THE POTENTIALS OF RAIL-ROAD INTEGRATION FOR PORT-HINTERLAND FREIGHT TRANSPORT IN NIGERIA

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Abstract Modern transport and freight distribution system all over the world are tending towards the adoption of best practices that are reliable, timely and cost-effective. This study evaluates the potentials of integrating rail-road system for port-hinterland freight in Nigeria. Much of the primary data was obtained through the administration of a questionnaire specifically designed to gather information on the cost involved, distanced covered, areal coverage, and time taken to deliver cargoes to consignees. The respondents that were sampled systematically for this study were truck drivers who were interviewed at the point of loading in Lagos and Port Harcourt port complexes. In all, 302 truck drivers were interviewed. Secondary data sources were from records of Nigerian Ports Plc and Nigerian Railway Corporation. The data was analyzed using frequency distribution, Student's *t*-test, and Geometric Mean analysis. The findings of this paper reveal that integrating rail-road for hinterland bound goods would be timely and potentially save 44.2% and 93.7% freight costs on the western and eastern flank respectively from the seaports of Lagos and Port Harcourt. Furthermore, the paired differences of the costs and time on both flanks were statistically significant using the Student's *t*-test statistics. The implications of these findings are that integrating the various modes of transport for port-hinterland freight distribution would make the nation's transportation system to be faster and more cost-effective.

Keywords: multimodal, intermodal, port-hinterland, concessioning, Lagos, Port Harcourt.

1. Introduction

Economic transformation, and indeed, the development of any country are hardly possible without an efficient transport system (Salim, 2003; Lingaitiene, 2006). This is because goods should be transported from origin to destination at minimal costs and time. Although, a few studies have considered port-hinterland transport within the country, most of these have largely focused on consolidation rather than distribution pattern especially at the regional level. Perhaps, the works of Falade (1999), Oni (2000), Ikporukpo and Filani (2000), Ubogu (2005; 2010) and Somuyiwa and Dosunmu (2008) provide a good starting point of a detailed analysis of freight transport in Nigeria. The consensus of the opinion is that maritime goods destined for the hinterland should be transported in a manner that allows each mode of transport to perform the function in which it has a comparative advantage.

Previous studies elsewhere (Hayuth, 1987; Krzyzanoski, 1995; Muller, 1999; Banomyong and Beresford, 2001; Kumar, 2002; Rangaraj, 2004; Khalid, 2006; Islam, et al., 2006) have so far indicated that transporting freight in a multimodal system, no doubt, has the

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greatest advantage in interregional flow of goods and that efficient flow of internationally traded goods require an effective multimodal transport with government assistance. In Europe for instance, intermodal freight transport has been considered as the most prospective, competitive and environmentally friendlier alternative to unimodal road freight transport in medium to long distance corridors (Janic, 2008), with investigations of rail/road intermodal transport gradually emerging as the most innovative area of freight transport research (Bontekoning, et al., 2004; Janic, 2007). The major reason for this trend is the desire to minimize freight transport costs and time spent in hauling cargoes to destination points. It is therefore not surprising to observe that in such countries, the major object of contemporary policy measures aimed at redistributing freight volume is in favour of rail/road intermodal system from departure zones to destination points rather than the sole reliance on unimodal systems, particularly road (Forkenbrock, 2001; Ubogu, 2005; Tsamboulas, et al., 2007).

Over the years, however, very little attention if any appears to have been given to integrated intermodal pattern of port-hinterland interactions in Nigeria despite the changing phases of global freight transport trend (Ubogu, 2001). Given the perceived importance of port-hinterland relationship, goods oscillating between the port and its hinterland regions should be an integral part of transport planning in the country (Badejo, 1998). However, a look at the freight transport system in Nigeria clearly falls short of this expectation as goods are hauled in a manner not consistent with efficient best practices (MITI, 2002). Incidentally, some studies carried out in Nigeria such as the works of Fatunde (1998) and Ogwude (1988) have concentrated on collection flows rather than distribution movements. Similarly, other studies have focused on the economic characteristics of trucking with specific emphasis on the operational cost structure, characteristic operational performance and the locational pattern of freight handling firms within the purview of hinterland-port orientation (Alokan, 1988; 1994; 1995). Most of these studies dealt with the “what” question of the movement of goods, the determinants of the operating characteristics and the pattern of trucking with their preoccupation merely relying on predictive tools. The research gap yet to be filled is therefore the disregard for how such commodities are to be transported given the locational imbalances in supply and demand of transport requirements (Rangaraj, 2004) and the relative advantages of the various modes in freight handling. The consequence is that these studies have largely ignored, or at best, been silent on the empirically proven benefits accruable to intermodal movements of port-hinterland freights.

It is therefore important to note that one of the characteristic features of this neglect is the inefficient and unreliable system of freight traffic in Nigeria (Fagbemi, 2006) since little emphasis has been placed on how goods are expected to move. For instance, the transit time of freight for containers to penetrate the hinterland, particularly in Nigeria is considerable (Oni, 2000; Ubogu, 2005; 2010). Furthermore, the present system of unimodal cargo delivery is, more often than not, associated with some goods not even reaching their final destination as road traffic accidents involving freight vehicles have become rampant in the country (Oni, 1998). Similarly, excessively high axle load trucks on paved and gravel roads reduce the life expectancy of roads especially during the rainy season. It has been documented that one truck axle has the same destructive impact on the road structure of about 10,000 car axles (Mercedes Benz, 2001). A major consequence of this is that billions of Naira are expended on road infrastructure on a yearly basis (FMWH, 1999).

