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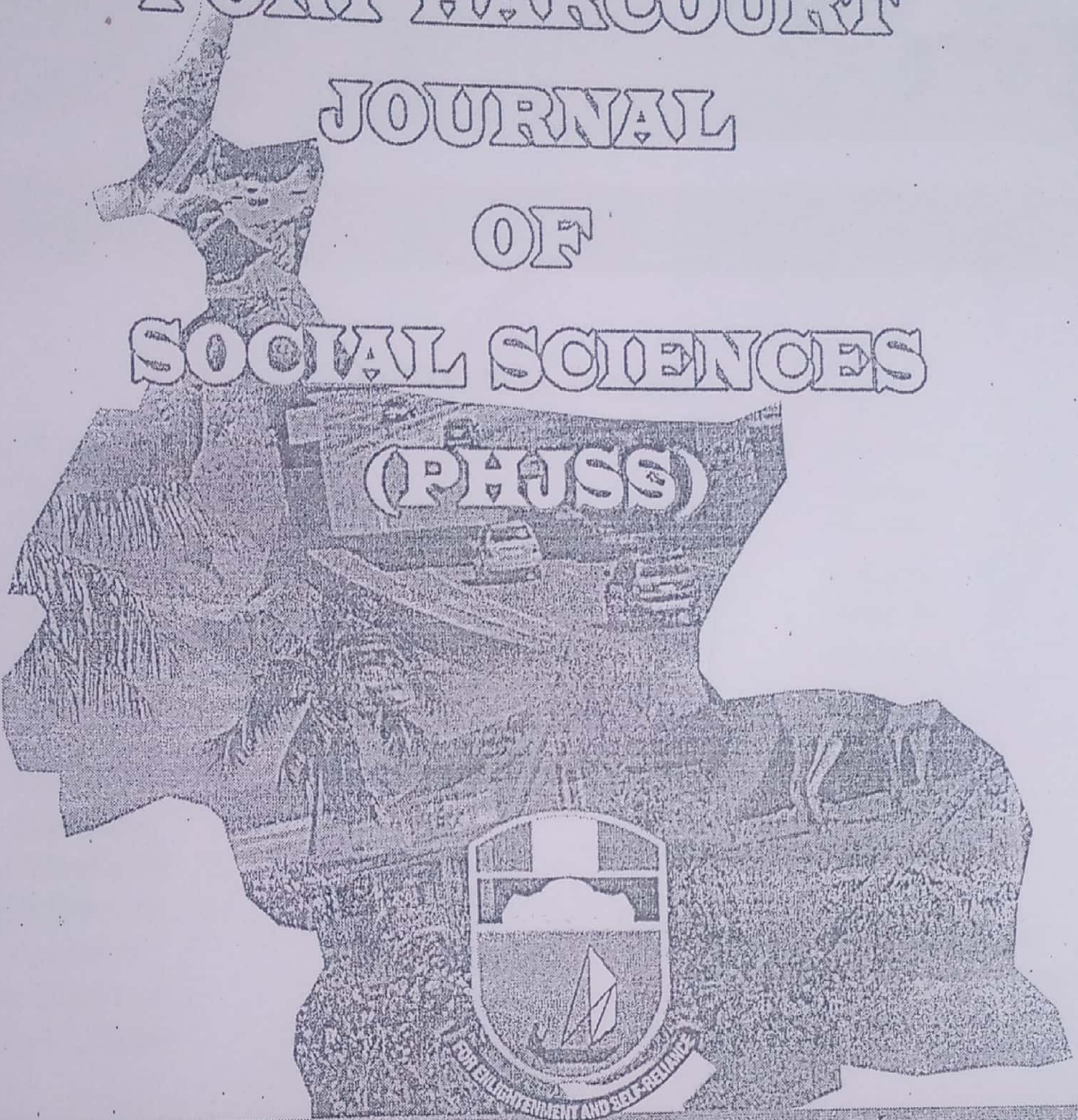

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Competitiveness Analysis of Selected Seaports in West African Coast Region Using Analytical Hierarchical Process

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Abstract

This research analysed the competitiveness of selected ports in West Africa Coast region with respect to vessel traffic, cargo throughput, and container traffic. Data on vessel traffic, cargo throughout, and container traffic (criteria) were collected and analysed for selected ports (alternatives) using Analytical Hierarchical Process (AHP). Apapa port (26.36%), is the most competitive port among the selected ports. It is 1.21 times more competitive than Tema port (21.41%), 1.48 times more competitive than the Tin-Can Island port (17.85%), 2.05 times better more competitive than Cotonou port (12.86%), 2.10 times better than Lome port (12.56%) and 2.94 times more competitive than Takoradi port (8.96%). The order of overall port competitiveness is Takoradi < Lome < Cotonou < Tin-Can < Tema < Apapa. Although Apapa port in Nigeria was the overall best, indices such as port services, port dues, cost of export and import, time taken to import and export, as well as documentation bureaucracy suggest the need for improvement in order to reduce the increasing preference for neighbouring ports by Nigerian business men/women. The ports' hinterland should be enlarged by extending the major corridors to the land-locked nations in the region, to enable Nigeria compete effectively with the neighbouring ports that are already controlling the traffic in those nations.

Keywords: Cargo traffic, competition, seaport, AHP.

1.0 Introduction

A comparison of the prices of vehicles in Nigerian ports and neighbouring port that was carried out in 2012 revealed that the prices of vehicles in the neighbouring ports were cheaper in all types and models. It also showed that although most of the importers were Nigerians, with Nigeria as their major, they import through the port of Benin because it offers them better value for money. Anecdotal evidence suggests a gradual but steady increase in port choice diversion, epitomized by the fact that while our neighbouring ports and the adjoining roads are always very busy, some Nigerian ports are deserted. Earlier studies suggest that the diversion of cargoes lead to revenue loss (Giuliano, O'Brien, Dablanc, and Holliday, 2013). Specific to Nigeria, the diversion of cargoes from Nigerian ports to neighbouring ports leads to loss of revenue for the loser port (Chikere, Ibe, Stephens, Nze and Ukpere, 2014; Babalola, 2017); because any shipment meant for Nigerian market that arrives in a neighbouring port finds its way into Nigeria through cartelization, independent smugglers or due process. According to Omoke (2017), the first two cases deprive the government of the accruable revenue and the third is a huge loss to the economy and

Nigerians that go there to buy, because they pay customs duty to two nations. These are in addition to jobs lost to the neighbouring countries.

Competition is not a new phenomenon in a non-monopolistic market. Firms are allowed to compete among themselves. Although Stucke (2013) noted the lack of unanimity on the meaning of competition, it is observed competition, through the provision of alternative offers to choose from, goes beyond a consideration of the immediate cost to guaranteeing quality, service, safety and durability (which are all elements of bargain) U.S. Supreme Court (1978). Nonetheless, it is expected that competition should be fair, healthy and constructive, and bring out the best in the producers or service providers, as they struggle to satisfy their customers. The fairness in competition is perhaps predicated on the fact that it is influenced or moderated by existing legal and informal institutions (North, 2006). Just like in the wider market context, ports compete among themselves to satisfy their customers, and increase their market shares or retain their clients. The competition among ports is manifested in investment programs and marketing efforts. These investments may be in the improvement of intermodal facilities aimed at minimizing the dwell time of shipments, the expansion of the wharf and storage locations to allow carriers to concentrate operations, improvement in cargo handling facilities to increase port efficiency, or dredging of their waters to allow deployment of larger vessels by carriers. Malchow and Kanafani (2004) noted that marketing efforts may be targeted at enhancing the port's image, integration with major logistics chains, fair pricing, service incentives or motivations.

