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The World Bank and Economic Commission for Africa

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Multiple Ports of Call versus Hub-and-Spoke

Containerized Maritime Trade between West Africa and Europe

Gylfi Pálsson

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Africa Region
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The Sub-Saharan Africa Transport Policy Program (SSATP) is a joint initiative of the World Bank and the United Nations Commission for Africa (UNECA) to improve transport sector performance by promoting policy reforms and institutional changes.

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Foreword

Although traffic volumes in many Sub-Saharan countries have increased significantly during this decade, containerized maritime trade in West Africa is still in its infancy. Intermodalism, which is possible through containerization, is just starting to develop, and still has a long way to go regarding physical infrastructure, inland transport, and trade facilitation.

This paper looks at the costs and benefits of a hypothetical hub-and-spoke system in the region. Examining the system from the position of the carriers, the study asks what the cost reduction would be if the route system were changed from multiport to a hub system. Primary findings show that overall cost difference between the systems is negligible. Any cost reduction achieved would only benefit the hub, while costs for other ports would increase.

Although the maritime industry can help the economic development of countries, it is not a core industry. Significant lowering of maritime transport costs can be achieved through changes in policies, processes, and procedures, and through improved management. Most of these issues can be addressed at the country level, with each country, or even individual ports, making important advancements on its own. This usually requires only a minimum financial investments, but demands massive commitment.

The findings of this paper were presented at the Second SSATP Round Table on Trade and Transportation in West and Central African Countries, held in Cotonou in June 1997. Some premises of the study, such as the choice of a hypothetical hub, are for illustration purposes only and do not represent the World Bank's endorsement of the hub.

Peter Watson
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Glossary

TEU — Twenty-Foot Equivalent Unit
Vessel Nominal (Theoretical) Capacity — Stated TEU capacity of a vessel.
Vessel Effective Capacity — TEU capacity of a vessel as evaluated by the operator, given weight per box, ballast and similar considerations.
Vessel Utilization Ratio — The number of paying containers (sold space) as a proportion of effective capacity.

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Contents

Summary

Containerized maritime transportation to and from West Africa is as reasonably developed as can be expected given the region's commodity mix, cargo volume, port infrastructure, inland transport, and, especially, customs procedures.

Hub-and-spoke systems in containerized maritime transport often bring significant cost advantages, benefiting the various parties to the trade. Yet, comparison of a unit cost of the best example of a current multiple port call system with a hypothetical optimal hub-and-spoke system reveals only marginal cost benefit for the region. In addition, all the cost benefit would befall the hub itself, while costs for all other ports in the area would be higher. Transit time of import and export to and from the region would also increase for most ports.

A more promising improvement in the transport sector will likely come from further liberalization of transportation policies. Cases from South America and South Asia, areas where liberalization has recently been carried out, show substantial lowering of cost to the shipper. There are indications that this trend is starting to repeat itself in those West African countries where markets have just recently been opened to competition.

The maritime sector is a commercial endeavor that, in recent years, has become fluid and increasingly international. It is not a national core industry in itself, rather a conduit to successful cross-border trade. West Africa's attempts to regulate maritime policies and operations are, at best, futile but more likely are a high priced inhibitor to international trade and economic development.

The most effective way to cut the total logistics cost for West Africa is to improve current practices, rationalize customs operations, weed out corruption, increase port efficiency, and cut through red tape in order to create a commercial and user-friendly environment.

This paper discusses the containerized seaborne trade between West Africa and Europe. It gives an overview of current status of the maritime industry in the region, discusses ways in which less costly transportation chains can be achieved and, in particular, examines claims made on the benefit of a development of a hub-and-spoke system for the region.

The maritime transportation industry serving West Africa* has been late in adapting to the increasingly more efficient operations experienced in most other developing regions. The primary reasons for this are (a) inefficient port operations, (b) a lack of appropriate port infrastructure and land based distribution systems, (c) insistence on competition, (d) sheltering for national lines in the form of unorthodox interpretations of the provisions of the UNCTAD Liner Code, and, (e) candidly, the relative lack of economic importance and peripheral geographical location of the region.

The maritime industry serving West Africa has, nonetheless, shown signs of becoming more competitive in recent years, particularly as the concept of trade sharing has started to fade.

** The study defines this area as the coastal and landlocked states from Mauritania in the north to Angola in the south, as well as the island states of Cape Verde and Sao Tome and Principe.*

Containerized Seaborne Trade — West Africa And Europe

One of the major changes in worldwide maritime trade came, when transport operators ceased viewing their markets as individual pockets of port-to-port operations, and started to view their operation on a sub-regional, regional, or even global level consisting of door-to-door services. This holistic view is a key to the dramatic gains in cost and operational efficiency of the transportation industry, evidenced, for example, in Southeast Asia, and is largely brought about by the introduction of containers.

West Africa enjoys, as other regions have, at least some of the benefits of this trend. Still, four conditions exist that prevent the region from fully taking advantage of these developments:

- Regulatory and administrative environment impedes full development of the logistics concept.
- Port limitations, especially in terms of draft restrictions and operational deficiency in regard to daily throughput.
- Inland distribution, or pre- and on-carriage of containerized cargo is inefficient and costly.
- Many vessels calling in the region are smaller and less efficient than they could be, because of the disproportionate number of operators and the limited availability, especially northbound, of containerized cargo.

These four issues are important when discussing logistics costs associated with containerized cargo transportation in West Africa.

Protectionism vs. liberalization

In the South American maritime market, rates to and from Europe have fallen between 20–50 percent since cargo sharing was abolished, depending on direction and what part of the region is evaluated, while rates to and from the United States have declined by 25–35 percent. This story has been repeated in other countries where formal cargo sharing has been abandoned. This in turn leads to greater rationalization of other parts of the transportation chain, particularly port operations, but also inland carriage. The benefits to the economies of these countries have come in the form of less expensive import and export that is more competitive globally.

As far as is known, except for South Korea, which is planning to abandon the 40–40–20 method in 1998, only Sub-Saharan Africa still adheres to the UN Conference on Trade and Development's (UNCTAD's) formula.

The formula's legitimate usefulness, if ever any, is long gone. As developing nations in South America and Asia started to embrace the tide of competitive forces and open markets and reaping the subsequent benefits, many West African nations have held on to the old ways.

For years West Africa has tried to protect its national interests by shoring up its national shipping lines through UNCTAD's 40–40–20 distribution code for conference lines, which was conceived as a limited form of protection to allow the shipping industry in developing countries to grow.

Over time, this protection evolved in West Africa from its original intended use; applying liberally to non-conference cargo, non-liner shipping, and even to non-vessel operating national lines, thus requiring non-national transport operators to purchase costly carrying rights. The bureaucratic system of cargo sharing has taken many forms, such as collection of waiver fees, commission for traffic rights, issuance of routing restrictions, and instances where national parties responsible for allocation systematically give preferential treatment to one operator over another. Also, fines applied for non-compliance to the various rules tend to be exorbitant. The results are an infringement of the free trade concept, costly payments for service that has no apparent added value associated with it and, most importantly, a significant hindrance to growth in West African trade.

Understandably, this distorted logical market responses and a system developed that disregarded efficient allocation of resources, was non-transparent, excessively expensive, prone to corruption, and still failed in its original intent of protecting legitimate national interest.

On the brighter side, a slow but gradual liberalization development can be seen in the region. In 1995, both Senegal and Côte d'Ivoire abandoned the cargo sharing restraints that had been enforced and allowed free access to their market. As a result of this, Containerization International estimates that rates for cargo originating in or destined to Abidjan have declined by 30 percent. Considering other perhaps more accurate estimates for import from Europe to Abidjan and Dakar, the steady rate of decline since the beginning of 1995 had by autumn 1996 reached ranges of between 10–20 percent.

Yet, in the region from Mauritania in the north to Angola in the south — including island states and landlocked countries relying on transshipment through the coastal states — less than half the countries allow reasonably free seaborne transportation access, and the rest exercise cargo sharing in one form or another, most often without having their own operating national line.

The Sri Lankan national line, Ceylon Shipping Corp., was protected from outside competition through cargo reservation, until deregulation abolished the protection in 1990. Since then, freight rates for tea to Europe have fallen by 55 percent. Impressively, the rate reduction to Europe represents the equivalent of nearly 10 percent reduction in the fob price of tea, thus dramatically improving the competitiveness of the commodity in foreign markets.

Currently, UNCTAD is undergoing a reevaluation of the usefulness of the cargo sharing formula and, presumably, the view will be taken that shipping and transportation are services to international trade and not a basic industry of national importance in and by itself. This way, shipping will be viewed as a means to an end — i.e., trade rather than a status developing nations need to achieve. Thus, who physically renders transportation service becomes less important than the efficiency, costs, and service the market will decide are rational.

Operators

Given all the effort invested in maintaining an elaborate system for the protection of national lines in West Africa, it is interesting to see that their market share is very slim in the containerized trade between the region and Europe. According to best estimates, the five national lines that offer some containerized transportation only muster up about 6–7 percent of total capacity offered.

As in any industry protected for a long time from external competition, the sheltering weakens the industry rather than building a strong domestic company.

None of the national lines has managed to grow and become a prominent regional force in its own right, except for the potential of the Cameroonian line, Camship (which has a third of its shares in the hands of foreign investors and is comparatively free from government interference). Recently, three national lines, SITRAM (Côte d'Ivoire), Black Star (Ghana), and NNSL (Nigeria), have folded. Although their demise has many and varied causes, the core of these is that they were run as parastatal institutions and therefore with an agenda that was not necessarily customer friendly or market driven. In all cases, the ultimate inability to radically adjust to commercial realities signaled their sentence. None was able to survive when faced with increasing and transparent competition in their markets.