With the emergent structural changes in the country's geography of distribution, the fundamental question does not necessarily reside in the nature, origin and destinations of cargo flow, but how this freight moves from departure zones to destination points from the seaports (Hesse and Rodrigue, 2004). The primary purpose of this paper is to analyse the potentials of rail-road integrated approach for freight delivery as a veritable means of cargo distribution in completing the sea leg journey from the seaports to hinterland locations in Nigeria. This is with a view to assessing the potentials of integrating the different modes as a vital option of solving the inherent constraints facing shippers and haulage operators. In doing so however, this work seeks to determine the costs and temporal variation involved in freighting goods using combined rail and road in contrast to the present unimodal system of freight distribution.

2. Study Area

Nigeria which consists of a strip of land along the coast of the Gulf of Guinea is the study area with a substantial hinterland that comprises of numerous ethnic groups. Nigeria's territorial size is about 923.76 km^2 (Ogezi, 2002). The country lies between latitude 4° 1' and 13° 9'N and longitude 2° 2'E to 14° 30'E (National Population Commission, 1998).

Roads by far handle the largest freight transport share in Nigeria. The highways in the country generally account for about 70 % of the movement of goods and persons in the country (Akpoghomeh, 2002). This is largely attributed to the natural advantage provided by the existence of vast land mass in Nigeria, when compared with waterways, and perhaps the inadequate attention being given to the rail system (Adesanya, 1998). Presently, the country has an estimated length of over 200000 km of road (MITI, 2002; Akpoghomeh, 2002).

As regards the railways, there are two major links oriented in port-hinterland direction from the seaports of Lagos and Port Harcourt denoted hereafter as the western and eastern flanks respectively. It comprises of a total of 3505 km of narrow gauge-single track, running from the south to the north of the country. The Nigerian railways, though before now, played an active part in the movement of goods and passengers, its fortunes began to decline rapidly by the mid 1970s (Adesanya, 1998). Presently, a 320 km standard-gauge section has been constructed between Ajaokuta and Warri though currently not in use.

3. Data and Methods

The basic sources of data adopted in this research are the use of primary and secondary data source. The primary source of data was from responses to a structured questionnaire administered systematically to truck drivers. This research was carried out in two major port complexes of Nigeria (Lagos and Port Harcourt). The active period of the fieldwork was an experience that stretched from March to September, 2008. Both complexes account for more than 75 % of the shipping activities in Nigeria. The Lagos port complex alone handles over 60 % of the nation's total traffic while the Port Harcourt port complex handles about 15 % of the total traffic handled (NPA, 2004). Therefore, such ports are indirectly centres of haulage and trucking activities. Secondly, the two ports have the widest coverage in terms of physical distribution of goods that are hinterland bound.

Data available to the researcher shows that the freight hauled at the Apapa Wharf which is a terminal in the Lagos port complex is on the average of 1300 trucks while 350 trucks are loaded at Tin-Can port which is another terminal of the same port complex on daily basis from 10 am to 10 pm. All these were sampled in a systematic manner of every fifth truck encountered at the point of loading or waiting at port locations for onward movement to the hinterland. Similarly, the same procedure was adopted in sampling the respondents in the Port Harcourt complex with two major terminals. The complex with a loading capacity of 413 trucks per day was also sampled on the order of every fifth truck at the point of loading. On the basis of these capacities, 5 % samples from this population were selected for three days. This brings the total subjects sampled to be 242 and 60 truck drivers in Lagos and Port Harcourt respectively. In all, 302 questionnaires were successfully administered (see Table 1).

Also, an in-depth detailed interview consisting of relevant questions was conducted to the management of Nigeria Railway Corporation in Lagos and Port Harcourt stations to ascertain the state-of-the-art; time involved in conveying cargo from the coast to specific locations in the hinterland; cost involved and billing of goods since they interact with the goods; the current operational coverage of bulk haulage; their comparative advantage over other modes given their present infrastructures. Secondary sources of data concerning the volume of freight traffic and its modal share were obtained from the annual abstract of National Bureau of Statistics, Transport Digest and Nigerian Ports PLC.

The data was analysed using descriptive statistics, Geometric Mean Analysis (GMA) and Student's t-test. These techniques were used to ascertain the temporal and costs differences between the use of rail and road transport in completing the sea-leg journey to the city centre of hinterland locations in the country.

Table 1
The Sample Population of Truck Drivers

Port complex	Location of seaport	Estimated number of trucks loaded per day	Five per cent of the population sampled	Five per cent (5%) sample for three days	Questionnaires successfully returned
Lagos	Apapa Wharf	1300	65	195	191
	Tin Can	350	17.5	53	51
Rivers	Port Harcourt	271	13.5	40.6	39
	Onne	142	7.1	21.3	21
Total		2063	103.1	309.9	302

Source: Field Survey, 2008.

4. Results and Discussion

Any assessment of the movement of cargoes by whatever means must be made with the recognition that cargo is the major preoccupation of the freight distribution industry and that the essence of all operations in the industry is to ensure efficient handling of freight traffic (Odugbemi and Badejo, 1998). Goods destined to the hinterland are seen as crucial components of the space economy. The volume, size, characteristics and mode of transportation to destination points are necessary parameters of freight traffic analysis. The reason being that cargo movement is susceptible to the vagaries of delays, accidents, damages, pilfering, and other forms of logistical problems. Indeed, these constraints are normally the results of inefficient physical distribution system.