Port competition is an important topic in transport economics. This is due not only to the large volumes of goods involved in port throughput – a direct measure of a port's competitive strength – but also to derived effects in terms of employment and investment (Meersman, Van De Voorde, and Vanelslander, 2010). There seems to be no consensus opinion on what "port competition", prompting authors like Notteboom and Yap (2012) to observe that port competition is not a well-defined concept. However, Verhoeff (1977) believes that there is, however, a substantial body of literature that not only attempts to define the concept port competition, but also identifies the actors involved in seaport competition (Verhoeff,1977; Heaver, 1995; Goss, 1990 and Hayuth, 1993). It has been Notteboom and Yap (2012) observe that port competition varies and the nature of this competition depends on the type of port (gateway, local, transhipment) as well as the type of commodity (container, liquid bulk). Notteboom and de Langen (2015) observe that ports competition emerged as a complex and multi-faceted concept prompted by the changes in the market environment and the escalation of the rivalry between operators in the same port, between neighbouring ports, between multi-port gateway and entire port ranges. According to Vehoeff (1977), the description of port competition has been competitions between or within ports, and these competitions include intra-port competition - competition between companies found in the same port; inter-port competition - competition between ports; competition between port clusters (between a group of ports with joint geographical characteristics); and competition between port ranges (i.e. between a number of ports sharing the same coastline and having a more or less common hinterland. This can be viewed in Figure 1. It is worth noting that these forms of competition are not always isolated, any of the four levels of competition may affect the other levels (Verhoeff, 1977).

Cargo throughput is the sum of the import and export cargoes loaded and unloaded in a port in one year. The quantity of transhipment (sea-sea transport) cargo and transit cargo is also included in the total throughput (World Bank, 2003). Thus, the value of throughput is the most paramount measure, because it is the aggregate of the volume of trade in tonnes, from different traffic categories. It is also a major variable in determining port efficiency and productivity. Cargo throughput competition is a struggle towards enhancing the volume of cargo routed through a port. The port authority and the government monitor this to ensure that it does not diminished or overtaken by a competing port. The carriers, the shippers and the freight forwarders also see it as a major variable in their port selection decisions.

Musso, Piccioni, and Van de Voorde, (2013) and Meersman, Van De Voorde and Vanelslander (2010) noted that ports are homogenous entities that compete with each other at different levels for freight flows and investment in infrastructure. The determinants of port choice have been the subject of earlier studies, and it is believed that the level of infrastructure and development of a port influence the decision to uses a port or not. Malchow and Kanafani (2004) studied factors affecting port selection for export cargo liners in US using a multi-nominal logit model and found that while oceanic and inland distances negatively affect port selection, location is the most important characteristic of a port. Kim, Lee, and Shin, (2004) differentiated external factors from internal factors, and discovered, and found that while internal factors were time invariant, external factors on the other hand were time variant. Ng (2006) studied container transhipment in Northern European and found that other than monetary cost, time efficiency, geographical location and service quality affect port user's port attractiveness. However, Tongzon and Sawant (2007) which used revealed performance approach, found port cost and range of port services to be the significant factors that influence shipping lines' port choice using. In a study which used the Technique for Order Preference to Similarity by Ideal Solution (TOPSIS) to weigh the most dominant decision-making criteria as a method of selecting an optimized container seaport in the Persian Gulf, it was established that working time, stevedoring rate, safety, port entrance, sufficient draft, capacity of port facilities, operating cost, number of berths, ship chandelling, and international policies were critical factors that influence the selection of container seaport in the Persian Gulf (Sayareh and Alizmini, 2014).

Currently, there has been a shift in the relative weights of the determinants of port choice towards quality of services. The willingness of users to accept higher costs in exchange for a higher quality of services is concluded by many studies. For instance, Murphy and (1995) note that quality is more important than the cost of services and emphasized that reliability of the port remains the most important factor, followed by the speedy delivery of goods. Wong, Yan, and Bamford, (2008) confirm the importance of reliability as a factor in port selection and emphasized three aspects that differ from earlier literature: the level of sophistication of assessment methods used to select transport operators, the determinants of port selection classified with respect to the previous literature and decrease in the importance of cost. In another study, Magala and Sammons,(2008) identify freight and transit time as quantitative factors affecting port choice, emphasizing that ports must not only be efficient in themselves, but must also be efficient elements in logistics chains, where the total cost is less than the cost of the alternative chains with which they compete, for a comparable level of service. The quality and reliability of the complete supply chain are key factors. Hence, the degree of chain integration also influences the choice of a port. The introduction of ECOWAS treaty on free movement of goods and persons has provided a uniform basis for ports in the region to compete. However, the nature of cargo traffic competition in the region has not been determined. This research attempts to close the knowledge gap in this direction. Also, other researches on port competition focus on the input elements of port competitiveness, such as port charges, efficiency, port location, cargo size, infrastructure, reputation, customs regulation, level of ICT, reliability, etc. In other words, they seek to find out the input factors that the port needs to put in place or improve upon, to attract the patronage of the shippers, the carriers and the freight forwarders. However, no work has sought to determine the competitiveness of seaports with respect to the output factors. As much as ports can become competitive by the combination and/or modification of some input factors, the degree of the ports' competitiveness can only be determined by analysing the output factors which are the true products of the ports. Hence, analysis of cargo throughput, which is the most important ports out is necessary to gauge the actual competitive impact of the input factors or port modifications. This research therefore attempts to close the knowledge gap by analysing port competition using ports output as the basis, and by so doing, proffer a sustainable solution to incessant port of choice diversions by Nigerian businesses and individuals to ports in neighbouring countries.