The national lines that offer containerized transportation service run a fleet of small and generally old vessels. One reason for this has its roots in their practice of offering nearly exclusively service between their home countries and Europe, consequently limiting themselves to a small cargo base. This is one unfortunate side effect to the long adherence to the UNCTAD code. Hence, the limited direct competition among the national lines never led to the synergy and natural growth seeking strategies that, arguably, would have allowed some of these lines to become regional powers and helped them survival in the more intense competition of the mostly European lines. Even today, only two of the five national lines offer their services to West African countries other than their home base.

The containerized maritime trade between West Africa and Europe is primarily serviced by about fifteen carriers, whereof the two largest ones in the market, Delmas and the combined services of CMB–T, DSR–Senator Lines and Nedlloyd, are estimated to offer just under 50 percent of the capacity available. The capacity offered by the four largest operators is a little over 70 percent.

Generally, the service consists of visits to several European ports, from where the vessels straddle the coast of West Africa, calling numerous ports along the way. Often, the routes consist of a total of between ten and twenty ports. The closest exception to this would be Maersk's route, which uses Algeciras in Spain as the single port from where West African countries are served.

The three to four largest operators employ at least to some extent fully cellular vessels in the approximate range of 1,100–1,700 twenty-foot container equivalent units (TEUs), while other operators generally use far smaller vessels. This results in a merchant fleet employed being on average less than 800 TEU.

The importance of a vessel's TEU capacity in maritime transportation can not be understated. The table below gives an overview of rates of self sustaining charters, mostly geared, rented in for the Europe – West Africa trade in the period between November 1995 and August 1996. Most of these were chartered for a long term. This reveals the daily charter costs and, more importantly, the difference in cost per TEU when denominated in TEU price per day.

By comparison, larger geared vessels ranging from 1,800 to 2,500 TEU, that were chartered for other routes during the same period, were leased at rates between US$6 – 10 per TEU per day.

Cost structure that decides an operator's competitiveness is not directly reflected in this comparison — there are many other cost items not factored in, such as lease rate of container, bunker, port costs, and sales, management and other overhead costs. Yet, this does indicate the generally high basis on which the cost structure starts in the West Africa maritime industry.

Range of TEU Capacity	No. of Vessels	US$/day (vessel)	US$/TEU/day
1129–1162	5	12,150–13,250	10.50–12.00
504–576	7	7,500–8,100	13.00–16.00
184–428	5	5,600–7,400	17.00–30.50

Containerization International. Average TEU capacity of vessels chartered in this period, is 641 TEU.

There are three reasons why the cellular fleet serving the region has not evolved as fast as it has globally towards more efficient container vessels.

First, the cargo traffic, particularly northbound is a high mixture of unitized and non-unitized cargo, requiring more adaptability of vessels. This is because export from the region is primarily agricultural products, wood and miner-

als, which in its unprocessed form does not always lend itself easily to containerization. This explains the greater mix of vessel types and wide use of multi-purpose vessels.

Second, draft limitations in ports in the region do not generally support large vessels. The ports vary widely in their ability to accept and service container vessels, but nearly all are limited to vessels with draft of under 10 meters, thus making the 1,500–1,700 TEU vessels sometimes utilized in the routes about the largest that can be used. The graph on page 11 shows the relation between vessel's draft and capacity.

Third, one of the major advantages of containerization of cargo is the ease with which it changes modes (for example from vessel to truck to rail). In West Africa, however, this intermodalism is under-developed and a very small percentage of imported containerized cargo leaves a port area intact. Instead, the container is stripped in port and loaded on truck for delivery. Therefore, many of the export goods come to port non-containerized. Stuffing at that point has already taken away a large incentive for containerization to begin with. Because of this, West Africa has not seen the same rate of containerization of traditionally bulk cargo as many other regions. It is estimated that some 80% of containers are stripped or stuffed in port.

Cargo

Although notoriously difficult to find accurate information, based on the data collected it can be estimated that 1.3 million TEUs, both full and empty, are moved in and out of the region annually. These movements are served by 33 ports, which vary extensively in quantity handled and their operational capacity and efficiency. (For perspective, a single port outside the region, Durban in South Africa, moved 700,000 TEUs in 1994).

Approximately 500,000 TEUs are loaded import units, close to 70 percent of which come from Europe. On the export side, 320,000 loaded TEUs are moved. Following is *total regional quantity* (countries in the region between Mauritania and Angola, including island states and land-locked countries) and *sub-regional breakdown* (countries in the range indicated) of movements of containers.

From the table it can be seen that distribution of container cargo flow is rather unequal within the region, which mostly can be explained by the population concentration, but also by proportionally more importance of trade in the Gulf of Guinea.

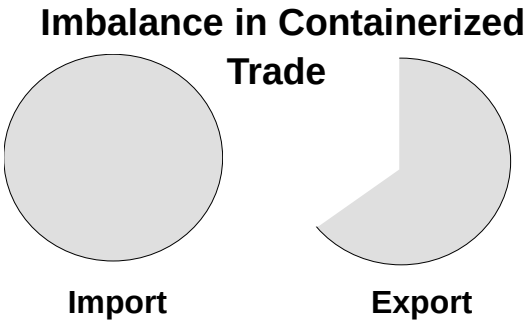
In '000 of TEUs	IMP			**Export**		
	Loaded	Empty	Total	Loaded	Empty	Total
West Africa:						
Mauritania — Angola	494	152	646	318	328	646
Sub-regions:						
Senegal – Cameroon	380	123	503	269	234	503
Coté d'Ivoire – Cameroon	319	97	416	220	196	416
Equatorial Guinea – Angola	105	30	135	51	84	135
Mauritania – Liberia	70	25	95	47	48	95

Various sources and author estimates. Information on some ports is dated or non-existent, and a fairly high level of uncertainty is involved, particularly for the southern part of the region. The figures should therefore be treated as rough estimates only.

The directional imbalance in containerized trade is significant. For the region, the ratio between import and export is close to 61:39, as can be seen graphically exhibited here. Consequently, an enormous number of non-revenue empty containers are exported from the region, resulting in hefty container repositioning costs to operators.

Intraregional trade is negligent. Although data on containerized cargo moving within the region are not available, a best estimate is that 20,000 TEUs are moved (import and export) between countries in the region. It is also known that in terms of value of all traded goods, only about 6 percent are exported to African countries south of Sahara.

An indication of the level of containerization of general cargo in the region is given by an estimate for five countries, Senegal, Côte d'Ivoire, Ghana, Nigeria, and Cameroon,



which UNCTAD has compiled. It was found that on the import side for these countries, 31.5 percent of general cargo is containerized and 36.7 percent for export.

Long-term growth of containerized transport in the region is impossible to estimate with any accuracy. Yet, it is important to set wide parameters, that will likely hold true for some time, in order to see how growth in container traffic may require adjustments by the maritime operators, ports and, especially, land based transportation operators.

Based on information from several countries it can be seen that the growth in container traffic tends to be erratic, even declining at times. This, of course, only reflects the volatile economic fortunes of the area. Yet, for some countries, growth has been continuous for several years. In 1990 Ghana registered 71.5 thousand TEUs in import and export, which by 1995 had reached 81.3 thousand TEU, representing 2.5 percent annual growth. For Côte d'Ivoire, the annual increase in the same period was close to 6 percent. Naturally, as several of the countries of the region are transshipment centers for neighboring landlocked countries, volume changes partly depend on them.

There are two primary factors that will affect growth in containerized transport: economic growth of the region and further containerization of cargo currently carried in bulk. For the former, there are some indications that the region may enjoy relative stability and sustained growth in the coming years, albeit not necessarily a spectacular one. Related to this is an increase in further processing of export goods. For the latter, experience from other regions of the world has shown that, when the land-based part of intermodal transportation, be it port operation or inland movements by truck or rail, becomes more cost and service efficient, a dramatic increase in containerization can follow.

If the region were to experience a long-term increase in containerized traffic by some 3 percent annually, which by all comparisons is a conservative estimate given the experience in other areas of the world, it would mean over 50 percent increase of import and export containers in fifteen years. A 5 percent annual increase would result in doubling of current container traffic in fifteen years. On an optimistic yet realistic side, especially given the relatively low base with which increase would be compared, a 7 percent increase would result in a 275 percent increase in container traffic in the same fifteen years. At any rate, barring some extraordinary developments, the increase in coming years will be substantial.

Future trends

Fifteen years is a relatively short time for an industry that depends a great deal on long-term assets. Interestingly enough, this is not a reference to the maritime operators, but to port operations. Vessel operation today does not mean high dependence on owned vessels, but a delicate balance between owned vessels and charters, depending on the cost advantage and degree of flexibility desired. Port operations, however, depend fully on the capital investment made, whether it be in equipment, or dredging, berths or land improvements. With the possible exception of fork lifts, their assets are bound in a port whose fortune is not only highly dependent on cost, operational efficiency and reasonably developed hinterland, but on geographical location.

Of the 33 ports that have some import and/or export of containerized cargo in the region, only about a half move more than 7,500 TEUs annually. Two thirds of all the imports enter through six ports: Dakar in Senegal, Abidjan in Côte d'Ivoire, Tema in Ghana, Lagos/Apapa and Tin Can Island in Nigeria, and Douala in Cameroon.