Ojekunle (2004) had rightly noted while reviewing urban freight flow in Nigeria that the location of markets and industries act as the threshold of demand. Markets and industrial zones constitute major freight generating and attracting nodes. Similarly, at the regional level, such populated industrial and commercial towns are hinterland freight hubs in Nigeria that receive substantial quantity of maritime goods. This excludes the port towns where substantial quantity of import goods terminates. It is therefore important to examine the volume of cargo penetrating the hinterlands of the country.

Table 2 shows the volume of cargo handled at the Nigerian ports by import, export and total cargo throughput. The cargo throughput tonnage reveals that the industry experienced a steady growth from 1990 to 2006. In 1990, the cargo throughput stood at 16169157. However, the traffic fell for a brief period during the country's political uncertainty of 1992 and 1993. The crises arose as a result of the annulment of 12 June , 1993 presidential election which truncated the democratic process that was meant to institute democratic system of governance in the country. The country then slipped into a pariah status in the comity of nations. Since 1995, there has been a rapid rise in cargo throughput culminating in an unprecedented volume in 2004. Two major reasons, perhaps accounted for this increase. First is the lifting of the ban on certain imported goods and secondly, the subsequent liberalization policies that have been put in place since 1999.

Indeed, as Ogunsanya and Olawepo (2008) observed, with greater stability in government, with the sustenance of the current economic reform, the future portends even greater rise in cargo throughput. The pattern becomes even more interesting when the total cargo throughput is broken down into exports and imports. Unlike export traffic, imports have exhibited a stable and continuous growth. An important picture painted by this trend is the volume of imports grossly exceeding the volume of exports. For instance, in 1998, import cargo accounted for 14286864 while export merely accounted for 5038854 tonnes. Similarly, the same trend is depicted in year 2005 as imports stood at 26051234 while exports accounted for 13551854 tonnes.

However, as glaringly as this data shows, the trend of the share of freight traffic transported by the various modes of transport is equally revealing (see Fig. 1). It is imperative to stress that both inward and outward moving cargoes are distributed using mainly road transport system. The trend depicted in Fig. 1 shows the freight traffic share of rail, road and inland waterways for goods transported to the seaports. An examination of the existing system of cargo distribution depicted

Table 2

Cargo Throughput at Nigerian Ports by Inward and Outward Traffic: 1990-2005 (in tonnes)

Year	Volume of traffic		Total
	Inward	Outward	
1990	9338801	6830356	16169157
1991	11021521	6819380	17840901
1992	13414501	5487925	18902426
1993	12897955	5739047	18637002
1994	9579969	4281879	13861848
1995	9289971	3983082	13273053
1996	10224300	5251001	15475301
1997	11213624	5369181	16582805
1998	14286864	5038854	19325718
1999	15751331	6481605	22232936
2000	19230496	9702384	28932880
2001	24663791	11271901	35940592
2002	25206380	11780861	36987241
2003	27839293	11926652	39765945
2004	26907075	13909872	40816947
2005	26051234	13551854	39603088

Source: Nigerian Ports Authority, Lagos

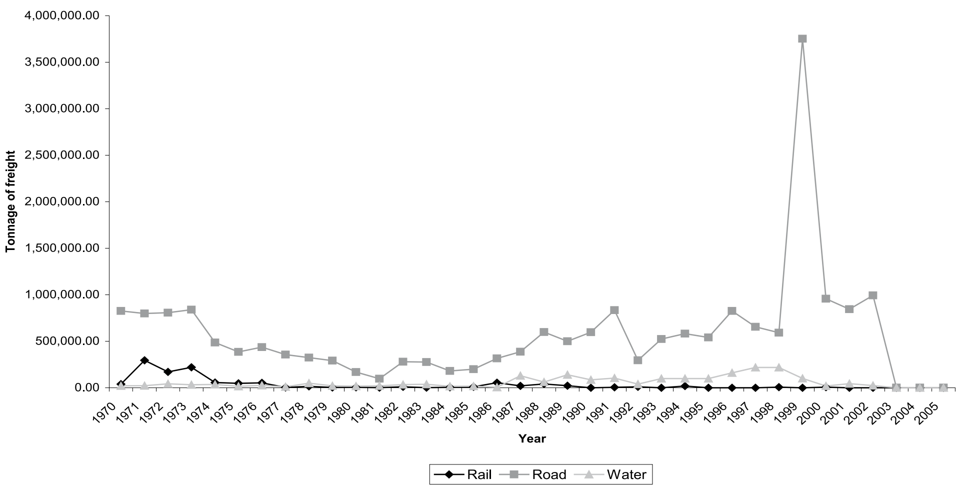

Fig. 1.

Tonnage of Goods Conveyed to Nigerian Seaports by Mode of Transport in the figure reveals that cargo distribution in Nigeria is mainly based on road haulage. The freight share of rail is worrisome as available statistics show that road transport was predominantly used to transport goods to the seaport between 1970 and 1990 and it still accounts for a very significant proportion to date. For instance, from 1970 to 2006, rail's share only accounted for 4.74 % compared to 86.56 % for road and 8.70 % for water.

In spite of Nigeria's rail transport comparative advantage in conveying freight, its share in moving both domestic and maritime freight traffic is presented in Table 3 from 1990 to 2008. The picture painted by this figure shows that in 1990 about 237000 metric tons of freight were hauled by Nigerian railways. This decreased to 106000 in 1994 and then increased to about 1513077 tonnes of goods in 1998. By 2001, the volume decreased to 132813 tonnes and then dropped to 47409 tonnes in year 2008. The freight share of rail relative to road transport system clearly reinforces the unimodal pattern of freight distribution. Table 3 when compared with Fig. 1 reveals that from year 2000 to 2008, the rail freight share handled is perhaps internally generated freight. Indeed, ever since the 1970s, rail transport haul has been relegated to an insignificant position. The freight share of rail transport coupled with non-functional inland waterways heaps the whole responsibility of cargo distribution on road transport.