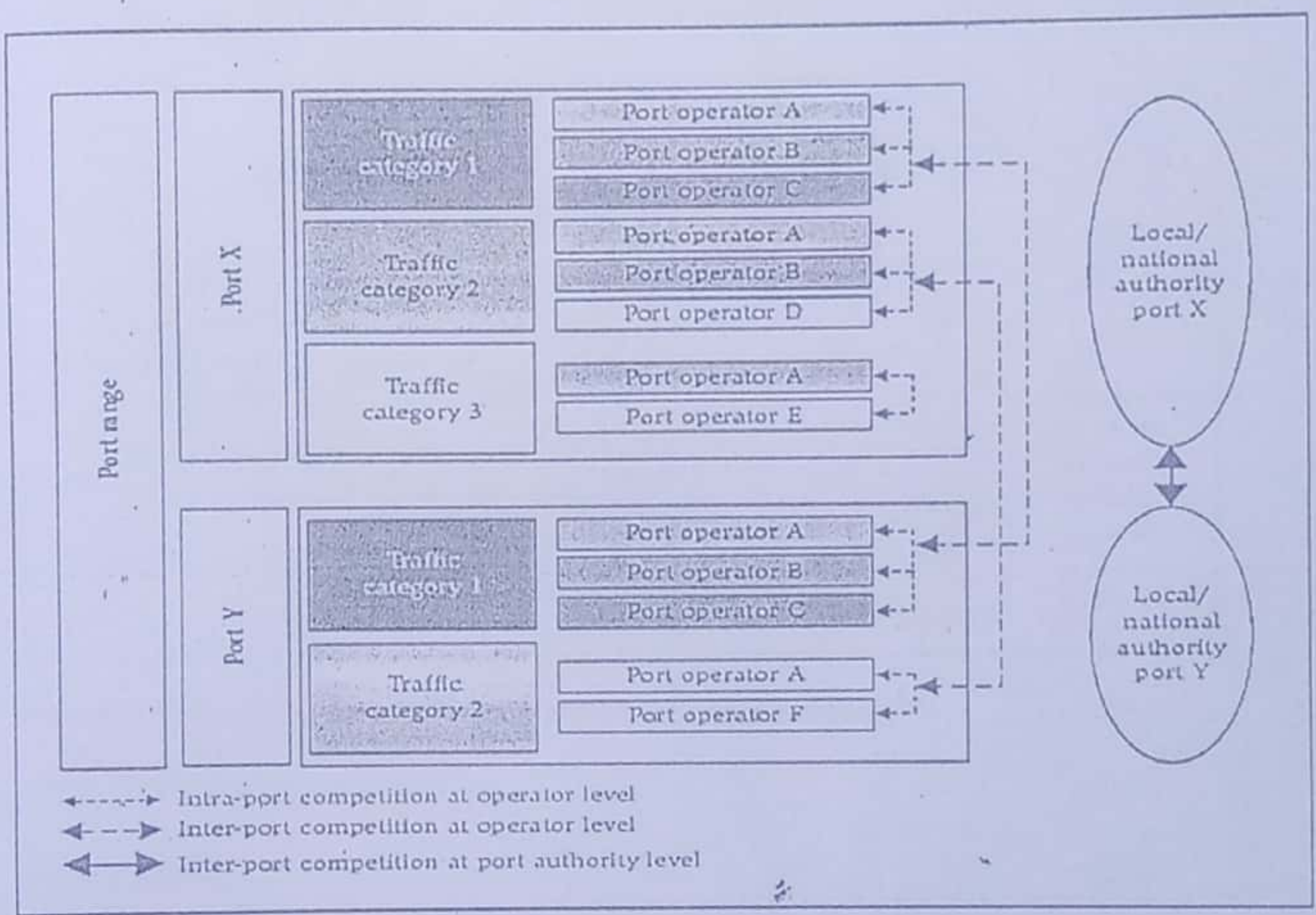

Figure 1: Different Levels of Port Competition within a Port Range
Source: Meersman, Van De Voorde, and Vanelslander, (2010).

2.0 Methodology

Study Area

This study was focused on selected Western African Ports. West Africa is situated between latitudes 4°*N* and 20°*N* and longitude 17°3′W and 16°E, has a total area of 5,112.903km^2, a population of about 340,000,000 and a population density of 49.2/km^2. The study was equally focused on large and very large ports, leaving out the small or minor ports that do not attract ocean-going vessels. Six ports considered were Apapa and Tin-Can Island ports (Nigeria), Cotonou port (Republic of Benin), Tema and Takoradi ports (Ghana), and Lome port (Togo) (Figure 2). The rationale for selecting the ports is the need for a homogenous port system, where the ports are assumed to be competing in a common economic zone, for instance, the ECOWAS Trade protocol that is operational in the region. Secondly, the pilot survey made before the commencement of the research showed that Nigerian ports face real competition with the above neighbouring ports. Two ports were also selected each from Nigeria and Ghana to gauge the nature of inter-port competition that exists among ports within the same geographic range. The study also focused on very large ports only, hence the choice of the six ports. The study attempts to assess the competitiveness of the ports by analysing cargo traffic in the region using operations data that covered a period of 15 years (1999-2013).

Figure 2. Geographic location of the selected West African ports

Source: http://www.skuld.com

Sources of Data

This study used both primary and secondary data. A survey questionnaire was used to generate the primary data on factors that influence port selection (choice of ports), whereas the secondary data were taken from the Ports Authorities, National Customs and Shippers Councils, National Bureau of Statistics, the World Bank, the Central Bank, UNCTAD and ECOWAS Statistics, and International Maritime Organization, for analysis.

Data Analysis

The steps in the analysis include the development of AHP model of port competition, data aggregation and time series analysis of competitive attributes, establishment of comparison matrix for both criteria and alternatives, determination of the overall competitiveness of the ports.

The Analytic Hierarchy Process (AHP) technique was used in this study. AHP model was used to determine the most competitive port in terms of cargo traffic in the coast region. AHP is a structured technique used to organize and analyze complex decisions, based on mathematics and psychology. Khan, Dulloo, and Verma, (2014) observed that AHP is a requirement prioritization technique that permits the evaluation of multiple diverse criteria that individual or collectively affect the final decision. It has been applied in a widespread variety of decision situations, in fields such as government, business, industry, healthcare, and education (Saaty, 2008, Saaty and Peniwati, 2013). AHP is a versatile technique that has found its applications in varied fields and problems due to its nice mathematical properties and the relative ease in obtaining data (Triantaphyllou and Mann, 1995; Khan, Dulloo, and Verma, 2014). AHP has been applied in industrial engineering applications (Putrus, 1990) and more specifically to layout design problems (Wabalickis, 1988). Boucher and McStravic (1991) demonstrated that AHP could also help in investments decisions by applying it to technology investment decisions.

Structure of the Decision Problem Considered

The decision problem considered in this study was made up of a number of M alternatives and N decision criteria, such that each alternatives were evaluated in terms of the decision criteria and the relative importance (weight) of each criterion determined. In view of the fact that the objective was to determine the best alternative, a typical problem would focus on determining the relative significance of the M alternatives when examined in terms of the N decision criteria combined. If we denote the performance value of the ith alternative (A_i) in terms of the jth criterion (C_j) by a_{ij}, where $i = 1, 2, 3, \ldots M$, $j = 1, 2, 3, \ldots N$, and the weight of the criterion $C_j = W_j$, then the typical multi-criteria decision-making (MCDM) problem could be represented by the following decision matrix shown in Table 1:

Table 1: A typical Multi-Criteria Decision-making Matrix

	Criterion						
	C_1	C_2	C_3	.	.	.	C_N
Alternative	W_1	W_2	W_3	.	.	.	W_N
A_1	a_{11}	a_{12}	a_{13}	.	.	.	a_{1N}
A_2	a_{21}	a_{22}	a_{23}	.	.	.	a_{2N}
A_3	a_{31}	a_{32}	a_{33}	.	.	.	a_{3N}
.	.	.	.	.	.		.
.	.	.	.		.		.
.	.	.	.		.		.
A_M	a_{M1}	a_{M2}	a_{M3}	.	.	.	a_{MN}

After comparing all the alternatives with each other in terms of each of the decision criteria and the individual priority vectors derived, the weights of importance of the criteria could also be determined through comparisons. Triantaphyllou and Mann [29] suggest that if a problem has M alternatives and N criteria, then the decision maker is required to construct N judgment matrices (one for each criterion) of order $M \times M$ and one judgment matrix of order $N \times N$ (for the N criteria). Furthermore, Triantaphyllou and Mann (1995) note that the final properties of the alternatives a given decision matrix could be determined using:

$$A_{AHP}^{i} = \sum_{j=1}^{N} a_{ij} W_j \qquad \text{(Equ. 1)}$$

$$\text{for } i = 1, 2, 3, \ldots M$$

AHP Model of Port Competition in West African Coast Region

A port is deemed competitive when it sufficiently appeals to its customers. The degree of this patronage of the port is evidenced in the port's share of the market within the region, such that the relative competitiveness of each port is determined by the weight of the port's output such as vessel traffic, cargo throughput, and container traffic. This study was therefore based on an AHP model which has three major components (goal, criteria, and alternatives) as shown in Figure 2.