Barring some major shifts in trade patterns, it can be assumed that these ports will continue to dominate with regard to containerized cargo handling in the near future.

Under a traditional scenario, this concentration might increase over time, rendering some of the secondary ports useless as far as container traffic is concerned. These ports would take on the characteristics of transshipment centers, from where vessels, trucks, and rail would distribute containers to a naturally delineated market based on cost advantage. Several arguments speak against such a vision.

- The port operations in the area are inefficient. Container lifts on and off vessels are sub-standard. Ghanaian ports, for example, register 7.5 to 10 discharges or loadings of boxes per hour and crane, while 20 to 35 moves per hour and crane is an acceptable standard in most European ports. Total port costs tend to be high relative to the service provided, and processing containers in port often takes 10–25 days. The inefficiency leads to high total costs for the shippers, both in terms of direct charges, but, even more important, in cost of time — e.g., financing and inventory charges, obsolescence of goods, added administrative cost and associated unreliability. For shipper, the better alternative is often higher direct costs, but substantial savings of time by having containers delivered directly to the port closest to the consignee.
- Customs operations in the region prevent a seamless connectivity between modes of transportation because of their red tape and expense. Nearly all containers are stripped in port for inspection, depriving shippers of the benefit of moving the goods containerized from the port. Goods are sometimes inspected more than once, often requiring several "incentive" payments to customs to have the goods cleared. This again, understandably, motivates shippers to minimize their cargo's exposure to customs.

The port of Tema in Ghana exemplifies the bureaucratic process, where close to 100 percent of imported containers are stripped. About 500 customs officers work in the port, and cargo clearance requires 26 steps in 5 separate stages. The few containers that are restuffed, sealed, and moved inland risk being reexamined by customs while in transit. In addition the cargo has to be customs bonded at two to three times its value, and special customs must be paid.

In contrast, taking the port of Charleston in the United States, for example, customs, using state-of-the-art information technology and standardized customs procedures, inspects only 3,000 containers annually while import into the port amounts to nearly 300,000 TEUs, representing 1 percent inspection rate.

- The lack of appropriate inland infrastructure and bureaucratic facilitation, once containers are cleared out of ports, keeps the ports from become transshipment centers. While in Europe it is a standard practice that containers are imported into a port and trucked from that port through sometimes several countries before they reach their destination, in West Africa that is not done, except in the case of landlocked countries. One of the primary reasons is that the road network, even in sub-regions that have high population density, is not well connected between countries. Another, no less important reason is the burdensome procedure associated with moving containers through borders.

A case in point is again the port of Tema, which within a 450 km radius has Abidjan, Côte d'Ivoire, in the west, and Lagos, Nigeria in the east. In this area, which includes fully or partly five coastal countries, there are seven ports, importing a total of 291,000 full TEUs. Yet, officially, there are practically no cross border movements of containers. A rational, seamless transportation is hard to achieve under those conditions.

- Finally, transshipment centers call for high reliability of operation. Before maritime operators would invest time and money in dedicated tonnage that may not be able to service smaller ports in the area, they must believe that nothing will prevent them from calling the assigned port(s). Unfortunately, this level of certainty is not associated with West Africa.

Inevitably though, the market will dictate the concentration of port volume. In the long term, the cost of building or maintaining two or more container ports in a single country within, say, 250–300 km of each other, will be deemed irrational, and investment will be diverted into strengthening the infrastructure needed to move goods within each country. Less likely, although fully rational, that same logic will be applied to ports in different countries.

The viability of the surviving national lines, or future start-ups, will ultimately be based on purely commercial grounds. The lines now protected in one form or another or subsidized by their governments, will sooner than later lose that protection and funding. It is worth looking at what happen to the South American national lines when they lost their protection. Some have experienced severe financial difficulties or even bankruptcy within months; in other cases the individual shipping companies adapted rapidly to the new competition, even expanding and strengthening in the process. The second scenario usually occurs concurrently with privatization of the lines, modernization of their fleet, and cooperative agreements with shipping companies from other countries.

The gradual rationalization of the industry will also likely be manifested in the decline in the number of operators serving the area. As liberalization of the seaborne trade continues, price competition becomes more prevalent, resulting in an increase in the average capacity of vessels, further cost reduction, and specialization of operators. The smaller lines, which do not have a secure niche market or agreements with larger operators, will inevitably fail in that competition. Only operators with some minimum market share will continue as players. Of course, the timing of this depends on how rapid growth will be experienced in containerized traffic in the region.

Cost Model Study

For the purpose of unit cost comparisons the paper will examine the region of *Senegal to Cameroon*. There are two reasons for this: (a) to reflect a route system common to many shipping companies operating in the West Africa–Europe trade, a sub-region where containerization of cargo is more prevalent; and (b) because information in this area is more reliable than elsewhere in the region.

A hub-and-spoke system in containerized seaborne trade is where cargo to a region is delivered to a primary hub in another region. The cargo is then disbursed from that primary hub to other areas in the region, whether by vessels, rail, trucks or inland waterways. Similarly, export from the region is accumulated in the primary hub, from where it is collected. These primary ports tend to be larger, have longer berths and have deeper drafts than secondary ports, and are usually specially equipped and operated to allow for a quick turnaround time of vessels. Also important is that primary hubs tend to be geographically central to the region and often have substantial hinterland — that is, a considerable amount of cargo that regardless of its status as a primary hub, would be distributed from that port.

The hub-and-spoke system is important to driving down transportation costs, because vessels used in this system are larger and more economical than usually possible in a system with multiple ports of call. An efficient land-based intermodal network further enhances such gains, although that discussion is beyond this paper's intent.

A primary port benefits immediately from the lower unit cost of transportation. But the overall benefit to the region is determined by whether the cost of transport to the primary port, cost accumulated in that port, and the additional cost of distributing the cargo through the region, is more or less than the cost of the multiple ports of call would be.

Transport of goods between Europe and Southeast Asia gives a good example of how an efficient trade route is constructed. Most transport operators on this route use two to four strategically located ports in Europe and call some four to six primary hubs in Southeast Asia, which often are visited in an alternating sequence, or so-called strings. The routes are set up independent of national boundaries. To and from these primary hubs — each of which now accommodates vessels of at least 3,500–4,000 TEUs — there are feeder routes and efficient inland distribution to the immediate sub-region. The prevailing view for the transport operators' selection of hubs are commercial: how large a vessel the ports accommodate, how centrally located they are, their operational efficiency, reliability and cost competitiveness, and the availability of a good distribution system (feeding service). This has made ocean carriage of cargo to and from East and Southeast Asia, as in many other areas of the world, very competitive.

The enhanced competitiveness of larger vessels can be seen by a recent Drewry Shipping Consultants estimate that unit cost in the new 6,000 TEU vessels, when fully utilized, amounts to 20 percent advantage over a 4,000 TEU vessel.

Purpose and premises of study

The use of a hub-and-spoke route system is practically nonexistent in West Africa, notwithstanding Maersk's erstwhile mentioned use of Algeciras, although the author is aware that Deco Line, a new entrant into West African–Europe trade, plans to call exclusively the port of Abidjan.

In recent discussions on trade and transportation issues in West Africa, it has been suggested that development of a hub-and-spoke system for seaborne trade to and from the region, would substantially drive down the transportation cost. The purpose of this section is to examine that claim in the following ways:

- Find the stripped unit cost of operation and service level offered, particularly in terms of schedule, for West Africa containerized cargo flow to and from northern Europe. This is for a direct route system, as well as a hypothetical hub-and-spoke system, in order to have a base against

which to compare and evaluate the benefits and drawbacks of a hub-and-spoke versus direct route systems.

- Discuss the results of the comparison and what effect a potential hub-and-spoke system could have on the future of maritime structure in the region, especially regarding a criterion for selecting a major hub.

The unit cost of containerized cargo is examined under two scenarios, both of which assume minimal changes to port facilities and operations.

DIRECT–ROUTE. A full service system that most operators currently use on the route, made up of several European ports and multiple ports of call along the coast of West Africa.

The data used herein is partly derived from general, accessible information about the larger operators in the trade, such as routes and times, partly on generic cost information for vessel operation and to some extent on information received directly from operators. The author has obtained this data from various sources. The cost information, while estimates, should be fairly accurate, as many of the inputs are widely available.

HUB–SPOKE. A hypothetical route system consisting of two ports in Europe and one port of call in West Africa, from where three feeder service routes are operated to eight other West African ports in the geographical range from Senegal in the north to Cameroon in the east. The cost data for this system is based on generic and widely available information. It should be a fairly accurate picture of what an operator would face when evaluating whether to adapt a hub-and-spoke system.

For evaluation purpose, a spreadsheet model was created (see Annex A). It consists of four parts:

- *Voyage input*, where the ports, port time, speed of vessel, and port costs are entered. This part is linked to a distance table (see Annex B), which contains distances between forty ports (eight European and thirty-two West African). This part of the model can easily be adapted to other trade routes, either by directly distances inputting between ports or by linking new distance tables to the spreadsheet.
- *Operating cost data*, where container utilization ratios and individual cost factors are entered. Alternatively, in absence of reliable detailed data or for a quick assessment, fixed daily cost can be entered.
- Results are shown in the last two parts: *cost information per day* and per leg, and a *two-graph comparison* of time and total cost per leg in port and sea. If detailed cost data has been inputted, specific breakdown of costs appears.

The stripped unit cost structure model was used to emulate cost structure for the larger operators. As the study aims at determining claims of benefit of a hub-and-spoke system, a vessel and route are selected for the comparison that represents an economical operation of the current direct route system. The logic here is that if, within a single system, there are vessels and operations that do not measure up to the most economical vessel size and operation, that system needs improvement.