There is no doubt that the major means of freight distribution is by road. The major type of trucks used in transporting cargo to destination points consists of articulated trucks and lorries. As Table 4 shows, a larger proportion of the trucking firms (58.9 %) deploy exclusively articulated vehicles comprising tankers and trailers of different kinds. Only 8.9 % of the

Table 3
Rail Freight Traffic; 1990-2008

Year	Freight Carried (Metric Tons)
1990	237000
1991	330000
1992	240000
1993	106000
1994	106000
1995	107878
1996	137661
1997	533150
1998	1513077
1999	738691
2000	116837
2001	132813
2002	98190
2003	58790
2004	62575
2005	93762
2006	41551
2007	36758
2008	47409

Source: Nigerian Railway Corporation and National Bureau of Statistics

Table 4
Percentage Distribution by Vehicular Type and Areal Coverage of Haulage Operations

Type of Vehicle	Frequency	Percentage
Articulated trucks only	178	58.9
Lorries (911) only	27	8.9
Both	97	32.2
Areal coverage		
Within the Port City	66	21.9
States Close to the Ports	72	23.8
The Entire Country	133	44.0
Nigerian and Neighbouring Countries	31	10.3
Total	**302**	**100**

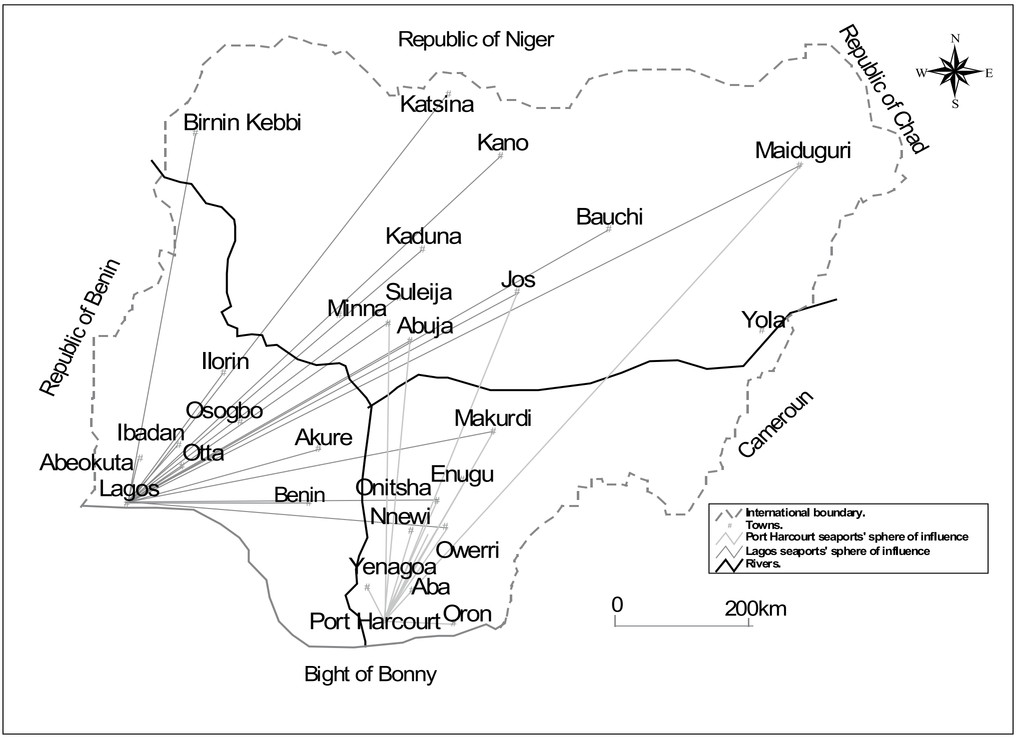

Fig. 2.
The Sphere of Influence of Lagos and Port Harcourt Seaports

operators exclusively use lorries. However, some firms were discovered to operate a mix of articulated trucks and lorries. The areal coverage of these vehicles (Table 4) shows that about 45.7 % of their operations terminate within the port cities and the states close to the ports. These are the areas that approximate some of the most industrialized areas of Nigeria.

This result is similar to the positions of Badejo (1998) that 45 % of the industrial activities are located in the Lagos zone and 23 % in the Port Harcourt and Calabar industrial axis. Those operators whose operations cover the entire country accounted for 44.0 %. Incidentally, 10.6 % of the truck drivers reported servicing both Nigeria and the neighboring countries. It must however be mentioned that the hinterland of the sea ports extends beyond the borders of the country. This is because the two landlocked countries of Niger and Chad depend partly on Nigerian sea ports for its maritime trade.

The choice of these ports by shippers is determined by geography and land use issues including journey time and cost of transport to reach the hinterland location from the sea ports. The notion of ports competing over the hinterland thus becomes glaring. Fig. 2 shows the areas of overlap between the two ports in their sphere of influence. The hinterland areas of overlap mean that they can be served by any of the two ports effectively. The hinterland of the ports can be determined by land transport connections for both road and rail. The road access is particularly important given the growth of “hub and spoke” operation in regional freight distribution.

The seaports of Nigeria are terminals in a multimodal transport system (Ubogu, 2001). They are points where the mode of transport changes from land to water borne system for the purpose of exports and from water borne to land transport system for the distribution of imports (Badejo, 1998). Consequently, such gateways are intermodal centres. Since multimodal transport requires the integration of sea, rail, road and pipeline transport, the critical factor is to control the entire chain of cargo distribution in an efficient, cost-effective and timely manner. The essence is to adopt an efficient freight distribution system that will complete the sea-leg journey.