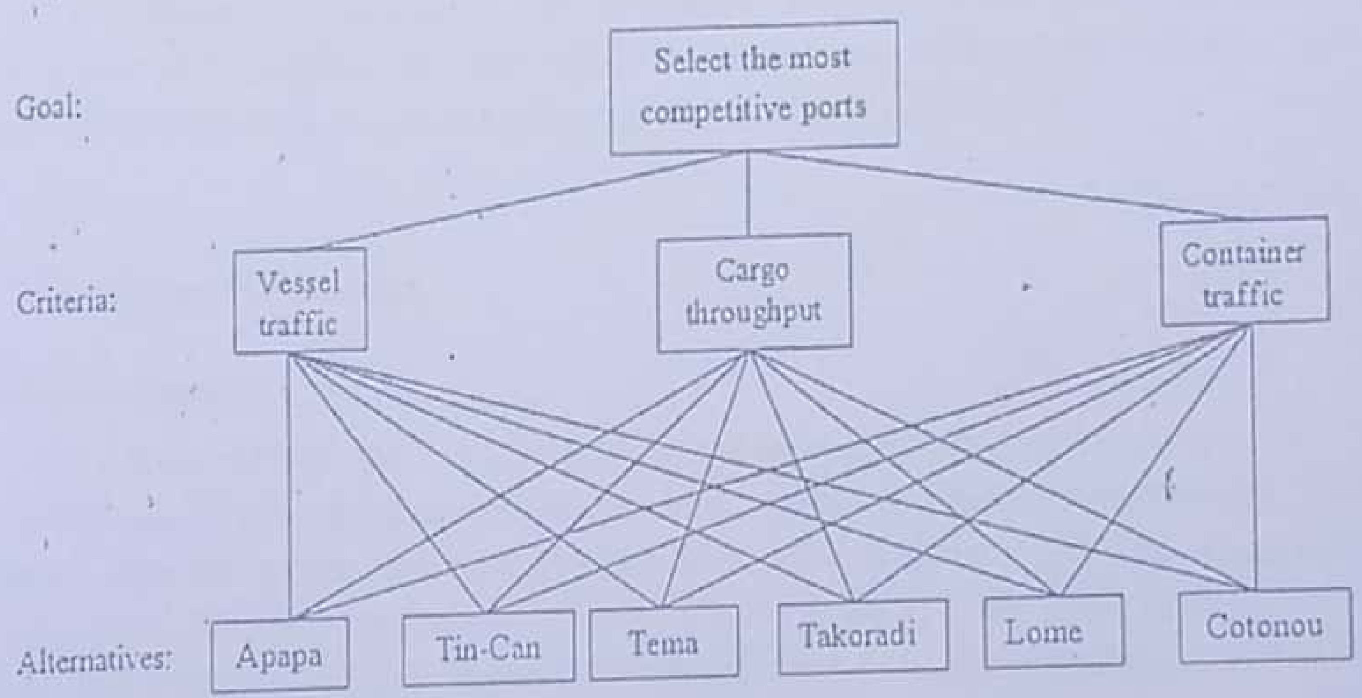

Figure 2: AHP model of port competition in the region

Data Aggregation and Time Series Presentation of Competitive Attributes

The next step involves the aggregation of the 15-year data of each of the ports. With the aggregate values, the descriptive statistics was calculated. The need to visualize the competitive patterns or trends of the ports was met by time series presentation of each of the competitive attributes. The graphical illustrations are important for observing the yearly performances of the ports with respect to the attributes.

Comparison Matrix of AHP Criteria

This involves the determination of the relative weight or importance of the criteria for port competition. It was the major result of a pilot survey conducted among shippers, freight forwarders and carriers to gauge the relative importance of vessel traffic, cargo throughput and container traffic in their bid to select a port in the region. This has to do with determining the relative weight or importance of the criteria for port competition. Using a scale such that the total score of the weights equals 10, vessel traffic, cargo traffic and container traffic were scored and presented in a table for the survey. The weights were used to generate the comparison matrix of AHP criteria from which the priority vector was obtained.

Comparison Matrix of AHP Alternatives

For a given criterion, the aggregate scores of the alternative ports was used to form the rows and the columns of the comparison matrix. Dividing the elements of the rows with that of the columns would yield a 6x6 matrix. The matrix was normalized by dividing each column of the matrix with sum of the elements of their respective columns. The next step involves averaging across the rows to obtain the normalized Eigen vector or priority vector with respect to the criterion being considered. This procedure was repeated for each of the criteria to yield the priority vectors. The priority vectors were brought together to obtain a 6x3 matrix of the Eigen vectors of the alternatives. With the elements of this matrix, one can infer how each of the ports fared with respect to each criterion.

Overall Competitiveness of the Ports

To determine the aggregate competitiveness of each of the ports, the combined priority vector of the alternatives were multiplied by the Eigen vector of the criteria to yield a 6x1 matrix that will show the overall competitiveness of each of the ports.

3.0 Results and Discussion

Time Series Analysis

This study utilised traffic statistics of two ports each, from Nigeria (Apapa and Tin-Can) and Ghana (Tema and Takoradi), to gauge the nature of inter-port competition within common geographic ranges, and one port each from Benin (Cotonou) and Togo (Lome), for the analy sis of inter-port competition in the sub region (Table 2, Table 3 and Table 4).

The time series graph of the data shown on Tables 2, 3 and 4 are shown in Figures 3, 4 and 5. The trend indicates a remarkable performance of Apapa Port with respect to cargo throughput competition. It maintained a very wide margin from Tin-Can and Tema.

Figure 3 indicates an outstanding performance of Tema in terms of vessel traffic up to 2010, before it declined marginally and was overtaken by Tin-Can Island and Takoradi ports that that had sustained improvements in the number of vessels over the years. Apapa, Lome and Cotonou ports never outperformed Tema in this respect within the period under consideration. From 2009 to date, Takoradi outperformed Lome and Cotonou.

The time series graph of cargo throughput in Figure 4 indicates that Apapa port outperformed the other ports in cargo throughput competition, maintaining a very wide margin from Tin-Can Island and Tema Ports. It could also be observed from the graph that Tin-Can Port improved from almost a stagnant state to outperform Tema with a wide margin. However, Tema has always outperformed Lome and Cononou.

In terms of container traffic, Tema port performed better than the other ports, except for a dip in 2010, when it was outperformed by Tin-Can Island Port, whose performance oscillated between 1999 and 2005 when it stabilized and witnessed sustained improvement for the rest period under consideration (Figure 5). Between 1999 and 2008, Apapa port had sustained annual increments in container traffic (Figure 5).