The study does not attempt to arrive at potential difference in cost to individual shippers, because there are numerous factors affecting the ultimate cost that have nothing to do with the route system used. It can be termed thus: if difference in stripped unit cost is substantial and in favor of a hub-and-spoke system, it indicates the potential for an operator to gain over the competition.

Data and description of study

The following points describe the data used and how the study was conducted.

A. General

- All fixed and only some variable vessel operating costs are examined. This is done to concentrate on the variance that truly can be traced to a cost difference based on the route system and the vessels used. Other cost factors not directly related to difference in route systems — such as, container leasing or financing costs, repositioning of empty containers and overhead — which are still important determinants for an operator's total cost, are excluded.

Also, port costs are omitted. Although it can be argued that changes in vessel sizes may have a direct bearing on the stripped unit cost borne under each system. These costs are excluded because detailed information for all the ports are not available and, more important, there are reports of fees and fines not uniformly applied. Adding port cost under those circumstances would skew the results.

- Continuous and fairly efficient port service is assumed, as is that no unreasonable delays will affect containers in the hub. This point will be discussed later.

- Databases were searched for the most economical and appropriate examples of new or used vessels for the hypothetical hub-and-spoke system, both the main vessels that could serve between Europe and West Africa, as well as the feeder vessels that could be used within West Africa. Oil cost figures are based on rates published in the summer of 1996.
- Applying the same utilization rate to a hub-and-spoke system and a direct route system minimizes any inherent uncertainty otherwise reflected in estimates on vessel utilization ratio. Ratios for the feeding routes in the hub-and-spoke system take account of the containerized import and export figures that apply to the countries that fall within each feeder route.

Vessel utilization ratios are 85 percent southbound and 55 percent northbound, for both systems. As mentioned earlier, imbalance in containerized trade between Europe and West Africa is closer to being in the ratio of 60:40.

- An examination of cargo flows in the region indicates some seasonality. Imports ebb in January, February, April and September, and rise in July, August, November and December. On the export side, the high period is December to February, but October flows tend to recede. The reason for this is the assessment of TEU capacity needed to serve the region under a hub-and-spoke system.
- For the hub-and-spoke system, a US$140 per TEU transshipment cost is assumed in the West African hub used. Although this is close to what transshipment cost is in moderately priced European ports, it is US$ 20 less than rate schedule of the port indicates for two discharges or loadings.
- Although great care was taken to arrive at reliable numbers, some estimates had to be made. It is therefore very important that the cost results of this study be used for comparative indications only.

B. Direct–Route

- The sailing schedules for direct route system and times at sea and at port, are based on calls at the following ports. These seem to be fairly representative of the schedules of the larger operators.
  - Antwerp – Felixstowe – Rouen – Le Havre – Montoir – Dakar – Abidjan – Tema – Cotonou – Lagos – Douala – Tema – Abidjan – Dakar – Montoir – Le Havre – Antwerp. The route is forty-two days long.
- Information on daily charter cost, oil consumption and other cost items used to arrive at a unit cost, have been based on a 1,650 TEU fully cellular vessel with an effective capacity of 1,450 TEUs. From this information, the cost model was constructed.

C. Hub-and-spoke

Before examining the stripped unit cost in the hypothetical hub-and-spoke system, it was necessary to evaluate whether there were any restrictions related to availability of containerized cargo, identify the optimal hub and associated feeder routes, as well as find the most appropriate vessels that could serve as models. Each of these issues will be discussed.

CARGO. Availability of containerized cargo is evaluated to find out whether it is a constraint on maximum vessel size. Based on the information found, that is not the case.

- There are some 380,000 loaded TEUs imported into the sub-region annually, of which approximately 70 percent or 266,000 are from Europe. From the region, 188,000 loaded TEUs are exported to Europe.
- The European ports chosen for the hypothetical hub-and-spoke system are in Northern Europe. Because the Mediterranean traffic is estimated to be one third of the European total, some 178,000 TEUs are imported from Northern Europe annually.
- Considering this, the weekly TEU capacity needed to serve the region can be estimated at just about 4,100, given that a 20 percent slack in the capacity offered is needed because of seasonality, repositioning of empty containers, and special equipment. Assuming a minimum of weekly service to the region, the cargo constraints are on a vessel of maximum effective capacity of 4,100 TEUs.

ROUTE. A few ports were evaluated to find the optimal hub in West Africa. This selection is for the comparative purpose of this study, and reflects only the author's assessment of the current status of ports in the region. Abidjan was chosen as the primary hub for the following reasons:

It is centrally located and supported by a strong hinterland — i.e., it already has a considerable amount of containerized traffic flowing through its port, including some transshipment cargo for landlocked countries.

Distance Table

	Germany	France	Ivory Coast	Guinea	Benin	Senegal	Cameroon	Sierra Leone	Nigeria	Togo	Ghana
To / From	Hamburg	Le Havre	Abidjan	Conakry	Cotonou	Dakar	Douala	Freetown	Lagos	Lome	Tema
Hamburg	0	500	3983	3268	4365	2835	4803	3323	4424	4312	4226
Le Havre	500	0	3525	2810	3907	2377	4345	2865	3966	3845	3768
Abidjan	3983	3525	0	764	398	1166	830	718	457	345	259
Conakry	3268	2810	764	0	1146	450	1580	69	1205	1093	1007
Cotonou	4365	3907	398	1146	0	1548	481	1100	62	70	154
Dakar	2835	2377	1166	450	1548	0	1987	505	1607	1495	1409
Douala	4803	4345	830	1580	481	1987	0	1533	439	533	600
Freetown	3323	2865	718	69	1100	505	1533	0	1159	1047	961
Lagos	4424	3966	457	1205	62	1607	439	1159	0	134	213
Lome	4312	3854	345	1093	70	1495	533	1047	134	0	90
Tema	4226	3768	259	1007	154	1409	600	961	213	90	0

Of all the ports in the region, it is least restrictive on vessel size. The channel draft at the port is 10.35 meters. Berths are 250 meters.

- The port allows a 28-day route.
- The port already offers comparatively good infrastructure, including two gantry cranes. The stevedore efficiency at the port would not be enough to handle the cargo in question, and the current container yard is small; but, for the purpose of making a cost comparison based on routes this, is ignored.
- Lagos/Apapa was considered as well, but not used in the hub-and-spoke scenario, because of draft restrictions, exorbitant port costs, and one extra day sailing time.

Choosing Hamburg and Le Havre assumes a good representation of where the goods are coming from and going to; Hamburg because of its position as a distribution port into the mainland and the north and Le Havre for the considerable share of the goods originating in or destined for France. At any rate, selection of other ports along the European Atlantic coast or even a two-port Mediterranean route would not materially change the results.

Based on this, the hypothetical route system constructed would be as follows:

NORTH/SOUTH TRADE.

Hamburg– Le Havre – Abidjan – Le Havre – Hamburg

Feeder Route East – A.

Abidjan– Douala – Lagos – Cotonou – Abidjan

Feeder Route East– B.

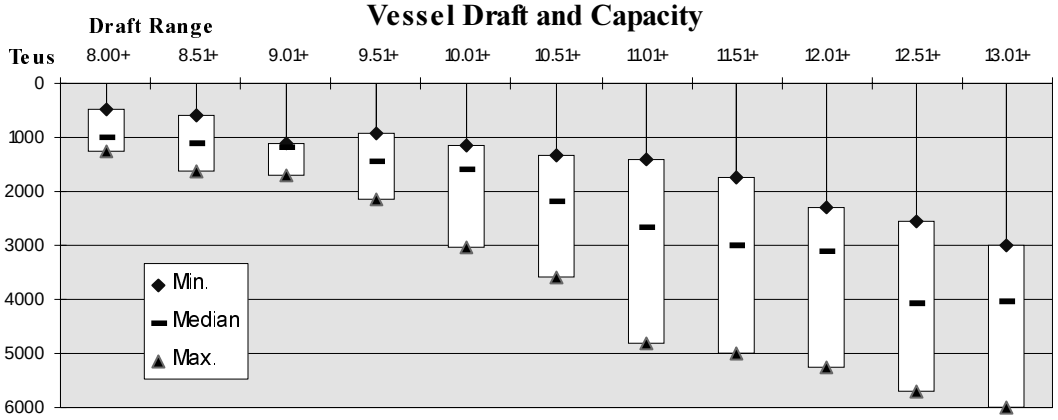
Abidjan – Tema – Lome – Lagos – Abidjan

Feeder Route North.

Abidjan – Freetown – Conakry – Dakar – Abidjan

VESSELS**.** An extensive database was used to search for the most appropriate vessels for use between Europe and West Africa, as well as for feeder service within the region. Following is a description of the vessels chosen.

- Due to draft limitations in Abidjan, the largest vessels that are usable, are of a maximum 2,100 TEU capacity, with an effective capacity of approximately 1,750 TEU, assuming 14 tons per TEU. The deadweight tonnage would be about 25,000.
  - Each vessel would be on a 28-day route at 17.6 knots and would be able to make optimally 13 trips per year. Each vessel would offer an annual capacity of over 22,000 TEUs. Based on that, in order to offer all the capacity through a hub-and-spoke system, 10 vessels would be needed for this leg. Thus, an average of 2.5 vessels coming from northern Europe would call at Abidjan every week.
- Based on the cargo flow within the sub-region that would result from a hub-and-spoke system, two larger vessels would be needed on the two routes east of Abidjan. For this, a comparison was made using the same kind of vessel as used in the direct route comparison, namely, a nominal 1,650 TEU vessel with an effective capacity of 1,450



Graph indicates container vessel capacity in TEUs, given certain draft ranges. Results based on examination of 950 vessels. The closer the median point is to either draft range, the greater concentration there is of vessels that fall between the median and that end of the range.