4.1. The Costs and Temporal Dimensions of Hinterland Freight Transport

Since the completion of the sea-leg journey must be made either by rail, road, inland waterways and pipelines, the task is then to develop a cost-effective and timely system needed to deliver hinterland bound goods. This purpose is to fashion a reliable multimodal system of freight distribution. This section therefore considers the variation in costs involved in transporting cargo to the hinterland by road and rail. The costs and time taken were derived by determining the overall average costs and time of transporting 30 tonnes of cargo to specified hinterland locations as reported by the respondents.

Table 5 shows the costs involvement and the time taken by road to move 30 tonnes of goods from Lagos seaport to the city centre of hinterland towns in Nigeria. However, it is important to note that handling times and costs when goods are transferred between trains and modes are assumed away. A cursory look at Table 5 shows that on average, as much as ₦ 80794 with delivery time of 19 hours is needed to transport cargo from the pier to Ibadan. For Maiduguri with a distance of 1625 kilometres by road, it takes an average time of 106 hours and ₦ 373333 to deliver cargo from Lagos seaport. This is not surprising as stoppages and other logistical problems such as delays are rampant with road haulage.

Similarly, Table 6 shows the costs and time needed to deliver goods from Port Harcourt seaport to hinterland towns in Nigeria. Transporting 30 tonnes to Aba, a distance of 64 kilometres from Port Harcourt, costs as much as ₦ 45221. This journey takes an average of five (5) hours to deliver goods to the city. A city like Gombe, a distance of 1184 kilometres, takes 80 hours with ₦ 320166 to deliver cargo. This attempt is not to belittle the importance of road haulage as it has been and still remains the ubiquitous wheel that keeps cargoes flowing within the country. Apart from the operational difficulties encountered in road haulage, freight costs are unequivocally a bane in the present system of cargo distribution. The task is to use the costs of road haulage and compare them with other methods especially rail transport system that is not effectively used. Strictly speaking, differential costs and time analysis are used as basis of comparison.

Also, Table 5 depicts the differential costs and temporal analysis by road and rail from Lagos seaports to hinterland towns linked by both transport systems. The use of only road transport to complete the sea-leg journey is compared with a proposed rail-road system. Presently, the standard rail billing rates are ₦ 4.70, ₦ 5.80 and ₦ 6.10 kobo per tonne-kilometre for dry goods, wet goods and billets/bitumen respectively. For the purpose of this study, ₦ 6.10 kobo has been used as the standard rail billing rate. For instance, the cost of moving 30 tonnes of consignment by road from Lagos to Kano is ₦ 264318 whereas rail is expected to cost ₦ 206058. Thus, an enormous differential cost in excess of ₦ 58260 could be saved when rail is used in freighting consignments to Kano. As regards the temporal variation in delivery time, 4, 8, 18, 19 and 26 hours could be saved when rail is adopted in transporting goods from Lagos to Ibadan, Ilorin, Minna, Kano, and Maiduguri respectively.

Similarly, the results displayed in Table 6 show that on the eastern flank, as much as ₦ 65271, ₦ 96646, ₦ 111363 and ₦ 85931 could be saved if rail was adopted in freighting goods to Makurdi, Jos, Gombe and Maiduguri respectively. Concerning the temporal dimension, as much as 12 hours could be saved when rail is adopted to transport goods to Makurdi, 6 hours for Gombe, 9 hours for Maiduguri and 4 hours for Jos. The implications of adopting sea-rail-road in a multimodal haulage system is that cargo will be cost-effective as rail will perform the function of long-haul operations while road ends the door-to-door service. The same scenario applies to the temporal gains that will be realized if goods are hauled in this manner. This is based on the premise that consignments ought to be delivered not only at the appropriate costs but also in the minimum time possible.

Furthermore, the differential costs are subjected to Geometric Mean (GM) test to ascertain the overall average percentage difference in costs saved by moving goods from the seaports using rail-road system rather than the sole reliance on road haulage. This average is used in special cases, one of the most important being the overall average percentage of change. According to Schuyler, (2005) and Robinson and Schneider, (2007) when percentage differentials are valuable to a study and/or when costs and temporal requirements are expressed in ratios or percentage of previous measurements, the correct average to use is the geometric mean. Table 7 presents the GM analysis of the differential costs on the western

Table 5
The Costs and Time Needed to Deliver Goods (30 tonnes) From Lagos Port Complex to Hinterland Towns in Nigeria

Freight transport from Lagos port complex										
Towns	**Distance by road**	**Distance by rail**	**Cost by road (₦)**	**Cost by rail (₦)**	**Difference in cost (₦)**	**Cost/ Tonne/ Km by road (₦)**	**Cost/ Tonne/ Km by rail (₦)**	**Duration of delivery by road (hours)**	**Duration of delivery by rail (hours)**	**Difference in time**
Ibadan	166	193	80794	35319	45475	16.22	6.10	12	8	4
Osogbo	256	293	118750	53619	65131	15.46	6.10	24	12	12
Ilorin	325	391	129758	71553	58205	13.30	6.10	24	16	8
Minna	762	743	189375	135969	53406	8.28	6.10	48	30	18
Kaduna	925	909	230000	166347	63653	8.28	6.10	67	48	19
Jos	1034	1173	260526	214659	45869	8.39	6.10	70	56	14
Kano	1175	1126	264318	206058	58260	7.49	6.10	72	53	19
Bauchi	1166	1310	285455	239730	45725	8.16	6.10	76	60	16
Gombe	1354	1476	295000	270108	24892	7.26	6.10	76	64	12
Maiduguri	1625	1878	373333	343674	29659	7.66	6.10	106	80	26
Average cost per-tonne-kilometre						**10.05**	**6.10**			