Table 2: Traffic Data for Apapa and Tin-Can Island Ports in Nigeria

NIGERIA						
YEAR	NUMBER OF VESSELS		CARGO THROUGHPUT (TONNES)		CONTAINER TRAFFIC (TEUs)	
	APAPA	TIN-CAN ISLAND	APAPA	TIN-CAN ISLAND	APAPA	TIN-CAN ISLAND
1999	837	360	7890170	2921032	137540	91893
2000	858	443	9164477	3138007	131466	85066
2001	1022	474	11461451	4133077	152112	91019
2002	929	405	11754539	4105028	184364	94847
2003	882	549	11875265	4583505	201132	89694
2004	891	504	12294640	4079946	232761	68192
2005	955	495	13432106	4743741	350143	54217
2006	1376	903	15112819	7372042	356012	166186
2007	1359	1185	18547253	10303300	444466	266634
2008	1452	1367	20809224	11515623	530921	416479
2009	1545	1582	21566202	13541016	490350	543999
2010	1588	1666	21239855	14478838	554153	574018
2011	1594	1857	22808353	16242256	336864	709880
2012	1421	1627	21065520	15219672	317674	780678
2013	1498	1725	21730426	16103981	402545	826037
Total	18207	15142	240752300	132481064	4822503	4858839
Average	1213.80	1009.47	16050153.33	8832070.93	321500.20	323922.60

Source: Abstract of Ports statistics, UNCTAD and World Bank statistics

Table 3: Traffic Data for Tema and Takoradi Ports in Ghana

GHANA						
YEAR	NUMBER OF VESSELS		CARGO THROUGHPUT (TONNES)		CONTAINER TRAFFIC (TEUs)	
	TEMA	TAKORADI	TEMA	TAKORADI	TEMA	TAKORADI
1999	1190	352	6368539	2709425	197900	37843
2000	1163	368	6217715	2851003	206768	39803
2001	1169	426	6338165	3129481	221468	43710
2002	1272	463	6841481	3400904	223377	47501
2003	1172	494	7391268	3825276	305868	41113
2004	1381	544	8447655	4184384	342882	43020
2005	1643	699	9249977	4635733	392761	49321
2006	1994	610	8046838	4719617	425408	51042
2007	1672	594	8378682	4053632	489147	52226
2008	1568	615	8727049	4016813	555009	52372
2009	1634	956	7406490	3371980	525694	47828
2010	1787	1277	8696951	4012139	590147	53041
2011	1667	1798	10748943	4947201	756899	56595
2012	1521	1664	11468962	5310697	824238	60746
2013	1553	1364	12180615	5452025	841989	52373
Total	22386	12224	126509330	60620350	6899555	728536
Average	1492.40	814.93	8433955.33	4041356.67	459970.33	48569.07

Source: Abstract of ports statistics, UNCTAD and World Bank statistics

Table 4: Traffic Data for Lome and Cotonou Ports

YEAR	TOGO			BENIN		
	LOME			COTONOU		
	NUMBER OF VESSELS	CARGO THROUGHPUT (TONNES)	CONTAINER TRAFFIC (TEUs)	NUMBER OF VESSELS	CARGO THROUGHPUT (TONNES)	CONTAINER TRAFFIC (TEUs)
1999	368	2309868	50246	447	2327513	58882
2000	423	2655433	57763	621	3235876	81862
2001	473	2969424	75818	643	3309890	89168
2002	632	3976055	99516	674	3469912	91994
2003	726	4567404	170115	796	4290190	98188
2004	705	4429345	184998	907	3969000	97801
2005	809	5080033	204614	1196	5152859	158201
2006	851	5349195	215898	1393	5998636	183575
2007	983	6183771	237891	1407	6152000	167800
2008	1158	7280810	296109	1299	6998000	312000
2009	1166	7326128	354480	1300	6698365	299500
2010	1175	8006000	339853	1011	6961000	316744
2011	1063	8248000	352695	989	6807000	334798
2012	989	7772000	288481	1054	7441000	348190
2013	1120	8698524	311470	1105	7805503	365246
Total	12641	84851990	3239947	14842	80616744,	3003949
Average	842.73	5656799.33	215996.47	989.47	5374449.60	200263.27

