.

Gonzalez, A. (2016). Conecting To Compete: Trade Logistics in the Global Economy. Washington D.C: The World Bank Group.

Harding, A., Pálsson, G., & Raballand, G. (2007). Port and Maritme Transport Challeges in west and central Africa. Sub-Saharan Africa Transport policy Program (SSATP).

Kunaka, C., & Carruthers, R. (2014). Trade and Transport Corridor Management Toolkit. Washington, D.C.: World Bank.

Luguje., M. (2004). A comparative study of import transit corridors of landlocked countries in West Africa.

Martí, L., Martín, L., & Puertas, R. (2017). A DEA Logistics Performance Index. Journal of Applied Economics, XX(1), 69-70.

Rodrigues, J.-P. (2017, October 2). The Geography of Transport Systems fourth Edition. Retrieved september 20, 2017, from Hofstra: http//people.hofstra.edu/geotrans/eng/ch7en/conc7en/ch7c3en.html

Tongzon, J., & Oum, T. (2007). Port Performance and Gateway Logistics. International Conference on Gateways and Corridors. Vancouver.

UNCTAD. (1992). Strategic Planning for Port Authorities: The impact of characteristics on international maritime transport cost. Geneva: Elsevier.

UNECA. (2009). Sixth session of the Committee on Trade, Regional Cooperation and Trade. United Nations Economic Commission For Africa. Addis Ababa, Ethopia.

World Bank. (2016). Logistics Performance Index. Retrieved 11 2017, from The World Bank: http://data.worldbank.org/indicator/LP.LPI.OVRL.XQ?view=chart

APPENDICES

Appendix 1: Forecasted population of Landlocked West Africa

	Niger	Burkina Faso	Mali
2017	3.70	1.26	4.65
2018	3.87	1.34	5.02
2019	4.04	1.43	5.38
2020	4.22	1.51	5.75
2021	4.39	1.60	6.12
2022	4.56	1.68	6.49
2023	4.73	1.76	6.85
2024	4.91	1.85	7.22
2025	5.08	1.93	7.59
2026	5.25	2.02	7.96

Appendix 2: Summary Output for LLC tonnage regression analysis

Regression Statistics	
Multiple R	0.89
R Square	0.79
Adjusted R Square	0.76
Standard Error	0.61
Observations	10

ANOVA					
	df	**SS**	**MS**	**F**	**Sig F**
Regression	1	11.19	11.19	29.93	0.00
Residual	8	2.99	0.37		
Total	9	14.18			

	Coeff	**Std Er**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	-9.76	2.27	-4.3	0	-15	-4.52	-15	-4.52
Mali	0.78	0.14	5.47	0	0.45	1.11	0.45	1.11

Regression Statistics	
Multiple R	0.96
R Square	0.93
Adjusted R Square	0.92
Standard Error	0.08
Observations	11

ANOVA					
	df	**SS**	**MS**	**F**	**Sign F**
Regression	1	0.83	0.83	115.37	0.00
Residual	9	0.06	0.01		
Total	10	0.89			

	Coeff	**Std Er**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	-2.16	0.28	-7.79	0	-2.79	-1.53	-2.79	-1.53
Burkina Faso	0.18	0.02	10.74	0	0.15	0.22	0.15	0.22

Regression Statistics	
Multiple R	0.93
R Square	0.86
Adjusted R Square	0.84
Standard Error	0.24
Observations	11

ANOVA					
	df	**SS**	**MS**	**F**	**Sign F**
Regression	1	3.28	3.28	54.94	0
Residual	9	0.54	0.06		
Total	10	3.82			

	Coeff	**Std Er**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	-1.94	0.63	-3.09	0.01	-3.35	-0.52	-3.35	-0.52
Niger	0.27	0.04	7.41	0	0.19	0.35	0.19	0.35