TEUs, sailing at an average of 16 knots. As can be seen on the information below, this size vessel may be large, but, undoubtedly, if Abidjan were a transshipment center, cargo from the Mediterranean, Asia, and North America would find its way there as well. Thus, selection of feeder vessels assumes an optimal situation.

- *Feeder Route East A.* Based on import cargo from Northern Europe only, some 62,000 TEUs import would be transshipped via Abidjan on this route (including slack), or an average of 1,200 TEUs weekly. Feeder route is estimated to take 10 days, thus implying need for more than one vessel.
- *Feeder Route East B.* Annual capacity of 75,000 TEU capacity is needed on this route, which is eight days. Two vessels would be needed.

- Feeding along the coast north of Abidjan would require a smaller vessel, here presumed to be a 1,000 TEU nominal capacity, or 900 effective capacity, sailing at 16 knots.
  - *Feeder Route North.* Would need 42 ,000 TEU capacity annually. The route is twelve days visiting three ports. Two vessels accommodate this route.

Service

From the assumption made about a hypothetical hub-and-spoke system, there can only be an evaluation about the service level for the transit time between Europe and individual West African ports.

Predictably, service to Abidjan would improve because African ports north of it would not be called. Additionally, based on the model and underlying assumptions, service to Douala and Lome would improve moderately. However, service to the ports north of Abidjan would suffer, and significantly so in the case of Conakry and Dakar. Transit time to other ports would not be affected drastically.

Still, a hub-and-spoke system would open up the possibility of wider ocean transport coverage and the possibility of a number of smaller ports being called from Abidjan.

The table on the top of page 12 gives an overview of transit times, port to port, assuming an average transit stop in Abidjan of two days for the ports to the east of Côte d'Ivoire, and three days for the ports to the north of the country. Admittedly, the presumed transit time is tight, and comparable to internationally best performing ports, but any inefficiency in this regard would preclude Abidjan, or any other port for that matter, from serving as a hub.

Unit cost comparison

This is an examination of operators stripped unit cost that does not translate directly into correlating change in revenues that an operator might collect. Thus, the figures presented in this section are not at all comparable to revenues collected for each TEU on this route. This is because of numerous cost figures that apply to the trade, and are omitted in this study because of their irrelevance for comparison purposes. These figures apply equally to both systems and, in, some cases, they are a result of a difference in the

From Le Havre Days port to port.	Direct–Route * system (current)	Hub-and-spoke * (2–3 d. in transit)	Change
Abidjan	13	11	-2
Conakry	13	19	+6
Cotonou	16	20	+4
Dakar	9	20	+11
Douala	19	16	-3
Freetown	14	16	+2
Lagos	16	17	+1
Lome	17	16	-1
Tema	14	15	+1

** estimates*

service level or depend on operator efficiency issues not related to vessel. In addition, actual vessel utilization rate may be different from what is portrayed in this study. Still, this should not affect the comparative purpose of the study.

Actually, what is often found, is that total operators' cost is two to three times higher than the stripped unit figures present. This method resulted in the stripped unit costs in US$ per TEU, as shown on the top of page 13.

According to the results of the model, unit cost to and from Abidjan drops considerably, but increases for all other ports. The weighted average cost difference between the two systems is US$12 per paying TEU in favor of a hub-and-spoke system, or a little more than 3 percent reduction in stripped unit cost.

Sensitivity Analysis

The sensitivity analysis was run on the unit cost difference found in the study. This was done by identifying twelve primary cost items leading to a hub-and-spoke unit cost for the primary vessel serving Abidjan, assuming a normal distribution of possible outcomes with a standard deviation of up to 10 percent of indicated cost and subjecting them to 5,000 random trial runs. Although it may be argued that for some cost factors the potential uncertainty is greater than 10 percent, and therefore the standard deviation should be higher for those, this exercise at minimum serves the purpose of identifying the factors that most likely are to change the results. The analysis was conducted using a forecasting and risk analysis program. For full results of analysis please refer to Annex D.

The analysis indicates two important findings:

- Of the twelve cost items, the average container utilization ratio contributes to the greatest variance in results, followed by effective vessel capacity and then vessel price. Thus, in the evaluating of the results of the model, the greatest risks concern the utilization of capacity and the cost of the vessel.

Although these results might have been predicted, it is surprising how dominant the container utilization is, since it was responsible for over half of the variances in the unit cost. Other factors that affect the results — depreciation time of vessel, transshipment cost in Abidjan, vessel maintenance cost and number of crews per vessel — are significantly less important.

- The other primary results show that, according to the trial runs, the mean of the trials was -2.43 percent, or 0.8 percentage point lower than was the case in the study. This indicates that, given a normal distribution of individual variations of the cost factors, there is probably less benefit in a hub-and-spoke system, than the results of the study indicate. Quoted in percentages, there is a 51.2 percent likelihood that the cost advantage of a hub-and-spoke system is less than the 3.25 percent indicated by the model (see graph). Admittedly, this difference is not pronounced enough to be of valid concern in interpreting the data.

The standard deviation was 7.82 percentage points. Thus, two standard deviations give the range -18.07 to +13.21. Full three standard deviations give the range -25.89 to +21.03. Mean standard error was 0.11 percent.

The sensitivity analysis also shows how little the assumptions have to change to make a marked difference in final results: if transshipment cost increased from US$140

For an *existing* direct route system:			
• North/South Trade (average cost for all ports)			$418
For a *hypothetical* hub-and-spoke system:			
• North/South Trade (Abidjan/Europe only)		$229	
▪ Feeder East – A.	Feedering only	$237	
	to/from Europe		$466
▪ Feeder East – B.	Feedering only	$229	
	to/from Europe		$458
▪ Feeder North.	Feedering only	$237	
	to/from Europe		$466

Cost in US$ pr. TEU	Direct–Route [1]	Hub-and-spoke [2]	*Change %* [3]
Abidjan	418	229	*-45. 20*
Feeder Route East A.			
Douala, Lagos, Cotonou	418	466	*+11.50*
Feeder Route East B.			
Tema, Lome, Lagos	418	458	*+9.57*
Feeder Route North.			
Freetown, Conakry, Dakar	418	466	*+11.48*
Weighted Average [4]	**418**	**406**	*-3.25*

[1] *Direct Route. Unit costs are average costs per TEU for all ports of call shown in that schedule.*
[2] *Hub-and-spoke. Unit cost for individual ports. Includes US$ 140 transshipment cost for the feeder ports (all ports except Abidjan).*
[3] *Change %. Change in percentage between the two systems — direct route cost as base. Results in this column are based on dollars and fractions in columns [1] and [2] (whole dollars only shown here).*
[4] *Weighted Average. Weighted average in column [2] and [3] takes into account the proportional import and export of TEUs for each port.*

per TEU to US$158, a difference of US$18, any cost benefit derived from a hub-and-spoke system is wiped out.

Mindful of the US$20 difference in the assumed transshipment cost and the published rates for Abidjan, this further reinforces how close the results of the comparison between the systems are.

Results

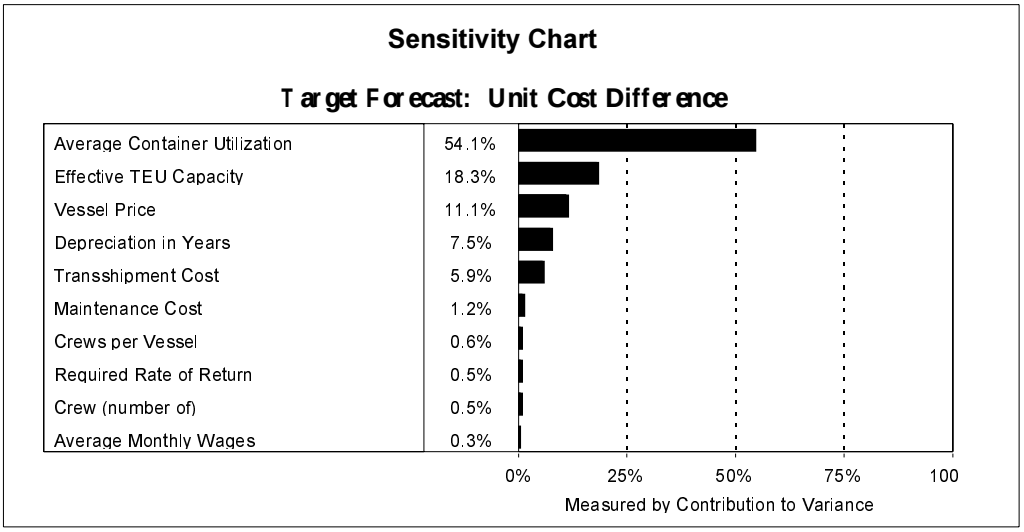
Keeping in mind the assumptions discussed earlier and the findings of the sensitivity analysis, from a cost perspective, the region as a whole would be marginally better off under a hub-and-spoke system than it is under the current direct route system. There are, however, several caveats.