Source: Abstract of ports statistics, UNCTAD and World Bank statistics

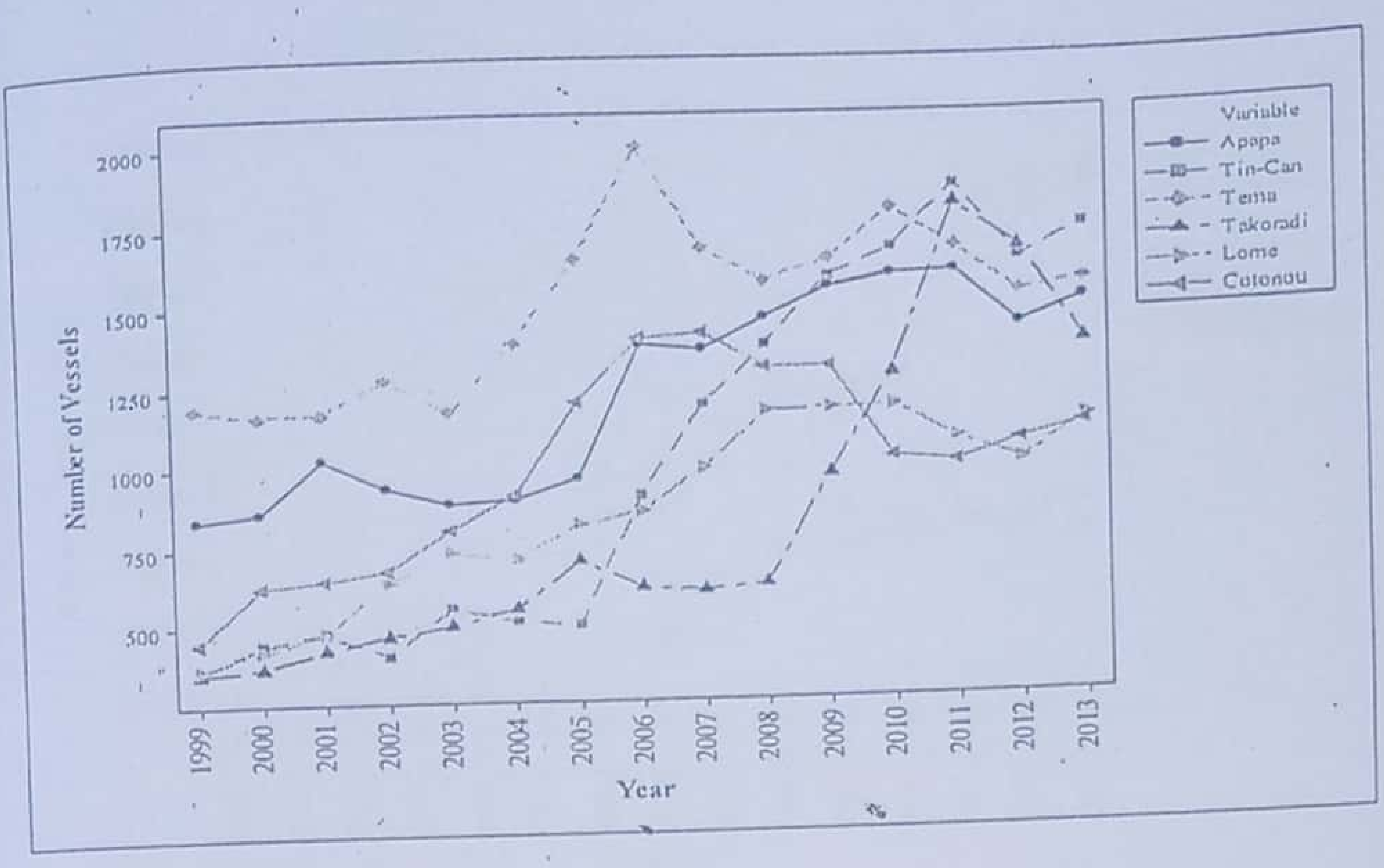

Figure 3: Time Series Graph of Vessel Traffic

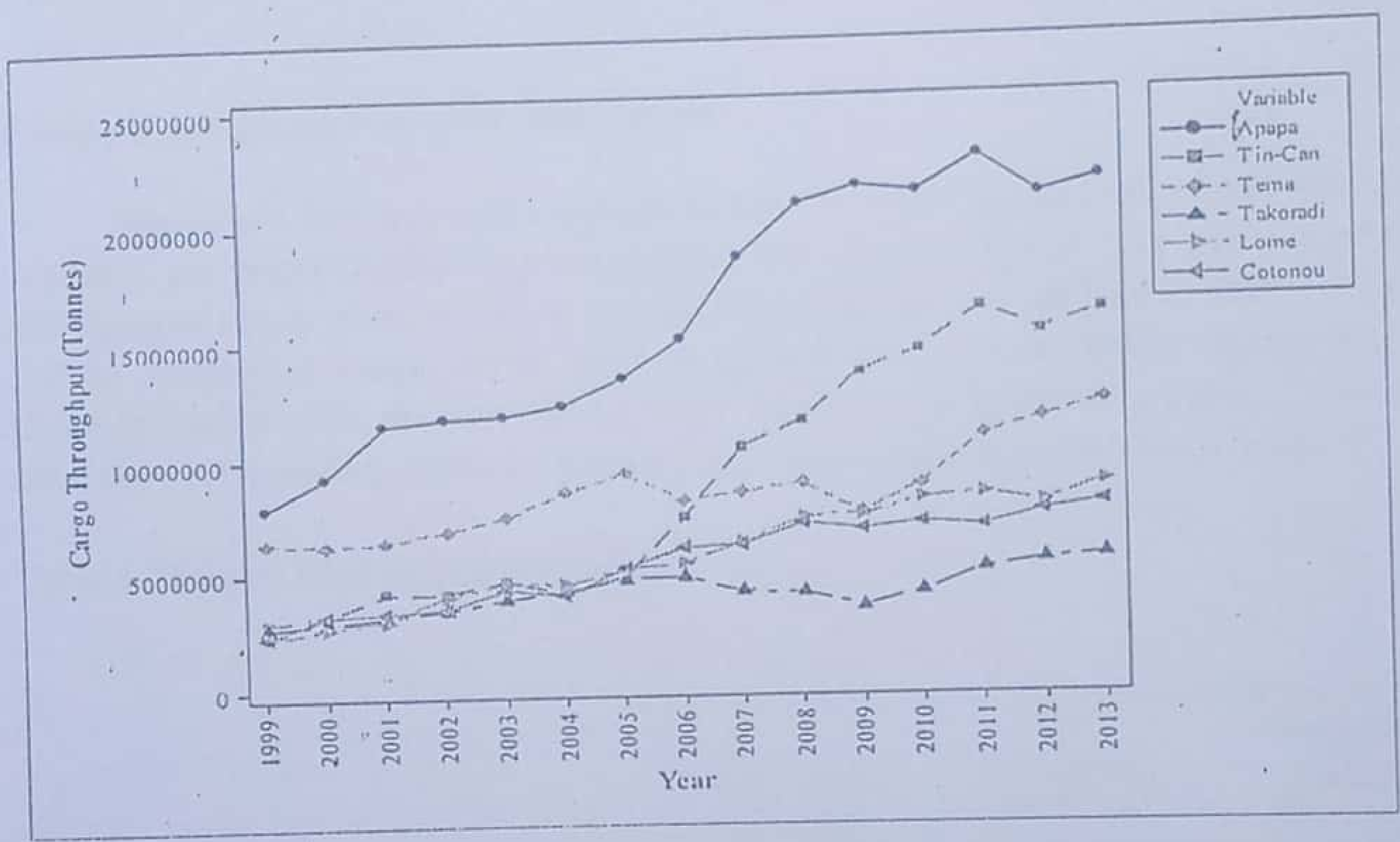

Figure 4: Time Series Graph of Cargo Throughput

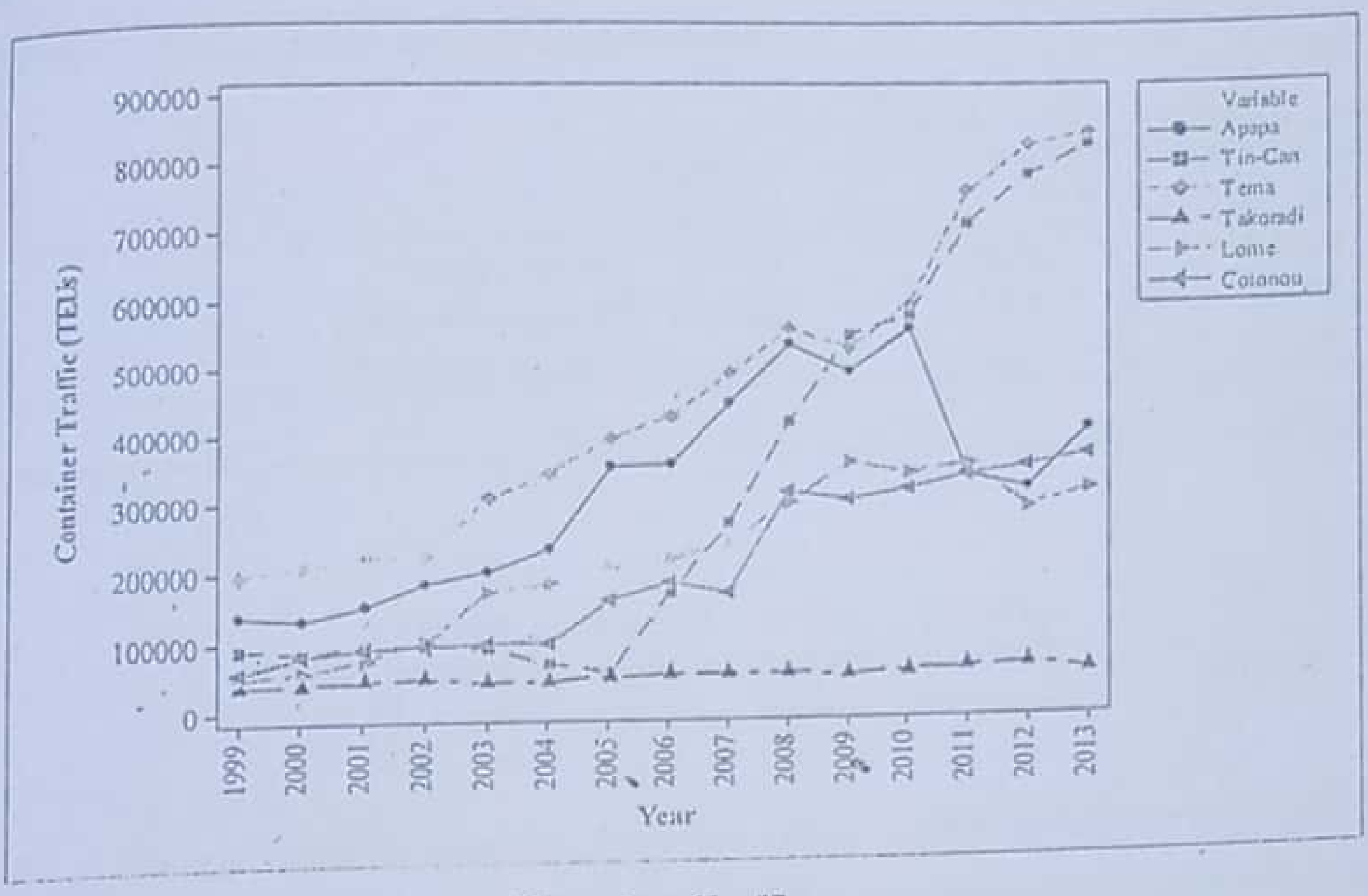

Figure 5: Time Series Graph of Container Traffic

Comparison Selected Port AHP Alternatives

The criteria that have been chosen as factors with which the port alternatives would be compared are vessel traffic, cargo throughput, and container traffic. The outcome of the questionnaire survey administered to stakeholders suggested that weights of 3.33, 5.00 and 1.67 be assigned to vessel traffic, cargo throughput and container traffic respectively as shown in Table 5 while the normalized relative weight matrix is shown in Table 6. Tables 5 and 6 upon manipulation, yields the normalized principal eigen vector as shown in equ. 2.