Table 6
The Costs and Time Needed to Deliver Goods (30 tonnes) from Port Harcourt Seaport to Hinterland Towns in Nigeria

Freight transport from Port Harcourt port complex										
Towns	**Distance by road**	**Distance by rail**	**Cost by road(₦)**	**Cost by rail (₦)**	**Difference in cost (₦)**	**Cost/ Tonne/ Km by road (₦)**	**Cost/ Tonne/ Km by rail (₦)**	**Duration of delivery by road (hours)**	**Duration of delivery by rail (hours)**	**Difference in time**
Aba	64	63	45221	11529	33692	23.55	6.10	5	2	3
Enugu	281	243	121785	44469	77316	14.45	6.10	24	10	14
Makurdi	525	463	150000	84729	65271	9.52	6.10	36	24	12
Jos	864	830	250000	153354	96646	9.64	6.10	68	60	8
Bauchi	996	975	290500	178425	112075	9.75	6.10	78	74	4
Gombe	1184	1141	320166	208803	111363	9.01	6.10	84	78	6
Maiduguri	1460	1443	350000	264069	85931	9.99	6.10	93	84	9
Average cost per-tonne-kilometre						**12.27**	**6.10**			

Source: Field survey, 2008

Table 7

Geometric Means Analysis of Differential Costs on the Western Flank

From Lagos to	Cost by Road (Pi)	Cost by Rail (Pj)	Px = Pj as % of Pi	Log x
Ibadan	80794	35319	228.7	2.3593
Ilorin	129758	71553	181.3	2.2585
Osogbo	118750	53619	221.4	2.3453
Minna	189375	135969	139.2	2.1438
Kaduna	230000	166347	138.2	2.1407
Kano	264318	206058	128.2	2.1081
Jos	260526	214659	121.3	2.0841
Gombe	295000	270108	109.2	2.0382
Bauchi	285455	239730	119.0	2.0758
Maiduguri	373333	343674	108.6	2.0359
Total				**21.5897**

flank compared with rail transport system. The results presented reveal that the value of the differential by pier-rail-road compared to only pier-road distribution of hinterland-bound goods is 44.2 %, Eq. (1) and Eq. (2). The implication of this result is that 44.2 % of the freight costs could be saved if hinterland-bound goods are conveyed in a multimodal pattern from Lagos seaport to the city centre of the hinterland locations on this route. Unlike the costs differential on the western flank, the GM analysis on the eastern flank (Table 8) is far more revealing. This is because a substantial 93.7 % of freight costs could potentially be saved if multimodal pier-rail-road was adopted in cargo haul operation to all the locations on this route Eq. (3) and Eq. (4).

$$\log G.M = \frac{\sum(\log x)}{n} = 21.5897/10 = 2.15897 \quad (1)$$

(Antilog of 2.15897=144.2)
144.2-100=44.2% (2)

Indeed, economic and reliability considerations dictate that road ought not to be the choice in interregional movement of hinterland goods. There is therefore the need to adopt a reliable multimodal freight system. The result presented above is not surprising as certain deductions can be inferred from the two port-hinterland routes. The first probable reason is that the relative condition of the roads may be responsible for the marked variation in the GM. This is because the condition of the eastern road corridor is far more deplorable than the western flank. Secondly, the variation could be a reflection of the relative insecurity associated with haulage operations on that corridor. It is therefore logical to conclude that the road condition and incessant armed robbery on that route could be the prime factors. As a consequence, the differences in operational difficulties are translated to freight cost.

Table 8

Geometric Mean Analysis of Differential Costs on the Eastern Flank

From Port Harcourt	Cost by Road (Pi)	Cost by Rail (Pj)	Px = Pj as % of Pi	Log x
Aba	45221	11529	392.2	2.5935
Enugu	121785	44469	273.9	2.4375
Makurdi	150000	84729	177.0	2.2480
Jos	250000	153354	163.0	2.2122
Bauchi	290500	178425	162.8	2.2116
Gombe	320166	208803	153.3	2.1856
Maiduguri	350000	264069	132.5	2.1223
Total				**16.0107**

$$\log G.M = \frac{\sum(\log x)}{n} = 16.0107/7 = 2.2872 \quad (3)$$

(Antilog of 2.2872 = 193.7)
193.7 – 100 = 93.7% (4)

The Student's-t test values as shown in Table 9 indicate that the calculated *t-test* for all the compared means was significant. For instance, the combination of pier-rail-road compared with pier-road freight costs on the western flank is *t-test* = 11.440, p. <0.001. Similarly, the temporal variation was also significant with the *t-test* value of 7.633, p. <0.001. This implies that there is a significant difference in costs and time involved in freighting cargoes using the present pier-road system and the proposed multimodal pier-rail-road system of seaports interacting with their hinterland.

The result of the eastern flank is similar to the result of the western flank. This is revealed by the fact that the compared mean's *t-test* is statistically significant, *t* value = 7.929, p. <0.001 for freight costs. The time difference is also significant with *t* value = 5.237, p. <0.002. This also implies that there is a significant variation in the freight costs and delivery time by pier-rail-road compared to pier-road system in delivering goods to the city centre of hinterland destinations. The summary of this test, strictly speaking, is that there is a significant difference between the proposed multimodal freight distribution system and the present system of freight delivery.