- The stripped unit cost difference is not pronounced. As can be seen both in the cost unit results, and more clearly in the results from the sensitivity analysis, there is very little comfort level. This is understandable because the vessels that could be used in a hub-and-spoke system in West Africa would only be incrementally larger than the optimal ones currently used by larger operators. That difference is even smaller, when viewed in terms of effective capacity.

If all cargo was diverted to a hub-and-spoke system, and all the unit cost savings were used for the benefit of the customers — both unlikely assumptions —the US$12 difference in unit costs between direct route and hub-and-spoke might then represent the maximum potential rate reduction per TEU.

- The only clear "winner" would be the hub, Abidjan. Alternatively, under a hub-and-spoke system, all West African ports could be "losers," except for Abidjan. As such, that port would reap all the benefits, while, in terms of cost and to a great extent service level, all other ports in the region would be worse off.

The unit cost of ocean transportation to and from Abidjan would drop by nearly half. This is important because it is a clear indicator that more economical transportation, reflected by larger vessel and assuming sufficient

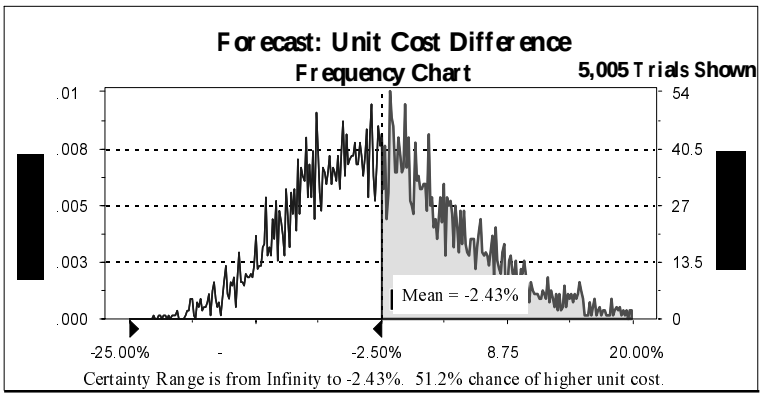


cargo, can have a dramatic effect on the cost structure of an operator. Indeed, it can be safely assumed that, if ports in the region supported larger vessels, an overall much clearer unit cost difference will be realized.

- Minor changes in the flow of goods to and from the region, e.g., lesser proportional importance of Abidjan, would rapidly change these results. This re-emphasizes the point that the difference in unit costs is very small.
- The choice of feeder vessels for the eastbound routes implied that some cargo destined to West Africa from other regions than Northern Europe would be feedered through Abidjan. Thus, larger vessels are assumed in the model than otherwise possible. Had smaller feeder vessels been assumed, the unit cost difference results would be wiped out or possibly reversed.
- In sum, the findings do not indicate a clear case for or against a hub-and-spoke system in the West African–European trade, given the physical limitations that exist. The estimated cost-benefit is not conclusive enough to suggest advocating a hub-and-spoke and the changes in service levels, especially for the northern cities, are rather one-sided against such a modification in the sailing system, without substantial lowering of costs.

Hub-and-spoke exhibits its greatest advantage when there is a distinct distribution point in a region that is cost-effective for larger vessels and saves significant sailing time between hubs' primary ports, when compared to the time spent visiting the primary port and other ports in the region. In this region, vessels between Europe and West Africa have to straddle the coast and pass by most of the ports of relevance, whether they are in a direct–route system or a hub–spoke system. Most of the time saved is therefore port stay time. To a great extent this diminishes one of the two primary advantages of a hub-and-spoke system.

Physical limitations such as port and channel drafts, prevent the substantially larger deep-ocean vessels from calling Abidjan. The largest possible vessels have a nominal capacity of close to 2,100 TEUs, while many of the vessels currently in use in the trade have a nominal capacity of between 1,200–1,700 TEUs, allowing for accommodation at several ports in the region. Difference in operating cost is



not enough to make a marked difference, especially when considering the additional number of vessels needed for the feeder service from Abidjan to other port in the region.

There are a number of operators serving the region, and while this unit cost comparison is with the larger operators, a sizable portion of the capacity offered is in smaller, older, and less efficient vessels. Further, it is credible that the existence of smaller, ineffective operators keeps upward pressure on freight rates. One could conclude that a rationalization in the fleet, presumably with a significant reduction in the number of operators and an increase in individual operators' market share, would bring a healthier cost structure to the service — a change that arguably will take place once the West African maritime markets liberalize.

The various parties will view a potential hub-and-spoke system and the results of this study differently. The following discussion attempts to summarize the conceivable perspectives of maritime operators, buyers and sellers of containerized seaborne service (importers and exporters), ports, and the countries affected.

Maritime operators. From an operational safety viewpoint, it does not make sense to build a system that relies on service in only one country in this or any other region. If vessels are used that can only call on one port in the region, then an extraordinary situation in that country could temporarily shut down trade in the whole region while operators were adjusting their merchant fleets to call alternative ports. This issue alone would very likely prevent operators from taking advantage of marginal cost improvement of larger vessels calling one port. Thus, at least one additional port in a nearby country that could at least temporarily accommodate larger vessels would be needed.

Operators would not be the only ones taking risks by relying on one primary port and not having a second port in the region that could accommodate larger vessels. Sovereign states would be taking substantial risks, as their foreign trade would be dependent on this primary hub.

When there is open and free market access in maritime trade, it is inevitable that competition will increase. Healthy competition causes an operator to continuously search for a competitive advantage, part of which unquestionably is a cost advantage. If there was a clear-cut cost benefit in adapting a hub-and-spoke system and few or no service disadvantages, one or more operators would do so.

Although ultimately a market decision, a hub-and-spoke service in an open market may offer niche opportunities for smaller operators as feeder lines. A hub-and-spoke operator may enter into an agreement with other operators to provide feeder service within the region. Thus, an opportunity for some efficient surviving national lines may lie in such specialized regional services.

Buyers and sellers. Experience tells us that the direct consumers of maritime service — importers and exporters — are those that languish during market distortions. Similarly, they benefit when there is a rational allocation of resources — an equilibrium of rationality that the market will decide once in a state of openness. Sequentially, the immediate links to the importers and exporters — consumers of their goods, be it individuals or other firms — benefit indirectly.

Importers and exporters are not a homogenous group. Some may e service levels offered, while cost is paramount to others. Consequently, if a significant cost advantage was achieved in a hub-and-spoke system in West Africa, it would not necessarily prevent a specialized, possibly more costly, maritime service to thrive simultaneously.

In the absence of a cost effective hub-and-spoke system, any incremental improvement in total logistic cost will be notable. Evidence shows that the greatest improvements will come from more efficient port operations, any improvement in customs operation and simplification in import and export processing.

Ports. A port vying for a spot as a primary hub would need large scale financing. Presumably, significant development of the port area would need to be undertaken: dredging, berth improvements, equipment investment, container yard enlargements, and so forth. Massive investments made in order to position a port as a hub is risky, especially since there is no one port in the region that has a distinct geographical advantage. Actually, any one port along the coast from Coté d'Ivoire to western Nigeria could be a hub if appropriate investments were made. Maritime operators will understandably use the ports that best fit their business strategy at each time. Plans for such port developments might therefore need to include commitment from a number of operators, both in terms of usage and financing.

Primary ports will see substantial increase in revenue. Not only will transshipment charges be collected, but het-

erogeneous secondary effect can be expected as the port grows in importance.

The effect on secondary ports, the ports being feedered to, does not have to be negative. Many will continue to see similar containerized cargo flows, but this time feedered from the hub. The principal and possibly adverse effect on some secondary ports will gradually come once the maritime market in the region has opened up, infrastructure starts improving, and inland container distribution becomes more competitive. Then, ports in proximity with each other will strife for survival. In the future, ports will mainly see competition from land based container movements.

Conclusions

A change in West Africa from a multiple port of call system to a hub-and-spoke system, is not now an effective option in lowering shippers' total transportation cost. The maritime industry in the region is as developed as can be expected given current constraints of the region. In the future such change may become one more cornerstone on which to build a prosperous future.

As the maritime industry is a vehicle to the economic benefits of trade, liberalization of the industry is a prerequisite to rational allocation of resources. Once cargo reservations for national flag carriers have been abolished, the markets opened up, and commercial views allowed to dictate, it is likely that there will be a reduction in the number of carriers, an increase in vessel sizes, and, an elimination of the non-value adding, non-operating national shipping companies. What happens to national lines actually offering service depends on their approach to adapting to unhindered competition. The various fortunes of South American national lines, in a similar situation only a few years ago, should serve as a guide.

An immediate action would be to incrementally build a commercially friendly transportation environment, country by country, port by port. This effective way of lowering the total logistics cost of the region will require, *inter alia*, changes in policies, processes, and procedures, and improved management, such that a reasonable balance between administrative necessities and commercial friendliness is achieved. It requires focusing on the practices of current operations; greatly improving efficiency of customs and rationalizing its practices, increasing significantly productivity of the ports through container lifts and speedy handling service, and a serious effort to weed out corruption. The comparatively small financial investments needed in such an effort are not only the most cost effective in achieving significant and immediate transport improvements, but also the most sensible for the long-term prosperity of trade in the region. What is needed is a review of each individual operation and process, aimed at answering how its efficiency can be improved and its connectivity to other parts of the logistics chain made seamless.

The advantage of container transportation is manifested with the ease at which boxes change modes. In West Africa, this advantage is currently not a realistic large-scale option, since land based infrastructure is seriously underdeveloped. The developmental focus in this respect will be on opening up container inland transport. This may involve opening of inland depot centers, maintenance of roads and bi- or multilateral agreements to facilitate land-based, cross-border movements.