Table 5: Weights Used in Comparison

	Vessel Traffic (W=3.33)	Cargo Throughput (W=5.00)	Container Traffic (W=1.67)
Vessel Traffic (W=3.33)	1	0.6667	1.9940
Cargo Throughput (W=5.00)	1.5015	1	2.9940
Container Traffic (W=1.67)	0.5015	0.3340	1
Sum	3.0030	2.0007	5.988

Table 6: Normalized Relative Weight of Matrix

	Vessel Traffic	Cargo Throughput	Container Traffic
Vessel Traffic	0.3330	0.3332	0.3329
Cargo Throughput	0.5000	0.4998	0.5000
Container Traffic	0.1669	0.1669	0.1670
Sum	1	1	1

$$W_1 = \frac{1}{3}\begin{Bmatrix} 0.3330 + 0.3332 + 0.3329 \\ 0.5000 + 0.4998 + 0.5000 \\ 0.1669 + 0.1669 + 0.1670 \end{Bmatrix} = \begin{Bmatrix} 0.3333 \\ 0.5000 \\ 0.1667 \end{Bmatrix} \qquad \text{(Equ.2)}$$

Using the data for shown on Table 4, 5, and 6, an AHP comparison matrix of these alternatives could be developed, which upon further manipulation, yields the principal eigen vectors of these alternatives based on the chosen criteria. Table 7 is the comparison matrix of AHP alternatives, while Table 8 is the normalised relative weight matrix derived from Table 7 using vessel traffic as a criterion. Equ. 3 is the normalized principal eigen vector.

Table 7: Comparison Matrix of AHP Alternatives in Terms of Vessel Traffic

	Apapa (18207)	Tin-Can (15142)	Tema (22386)	Takoradi (12224)	Lome (12641)	Cotonou (14842)
Apapa (18207)	1.0000	1.2024	0.8133	1.4895	1.4403	1.2267
Tin-Can (15142)	0.8317	1.0000	0.6764	1.2387	1.1979	1.0202
Tema (22386)	1.2295	1.4784	1.0000	1.8313	1.7709	1.5083
Takoradi (12224)	0.6714	0.8073	0.5461	1.0000	0.967	0.8236
Lome (12641)	0.6943	0.8348	0.5647	1.0341	1.0000	0.8517
Cotonou (14842)	0.8152	0.9802	0.663	1.2142	1.1741	1.0000
Sum	5.2421	6.3031	4.2635	7.8078	7.5502	6.4305

Table 8: Normalized Relative Weight Matrix of Vessel Traffic

	Apapa	Tin-Can	Tema	Takoradi	Lome	Cotonou
Apapa	0.1908	0.1908	0.1908	0.1908	0.1908	0.1908
Tin-Can	0.1587	0.1587	0.1587	0.1587	0.1587	0.1587
Tema	0.2345	0.2345	0.2345	0.2345	0.2345	0.2345
Takoradi	0.1281	0.1281	0.1281	0.1281	0.1281	0.1281
Lome	0.1325	0.1325	0.1325	0.1325	0.1325	0.1325
Cotonou	0.1555	0.1555	0.1555	0.1555	0.1555	0.1555
Sum	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

$$W_1 = \frac{1}{6}\begin{Bmatrix} 0.1908 & 0.1908 & 0.1908 & 0.1908 & 0.1908 & 0.1908 \\ 0.1587 & 0.1587 & 0.1587 & 0.1587 & 0.1587 & 0.1587 \\ 0.2345 & 0.2345 & 0.2345 & 0.2345 & 0.2345 & 0.2345 \\ 0.1281 & 0.1281 & 0.1281 & 0.1281 & 0.1281 & 0.1281 \\ 0.1325 & 0.1325 & 0.1325 & 0.1325 & 0.1325 & 0.1325 \\ 0.1555 & 0.1555 & 0.1555 & 0.1555 & 0.1555 & 0.1555 \end{Bmatrix} = \begin{Bmatrix} 0.1908 \\ 0.1587 \\ 0.2345 \\ 0.1281 \\ 0.1325 \\ 0.1555 \end{Bmatrix} \quad \text{(Equ.3)}$$

The normalized principal Eigen vector or priority vector based on vessels traffic shows that the most competitive port is Tema port which controls about 23.45% of the total traffic volume. In comparison with other alternatives, Tema port is 1.23 times more competitive than Apapa port (19.08%), 1.48 times more competitive than Tin-Can Island port (15.87%), 1.83 times more competitive than Takoradi port (12.81%), 1.77 times more competitive than Lome port (13.25%), and 1.51 times more competitive than Cotonou port (15.55%).

Tables 9 and 10 show comparison between AHP matrix and the normalized relative weight of the matrix using cargo throughput as a criterion. In terms of cargo throughput, the normalized principal Eigen vector (Equ. 4) shows that the most competitive port is Apapa which controls about 23.45% of the total cargo throughput. In comparison with other alternatives, Apapa port is 1.82 times more competitive than Tin-Can Island port (18.25%), 1.90 times more competitive than Tema port (17.43%), 3.97 times more competitive than Takoradi port (8.35%), 2.84 times more competitive than Lome port (11.69%), and 2.96 times more competitive than Cotonou port (11.11%).

Table 9: Comparison Matrix of AHP Alternatives in Terms of Cargo Throughput

	Apapa (240752300)	Tin-Can (132481064)	Tema (126509330)	Takoradi (60620350)	Lome (84851990)	Cotonou (80616744)
Apapa (240752300)	1.0000	1.8173	1.9030	3.9715	2.8373	2.9864
Tin-Can (132481064)	0.5503	1.0000	1.0472	2.1854	1.5613	1.6433
Tema (126509330)	0.5255	0.9549	1.0000	2.0869	1.4909	1.5693
Takoradi (60620350)	0.2518	0.4576	0.4792	1.0000	0.7144	0.752
Lome (84851990)	0.3524	0.6405	0.6707	1.3997	1.0000	1.0525
Cotonou (80616744)	0.3349	0.6085	0.6372	1.3299	0.9501	1.0000
Sum	3.0149	5.4788	5.7373	11.9734	8.5540	9.0035

Table 10: Normalized Relative Weight Matrix of Cargo Throughput

	Apapa	Tin-Can	Tema	Takoradi	Lome	Cotonou
Apapa	0.3317	0.3317	0.3317	0.3317	0.3317	0.3317
Tin-Can	0.1825	0.1825	0.1825	0.1825	0.1825	0.1825
Tema	0.1743	0.1743	0.1743	0.1743	0.1743	0.1743
Takoradi	0.0835	0.0835	0.0835	0.0835	0.0835	0.0835
Lome	0.1169	0.1169	0.1169	0.1169	0.1169	0.1169
Cotonou	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111
Sum	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

$$W_2 = \frac{1}{6}\begin{pmatrix} 0.3317 & 0.3317 & 0.3317 & 0.3317 & 0.3317 & 0.3317 \\ 0.1825 & 0.1825 & 0.1825 & 0.1825 & 0.1825 & 0.1825 \\ 0.1743 & 0.1743 & 0.1743 & 0.1743 & 0.1743 & 0.1743 \\ 0.0835 & 0.0835 & 0.0835 & 0.0835 & 0.0835 & 0.0835 \\ 0.1169 & 0.1169 & 0.1169 & 0.1169 & 0.1169 & 0.1169 \\ 0.1111 & 0.1111 & 0.1111 & 0.1111 & 0.1111 & 0.1111 \end{pmatrix} = \begin{pmatrix} 0.3317 \\ 0.1825 \\ 0.1743 \\ 0.0835 \\ 0.1169 \\ 0.1111 \end{pmatrix} \quad \text{(Equ. 4)}$$

In terms of container traffic, it could be seen from Tables 11 and 12 and equ. (5) that Tema port, with a share of 29.29% of the total container traffic volume, performed better than the alternative ports. In comparison, Tema port performed 1.43 times better than Apapa port (20.47%), 1.42 times better than Tin-Can Island port (20.63%), 9.48 times better than Takoradi port (3.09%), 2.13 times better than Lome port (13.76%), and 2.30 times better than Cotonou port (12.75%).