4.2. Variation in Per-Tonne Kilometre

Some scholars (Ikporukpo and Filani, 2000) have argued that the per-tonne freight rate of rail in 1981 between Lagos and Kano for several commodities was on average less than half that for road transport. Rail transport as a transport system is guided by a standard billing rate. Presently, the per-tonne kilometre for dry goods, wet cargo and Billet/Bitumen is ₦ 4.70k, ₦ 5.80k and ₦ 6.10k respectively. Nigeria appears to be more competitive on some roads such as the western flanks, reflecting the fact that certain major roads have been built or are maintained to higher standards.

Furthermore, column 7 of Table 5 and 6 shows the per-tonne kilometre by road on both the western and eastern port-hinterland flanks with average of ₦ 10.05k and ₦ 12.27k respectively. The per-tonne kilometre on the western link ranges from ₦ 16.22k from Lagos to Ibadan, ₦ 13.30k to Ilorin, ₦ 8.28 to Minna and Kaduna, as well as ₦ 7. 49k and ₦ 7.66k to Kano and Maiduguri respectively. The same trend is depicted on the eastern link. For instance, from Port-Harcourt to Aba is 23.55k, Enugu (₦ 14.45k), Jos (₦ 9.64k), and Maiduguri (₦ 9.99k). This picture is appropriately displayed in Figs. 4 and 5.

Indeed, the impact of distance on costs is such that the total transport cost per kilometre generally falls as journey distance increases. As a result, increases in journey distance will result in less than proportional increases in the total transport cost per vehicle load. Freight rates are tapered so that total transport charges increase with distance, but at a declining rate. Consequently, it is cheaper to transport freight over long distances than short distances (Chapman, 1979). Freight tapered rates reflect differences in the relative contributions of the fixed and variable components to total costs over long and short distances. It is on this premise that Brown and Allen (1998) argued that as trip length increases, larger and faster roads will generally be used by the truck driver and therefore, the average speed will increase. Another reason for the variation

Table 9
Student's-T Test Statistics of Paired Road and Rail (Cost/Time) on the Western and Eastern Flanks.

	Paired Differences					T	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std Error mean	95% confidence interval of the Difference				
				Lower	Upper			
PH COST (ROAD & RAIL)	83184.86	27755.73342	10490.68	57515.09	108854.6	7.929	6	0.000
PH TIME (ROAD & RAIL)	8.00000	4.04145	1.52753	4.26228	11.73772	5.237	6	0.002
LG COST (ROAD & RAIL)	49027.30	13552.53753	4285.689	39332.40	58722.20	11.440	9	0.000
LG TIME (ROAD & RAIL)	15.80000	6.54557	2.06989	11.11758	20.48242	7.633	9	0.000

**PH-Port-Harcourt LG-Lagos*

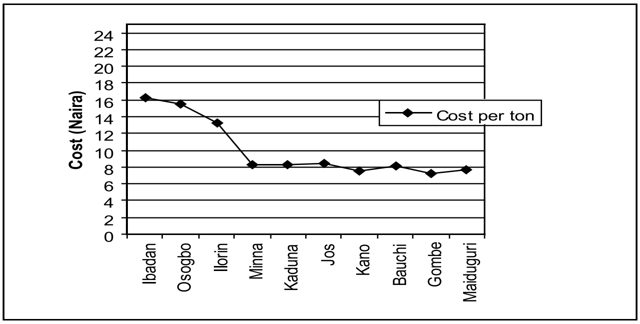

Fig. 3.
Distribution by Cost Per Tonne/km on the Western Flank from Lagos

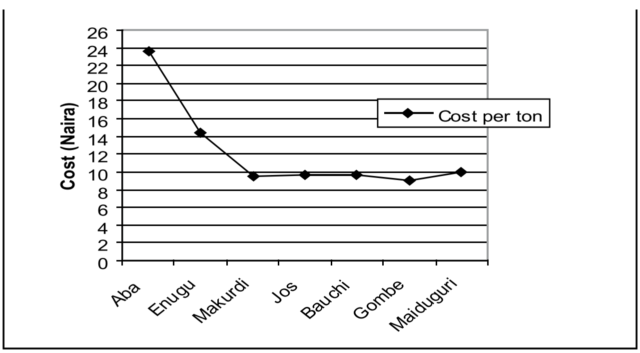

Fig. 4.
Distribution by Cost Per Tonne/km on the Eastern Flank from Port Harcourt

in costs per tonne/km is economies of scale which reduces transport costs on heavily used routes (Bradford and Kent, 1979). This may explain why the western flank has a lower rate than the eastern flank.

5. Policy Implications

The physical distribution of hinterland-bound cargoes at present from the seaports has had to contend with numerous constraints among which are delays, costly delivery system, accidents and increasing demurrage. Not much has been done to alleviate these problems because the best practice has not been put in place. Therefore, there is the need to recognize that the trade volume between ports and their hinterland is increasing both in quantity and sophistication, so it is important that efficient distribution system be adopted. This system should be based on a well developed, coordinated and integrated multimodal transport system.

As noted by Ikporukpo and Filani (2000) the competition between the road system and other modes is operationally unhealthy. It is therefore not surprising that with marked intermodal disparities in public sector investments in favour of road, other modes have had to be relegated to insignificant positions (Oni and Okanlawon, 2006). The greatest attention has been given to road mode in terms of planned and actual expenditure. There should be equitable allocation of resources to all the modes of transport rather than the discriminatory modal subsidies and public sector investment profile. This system of discriminatory government funding if not checked is capable of widening the functional gap between the different modes of transport.