It is inevitable that, as trade in the region grows and becomes more competitive, there will be some rationalization in how shipping operators view the ports. This will be a gradual process, allowing ports to vie for importance. This process cannot be dictated from above, but will happen based on the needs of the market and the responsiveness of ports to meet those needs.

Ultimately, the individual countries will be responsible for opening up the transportation, and decisions should be based on an honest review of how transportation policies and enforcement of rules hinder international trade.

A. Voyage

Note: Name of port has to be entered correctly for tables to identify distance (nautical miles - nm) . If distance between ports is not in table, the nautical miles may be entered directly (item 3 in column D).
Distances entered by hand override distance table for the ports in question.

1 Speed in knots
16.0

Call #	2 Ports	3 Distance		Sailing		4 In Port		Cumulative		5
	Port Gentil	nm	nm	days	hrs	days	hrs	days	hrs	Port Cost
1	Pointe Noire		327	0	20	1		1	20	$3,350
2	Abidjan		1,118	2	21	1		5	17	$5,000
3	Monrovia		470	1	5	1		7	22	$2,000
4	Tema		713	1	20	1		10	18	$4,500
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B. Operating Cost Data

Prices in USD

Container Utilization Data	6
TEU size	750
Effective TEU Capacity	680
Cont. Utilization to Region (%)	80%
Cont. Utilization from Region (%)	60%
Average Cont. Utilization (%)	70%

Charter	7
Rate pr. day	

Cost items 8-10 will be used

Note:
The category "Financing Costs" and first two items of "Operational Costs" need not be filled in if charter rate is used.
Cost item use gives better breakdown of factors affecting overall cost.
In case of conflicting information, the Time-Charter rate will be used in all relevant

Financing Cost	8
Vessel price (M$)	$22.0
Salvage value (% of price)	15.0%
Depreciation (years)	15
Req. Rate of Return (% on depr.)	14.0%

Operational Cost	9
Inactive time (%)	5.0%
Maintenance (% of value)	3.0%
Crew (number of)	14
Ave. monthly crew wages	$1,500
Crews pr. vessel	1.5

Bunker Cost	10
Heavy Fuel Oil ($ pr. ton)	$115
Usage at Sea (tns pr. day)	29.0
Usage in Port (tns pr. day)	1.0
Medium Diesel Oil ($ pr. ton)	$200
Usage at Sea (tns pr. day)	1.0
Usage in Port (tns pr. day)	3.0
Provisions ($ pr. day)	$550

C. Results

	Totals:	2,628	6 18	4 0	10 18	$14,850

Vessel Operating Cost:	pr. day	pr. leg
Depreciation less salvage	$3,416	$36,717
Required ROE	$563	$6,047
Cost of inactive time	$201	$2,160
Maintenance	$1,808	$19,438
Crew Cost	$1,050	$11,288
Port Cost (ave. at pr. day)	$1,381	$14,850
Bunker		
- Heavy Fuel Oil	$2,137	$22,971
- Medium Diesel Oil	$349	$3,750
- Provisions	$550	$5,913
Total Cost	$11,454	$123,134
Total Cost		
Sea	$11,122	$75,075
Port	$12,015	$48,059

Cost per TEU in US$:	day	leg
Average cost pr. paying TEU		
To or from region	12.03	129
To region	10.53	113
From region	14.04	151
(assuming 50% cost participation)		
Average cost pr. effective TEU capacity		
To and from region	16.84	181
(traditional)		

D. Graphs

Fig. 1. Time

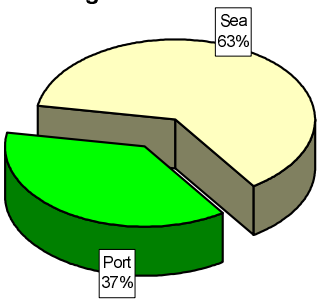
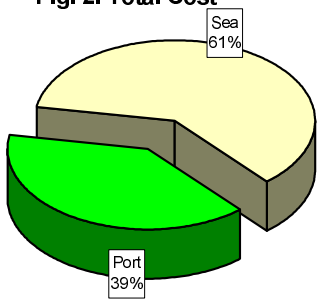


Fig. 2. Total Cost



11

Notes:
SAMPLE. FOR DEMONSTRATION PURPOSE ONLY !!
With the exception of nautical miles between ports, the figures indicated are made up.

1. General
This spreadsheet voyage model was created specifically for cost comparison study in the Europe - West-Africa ocean trade. This is reflected by the selection of port distances collected. However, the model can easily be enhanced or adapted to ocean trade in other regions, either by building up relevant distance tables or, alternatively, by simply inserting distances between ports directly in the model.
As the model was used to compare cost structure in sea trade only, some future users may find it beneficial to adjust the model to their particular needs, such as lease rates of containers, entry for THC, or even land transport costs from designated ports. Also, the model can be used as is and results transferred to new sheets to do whatever additional calculations are needed

3. Interpreting Results and Graphs
Results.
Cost factors are shown, as long as items 6 and 8-10 are filled out.
Vessel Operating Cost shows the cost of the voyage both per day and for the whole leg. The headings for each cost factor should be self-explanatory. Also, refer to the section here above. Cost is broken down by whether it is incurred at sea or in port. Average cost per port day and average cost per sea day are shown in the first column (under the "pr. day" heading), and total cost incurred at sea and in port are shown in the next column.
If a Charter rate is used, note that only crew,port and bunker charges and total costs will show.
Calculation for Cost per TEUs will show as long as item number 6 is filled out.
Graphs.
Two figures are presented. Figure 1, indicates what percentage of the time during the whole leg is spent at sea and what percentage is spent in port. Figure 2, shows what percentage of total cost is incurred at sea and what percentage is incurred in port (provided part "A. Voyage" is filled out).
If the Charter rate is used, Figure 2 will be invalid.

2. Notes on Use
The model is relatively straight forward. All formulas are contained in the sheet called "Route" and the only link is to the distance table.
To prevent accidental erasing or alteration of contents, each sheet has been protected (go to Tools - Un-protect Sheet - no password is being used). Unprotected cells, intended for data entry, are indicated with colored borders.
Future users may want to create new tables and link to the distance calculation (named "Distances" in column "E")
The sheet has four parts;
A. Voyage,
B. Operating Cost Data,
C. Results and,
D. Graphs.
Entry for calculation is primarily intended in parts A and B.

Cells for entry (identified by numbers).
Part A.
1. Enter the vessel speed. Sailing time, and therefore cost, is dependent on this.
2. Name of port. Port of call 0 is the port from where the voyage initiates. If distance between two ports is in the distance table in the sheet "Distance", it will automatically show. Note, however, that spelling of port name has to be exact (not case-sensitive).
3. If distance is not in table, it can be entered directly here. Still, a name has to be entered for the port, before calculation takes place. The model allows for a total of 20 calls from port of origin.
4. Enter number of days and hours vessel is at port. There is no need to enter "0" days or hours if that is applicable.
5. Enter port cost for designated port. Be aware of you premises, when interpreting the results, for example if port cost includes or excludes stevedoring.
Part B.
6. Optional. If you desire to see cost pr. paying TEU, total effective capacity of vessel and utilization rates (percentage of paying TEUs) can be entered. If utilization is set at 100%, TEU cost figures will indicate cost all TEUs carried - full and empties.
7. Optional. If a daily Charter rate is entered, results figures will only show crew and port cost, bunker and total cost. All parts of items 8 and first two entries of 9 will be overridden (items that have to do with financing and maintaining of vessel, as well as inactive time). If not all important parts of vessel financing and operating costs are known, it is recommended that this option will be used instead. Cost pr. TEU (item 6), will be calculated whether this option is used or not.
A red-lettered sentence underneath this item, will tell what option is being used for the calculation.
8. Optional (see item 7). Enter vessel price (new or market value), its salvage value at end of depreciation (as a percentage of value - this can be a 0% value), depreciation in years and, the required rate of return on equity (ROE, as percentage of the remaining depreciation value - this can be a 0% value).
9. Optional (see item 7). Inactive time is entered as a percentage of time the vessel will not be generating revenues, will it be due to scheduled docking, breakdown of vessel or any other reason (this can be a 0% value). Also, enter estimated maintenance costs as an annual percentage of the value of the vessel (again, this can be a 0% value).
Enter number of crew member, their average monthly wages (inclusive of all costs) and the number of crews employed (it is most common that a vessel employs anywhere between 1.2 - 1.8 crews).
10. Optional (see item 7). Enter cost of heavy fuel oil and medium diesel oil and the correlating usage at sea and in port. Provisions is a catch-all for all other bunker cost.

11. Optional. "Notes", is intended for route and vessel description and technical specifications, explanations of data or any other notes the user want to have visible.