Table 11: Comparison Matrix of AHP Alternatives in Terms of Container Traffic

	Apapa (4822503)	Tin-Can (4858839)	Tema (6899555)	Takoradi (728536)	Lome (3239947)	Cotonou (3003949)
Apapa (4822503)	1.0000	0.9925	0.6990	6.6194	1.4885	1.6053
Tin-Can (4858839)	1.0075	1.0000	0.7042	6.6693	1.4997	1.6175
Tema (6899555)	1.4307	1.4200	1.0000	9.4704	2.1295	2.2968
Takoradi (728536)	0.1511	0.1499	0.1056	1.0000	0.2249	0.2425
Lome (3239947)	0.6718	0.6668	0.4696	4.4472	1.0000	1.0786
Cotonou (3003949)	0.6229	0.6182	0.4354	4.1233	0.9272	1.0000
Sum	4.8840	4.8474	3.4138	32.3296	7.2698	7.8407

Table 12: Normalized Relative Weight Matrix of Container Traffic

	Apapa	Tin-Can	Tema	Takoradi	Lome	Cotonou
Apapa	0.2048	0.2047	0.2047	0.2047	0.2047	0.2047
Tin-Can	0.2063	0.2063	0.2063	0.2063	0.2063	0.2063
Tema	0.2929	0.2929	0.2929	0.2929	0.2929	0.2929
Takoradi	0.0309	0.0309	0.0309	0.0309	0.0309	0.0309
Lome	0.1376	0.1376	0.1376	0.1376	0.1376	0.1376
Cotonou	0.1275	0.1275	0.1275	0.1275	0.1275	0.1275
Sum	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

(Equ. 5)

$$W_3 = \frac{1}{6}\begin{pmatrix} 0.2048 & 0.2047 & 0.2047 & 0.2047 & 0.2047 & 0.2047 \\ 0.2063 & 0.2063 & 0.2063 & 0.2063 & 0.2063 & 0.2063 \\ 0.2929 & 0.2929 & 0.2929 & 0.2929 & 0.2929 & 0.2929 \\ 0.0309 & 0.0309 & 0.0309 & 0.0309 & 0.0309 & 0.0309 \\ 0.1376 & 0.1376 & 0.1376 & 0.1376 & 0.1376 & 0.1376 \\ 0.1275 & 0.1275 & 0.1275 & 0.1275 & 0.1275 & 0.1275 \end{pmatrix} = \begin{pmatrix} 0.2047 \\ 0.2063 \\ 0.2929 \\ 0.0309 \\ 0.1376 \\ 0.1275 \end{pmatrix}$$

Equ 5 shows the combined Eigen vectors of the alternatives with respect to the criteria.

$$W_2 = \begin{Bmatrix} 0.1908 & 0.3317 & 0.2047 \\ 0.1587 & 0.1825 & 0.2063 \\ 0.2345 & 0.1743 & 0.2929 \\ 0.1281 & 0.0835 & 0.0309 \\ 0.1325 & 0.1169 & 0.1376 \\ 0.1555 & 0.1111 & 0.1275 \end{Bmatrix} \qquad \text{(Equ. 6)}$$

The overall competitiveness of ports is determined through Equ. 7

$$W_1 * W_2 = \begin{matrix} & \text{Vessel Traffic} & \text{Cargo Throughput} & \text{Container Traffic} \\ Apapa & 0.1908 & 0.3317 & 0.2047 \\ Tin-Can & 0.1587 & 0.1825 & 0.2063 \\ Tema & 0.2345 & 0.1743 & 0.2929 \\ Takoradi & 0.1281 & 0.0835 & 0.0309 \\ Lome & 0.1325 & 0.1169 & 0.1376 \\ Cotonou & 0.1555 & 0.1111 & 0.1275 \end{matrix} * \begin{bmatrix} 0.3333 \\ 0.5000 \\ 0.1667 \end{bmatrix} \begin{matrix} \text{Vessel Traffic} \\ \text{Cargo Throughput} \\ \text{Container Traffic} \end{matrix} = \begin{bmatrix} 0.2636 \\ 0.1785 \\ 0.2141 \\ 0.0896 \\ 0.1256 \\ 0.1286 \end{bmatrix} \qquad \text{(Equ. 7)}$$

This is the product of the Eigen values of the alternatives of equ. (6) and that of the criteria equ. (2). The result shows that Apapa port (26.36%), is the most competitive port among the selected ports. It is 1.21 times more competitive than Tema port (21.41%), 1.48 times more competitive than the Tin-Can Island port (17.85%), 2.05 times better more competitive than Cotonou port (12.86%), 2.10 times better than Lome port (12.56%) and 2.94 times more competitive than Takoradi port (8.96%). The order of overall port competitiveness is Takoradi < Lome < Cotonou < Tin-Can < Tema < Apapa.

4.0 Conclusion and Recommendations

Port competition is a serious issue that should not be treated with laxity by any port that wants to be relevant in shipping business. This work has considered the competitiveness of selected ports within the West Africa. The order of overall competitiveness is Takoradi < Lome < Cotonou < Tin-Can < Tema < Apapa. This shows that show the most competitive ports with respect of vessel and container traffic is Tema port, while Apapa port is the most competitive in terms of cargo throughput. However, in spite of Tema performing better than Apapa in two (2) out of the three (3) criteria, Apapa port emerged the most competitive port along the West African Coast. This perhaps, is caused by the higher weight assigned to cargo throughput than the other criteria. The overall competitiveness result shows that while there is a strong inter-port competition between Apapa and Tin-Can Island ports in Nigeria, a weak competition exists between Tema and Takoradi ports in Ghana, as Tema dominated in all the criteria. Overall, Apapa port is the most competitive, pulling more than 25% of the total criteria considered. This overall competitiveness results notwithstanding, Nigerian ports need continuous surveillance with security cameras, dredging and expansion, better cargo handling equipment and electronic scanners. For instance, physical container examination should be could be replaced with electronic scanners that will not only ensure the examination of containers at the shortest possible time, but will also prevent cargo damages and losses associated with physical examination.

Information and communication technology (ICT) should be fully embraced to attain the speed needed in cargo clearance, and increase access to other benefits like cargo tracking and electronic processing of shipping documents. The ports should equally embark on a vigorous promotion and image building exercise to restore the confidence of Nigerians and companies that are already routing their cargoes through the neighbouring ports. Also, the hinterland should be extended to the land-locked nations to compete favourably with Ghana, Benin Republic and Togo.

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