Essentially, there is the need to modernize the Nigerian Railway Corporation (NRC) and the Federal Inland Waterways (FIW) so that it can carve its comparative share in the maritime freight market, especially long- haul freight lost to trucking. This implies constructing a good rail network in the country as well as dredging the Nigerian waterways that are connected to the seaports. It is nevertheless important to point out this note of caution that in revamping the NRC and the FIW transport, there is need to institute and enforce axle load regulation for trucks so that rail and inland waterways can win back their share of the freight traffic. As Pedersen (2001) suggests, increased investments in the railroad systems can only shift the competition between rail and road traffic more in favour of the rails if axle load regulations for trucks are enforced.

Other policy measures that could possibly help rail to reclaim its share of the freight traffic are rate, quantity and distance/route regulations (Ikporukpo and Filani, 2000; Olanrewaju, 1983). Rate regulation involves the fixing of rates by an agency in order to ensure that operators in a given mode do not have undue competitive advantage over operators in other modes. Rate regulation can be done either by imposing a fixed freight rate for the movement of a commodity or by specifying a minimum and maximum rate to be charged in freighting goods. The approach of quantity control concerns the control of the number of operators in a given mode or the number of vehicles each operator could own. This could be done through restrictive licensing. As regards distance/route regulation, it entails placing a limit on the distance over which a given mode could operate or specified route(s) to be operated or both.

Interface infrastructures are also expected to be put in place to facilitate the transfer or change of freight from one mode to another. This implies that as the modal infrastructures are developed, connecting facilities should also be provided to cater for inter-modal transfers at major terminal points. These interface points must be equipped with adequate cargo transfer equipments. Similarly, the establishment of Inland Container Depots (ICDs) is important in facilitating intermodal port-hinterland freight operations. The effective functioning of the ICDs would reduce to a reasonable level some of the inefficiencies associated with transporting goods to hinterland locations such as the exorbitant freight costs, traffic delays caused by the piece-meal loading, very slow movements and enroute breakdowns as well as armed robbery attack. (Oni, 2008).

In view of the dwindling resources available to the government to fund the transportation sector effectively, there is need for sector reform programmes in the country's transportation system either through privatization, commercialization or private-public-partnership (PPP). There should be a vigorous deregulation and privatization of the transport system so that well meaning operators can take up the challenge of organizing Multimodal Marketing Companies (MMC) to operate integrated services. However, there is need to extend such reforms to landside modes like road and rail system if their revitalization is to become a reality (Odeleye, 2002). The Nigerian Railways needs to be concessioned so that transport companies (haulage firms) and other range of third party logistics firms can hire, manage and run its infrastructures to the benefit of shippers, consignees and the nation at large.

6. Conclusion

This study has shown that the potentials of integrating rail-road in port-hinterland freight transportation would be beneficial to the economic development of the country. It is therefore important that efforts should be geared towards sustaining the emergence of a reliable transportation system that is characterized by timely, safe, efficient and cost-effective method of freight distribution. This paper has demonstrated in clear terms that integrating rail-road transport from Nigerian seaports to the hinterland would reduce freight cost, the time of delivery and unnecessary operational delays, accidents and loss of cargo in transit, and by extension, reduce the pressure on Nigerian roads.

For Nigeria to be able to achieve this, multimodal transport as a concept must be adapted into our national transportation system by incorporating it in our national transport policy. The infusion of this transport technique into our transportation system can only be effective if the country adopts the implementation of modern best practices in transportation such as deregulation and concessioning. The reason is that if Nigeria continues to regulate her modal infrastructures and restrict herself to conventional services, the country runs the risks of losing out in distribution trade that is increasingly becoming globalized.

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MOGUĆNOSTI INTEGRACIJE ŽELEZNIČKOG I DRUMSKOG TRANSPORTA ZA POTREBE TRANSPORTA ROBE OD LUKE KA ZALEĐU U NIGERIJI

Andrew Egba Ubogu

Sažetak: Savremeni transport i sistem isporuke tereta širom sveta teže primeni najboljih postupaka koji su pouzdani, pravovremeni i isplativi. U ovom istraživanju procenjene su mogućnosti integracije železničkog i drumskog transportnog sistema za potrebe prevoza tereta ka zaleđu od luke u Nigeriji. Veliki broj primarnih podataka je dobijen sprovođenjem posebno osmišljenog upitnika o troškovima, pređenom putu, oblasnoj pokrivenosti i vremenu isporuke robe do primaoca. Istraživanje je sprovedeno na uzorku vozača koji su popunjavali upitnik na punktu utovara u lučkim kompleksima Lagosa i Port Harkurta. Ispitana su 302 vozača drumskih teretnih vozila. Sekundarni izvori podataka su sačinjeni na bazi dokumentacije Nigerijskih luka Plc i Nigerijske železničke korporacije. Podaci su analizirani primenom metoda operacionih istraživanja. Rezultati rada pokazuju da bi se intergracijom drumskog i železničkog saobraćaja za potrebe prevoza robe ka zaleđu mogle ostvariti uštede troškova prevoza tereta od 44.2 % i 93.7 % na zapadnoj i istočnoj strani, po navedenom redu, od luka Lagosa i Port Harkurta. Uporedne razlike troškova i vremena na oba pravca pokazale su se statistički značajnim primenom Studentovog t-testa. Implikacije ovih rezultata ukazuju da bi integracija različitih vidova transporta za potrebe isporuke tereta od luke ka zaleđu učinila transportni sistem bržim i isplativijim.

Ključne reči: multimodalni, intermodalni, zaleđe, koncesioniranje, Lagos, Port Harkurt.