Distance between ports (nautical miles)

Table 1. West-Africa - Europe

To / From	Belgium Antwerp	Spain Barcelona	UK Felixstowe	Germany Hamburg	France Le Havre	France Montoir	Holland Rotterdam	France Rouen	Iv. Coast Abidjan	Nigeria Apapa	Gambia Banjul	Eq. Guinea Bata	Guinea B. Bissau	Liberia Buchanan	Guinea Conakry	Benin Cotonou	Senegal Dakar	Cameroon Douala	Sierra Leone Freetown	Nigeria Lagos
Antwerp		1881	141	405	252	608	149	322	3735	4176	2672		2823	3319	3020	4117	2587	4555	3075	4176
Barcelona	1881		1807	2129	1671	1470	1876	1741	3168	3609	2098		2249	2748	2449	3550	2013	3980	2504	3609
Felixstowe	141	1807		179	178	534	121	248	3661	4102	2598		2749	3254	2946	4043	2513	4481	3994	4102
Hamburg	405	2129	179		500	856	305	570	3983	4424	2920		3071	2567	3268	4365	2835	4803	3323	4424
Le Havre	252	1671	178	500		398	247	70	3525	3966	2462		2613	3109	2810	3907	2377	4345	2865	3966
Montoir	608	1470	534	856	398		603	468	3324	3765	2261		2412	2908	2609	3706	2176	4144	2664	3765
Rotterdam	149	1876	121	305	247	603		317	3730	4171	2667		2818	3314	3015	4112	2582	4550	3070	4171
Rouen	322	1741	248	570	70	468	317		3595	4036	2532		2683	3179	2880	3977	2447	4415	2935	4036
Abidjan	3735	3168	3661	3983	3525	3324	3730	3595		457	1125		1080	420	764	398	1166	830	718	457
Apapa	4176	3609	4102	4424	3966	3765	4171	4036	457		1566		1521	861	1205	62	1607	439	1159	1
Banjul	2672	2098	2598	2920	2462	2261	2667	2532	1125	1566			215	608	409	1507	96	1940	464	1566
Bata																				
Bissau	2823	2249	2749	3071	2613	2412	2818	2683	1080	1521	215			663	364	1462	256	1900	419	1521
Buchanan	3319	2748	3254	3567	3109	2908	3314	3179	420	861	608		663		247	802	749	1235	201	861
Conakry	3020	2449	2946	3268	2810	2609	3015	2880	764	1205	409		364	247		1146	450	1580	69	1205
Cotonou	4117	3550	4043	4365	3907	3706	4112	3977	398	62	1507		1462	802	1146		1548	481	1100	62
Dakar	2587	2013	2513	2835	2377	2176	2582	2447	1166	1607	96		256	749	450	1548		1987	505	1607
Douala	4555	3980	4481	4803	4345	4144	4550	4415	830	439	1940		1900	1235	1580	481	1987		1533	439
Freetown	3075	2504	3994	3323	2865	2664	3070	2935	718	1159	464		419	201	69	1100	505	1533		1159
Lagos	4176	3609	4102	4424	3966	3765	4171	4036	457	1	1566		1521	861	1205	62	1607	439	1159	
Libreville	4550	3975	4476	4798	4340	4139	4545	4410	850	513	1940		1896	1230	1575	551	1982	237	1528	513
Lobito	4982	4543	5041	5363	4905	4704	5110	4975	1500	1285	2502		2457	1797	2140	1308	2547	1059	2095	1285
Lome	4064	3490	3990	4312	3854	3653	4059	3924	345	134	1452		1409	749	1093	70	1495	533	1047	134
Luanda	4182	4410	4908	5230	4772	4571	4977	4842	1345	1089	2369		2324	1664	2007	1115	2414	858	1962	1089
Matadi	4929	4358	4855	5177	4719	4518	4924	4789	1270	1001	2319		2274	1611	1954	1030	2361	771	1912	1001
Mocamedes	5142	4570	5068	5390	4932	4731	5137	5002	1558	1396	2531		2486	1832	2169	1414	2574	1192	2126	1396
Monrovia	3269	2698	3195	3517	3059	2858	3264	3129	470	911	658		613	54	297	852	699	1285	251	911
Nouadhibou	2229	1655	2155	2477	2019	1818	2224	2089	1554	1995	484		644	1137	838	1936	399	2375	893	1995
Nouakchott	2403	1829	2329	2651	2193	1992	2398	2263	1388	1829	318		478	971	672	1770	228	2209	727	1829
Onne	4404	3837	4330	4652	4194	3993	4399	4264	687	296	1794		1749	1084	1429	338	1836	200	1382	296
Owendo	4562	3987	4488	4810	4352	4151	4557	4422	862	525	1952		1908	1242	1587	563	1994	249	1540	525
Pointe Noire	4796	4225	4722	5044	4568	4385	4791	4656	1118	846	2186		2141	1478	1821	875	2228	616	1779	846
Port Gentil	4538	3967	4464	4786	4328	4127	4533	4398	838	332	1928		1883	1220	1563	563	1970	294	1521	332
Port Harcourt	4419	3852	4345	4667	4209	4008	4414	4279	702	311	1809		1764	1099	1444	353	1851	215	1397	311
Porto Grande	2570	2070	2496	2818	2360	2159	2565	2430	1535	1976	527		655	1118	823	1917	465	2355	876	1976
San Pedro	3615	3048	3541	3863	3405	3204	3610	3475	120	577	1005		960	300	644	518	1046	950	598	577
Sao Tome	4397	3822	4323	4645	4187	3986	4392	4257	710	415	1787		1742	1077	1422	442	1829	285	1375	415
Takoradi	3866	3299	3792	4114	3656	3455	3861	3726	155	320	1256		1211	551	895	261	1297	701	849	320
Tema	3978	3404	3904	4226	3768	3567	3973	3838	259	213	1368		1323	663	1007	154	1409	600	961	213
Tin Can Island	4176	3609	4102	4424	3966	3765	4171	4036	457	1	1566		1521	861	1205	62	1607	439	1159	1
Warri																				

Gabon Libreville	Angola Lobito	Togo Lome	Angola Luanda	Zaire Matadi	Angola Mocamedes	Liberia Monrovia	Mauritania Nouadhibou	Mauritania Nouakchott	Nigeria Onne	Gabon Owendo	Congo Pointe Noire	Gabon Port Gentil	Nigeria Port Harcourt	Cape Verde Porto Grande	Ivory Coast San Pedro	Sao Tome Sao Tome	Ghana Takoradi	Ghana Tema	Nigeria Tin Can Island
4550	4982	4064	4982	4929	5142	3269	2229	2403	4404	4562	4796	4538	4419	2570	3615	4397	3866	3978	4176
3975	4543	3490	4410	4358	4570	2698	1655	1829	3837	3987	4225	3967	3852	2070	3048	3822	3299	3404	3609
4476	5041	3990	4908	4855	5068	3195	2155	2329	4330	4488	4722	4464	4345	2496	3541	4323	3792	3904	4102
4798	5363	4312	5230	5177	5390	3517	2477	2651	4652	4810	5044	4786	4667	2818	3863	4645	4114	4226	4424
4340	4905	3845	4722	4719	4832	3059	2019	2193	4194	4352	4568	4328	4209	2360	3405	4187	3656	3768	3966
4139	4704	3653	4571	4518	4731	2858	1818	1992	3993	4151	4385	4127	4008	2159	3204	3986	3455	3567	3765
4545	5110	4059	4977	4924	5137	3264	2224	2398	4399	4557	4791	4533	4414	2565	3610	4392	3861	3973	4171
4410	4975	3924	4842	4789	5002	3129	2089	2263	4264	4422	4656	4398	4279	2430	3475	4257	3726	3838	4036
850	1500	345	1345	1270	1558	470	1554	1388	687	862	1118	838	702	1535	120	710	155	259	457
513	1285	134	1089	1001	1396	911	1995	1829	296	525	846	532	311	1976	577	415	320	213	1
1940	2502	1454	2369	2319	2531	658	484	318	1794	1952	2186	1928	1809	527	1005	1787	1256	1368	1566
1896	2457	1409	2324	2274	2486	613	644	478	1749	1908	2141	1883	1764	655	960	1742	1211	1323	1521
1230	1797	749	1664	1611	1832	54	1137	971	1084	1242	1478	1220	1099	1118	300	1077	551	663	861
1575	2140	1093	2007	1954	2169	297	838	672	1429	1587	1821	1563	1444	823	644	1422	895	1007	1205
551	1308	70	1115	1030	1414	852	1936	1770	338	563	875	563	353	1917	518	442	261	154	62
1982	2547	1495	2414	2361	2574	699	399	228	1836	1994	2228	1970	1851	465	1046	1829	1297	1409	1607
237	1059	533	858	771	1192	1285	2375	2209	200	249	616	294	215	2355	950	285	701	600	439
1528	2095	1047	1962	1912	2126	251	893	727	1382	1540	1779	1521	1397	876	598	1375	849	961	1159
513	1285	134	1089	1001	1396	911	1995	1829	296	525	846	532	311	1976	577	415	320	213	1
	849	595	651	568	963	1280	2370	2204	303	12	415	84	318	2351	970	163	722	647	513
849		1332	234	471	207	1847	2935	2769	1127	861	453	776	1142	2912	1620	869	1380	1358	1285
595	1332		1146	1063	1430	799	1883	1717	390	607	908	600	405	1864	465	472	203	90	134
651	234	1146		262	407	1714	2802	2636	79	663	245	575	94	2779	1465	674	1218	1176	1089
568	471	1063	262		635	1661	2749	2583	809	580	162	488	824	2729	1390	591	1150	1099	1001
963	207	1430	407	635		1882	2962	2796	1238	975	618	909	1253	2939	1678	986	1462	1442	1396
1280	1847	799	1714	1661	1882		1087	921	1134	1292	1528	1270	1149	1068	350	1127	601	713	911
2370	2935	1883	2802	2749	2962	1087		197	2224	2382	2616	2358	2239	522	1434	2217	1685	1797	1995
2204	2769	1717	2636	2583	2796	921	197		2058	2216	2450	2192	2073	522	1268	2051	1519	1631	1829
303	1127	390	926	809	1238	1134	2224	2058		315	654	339	15	2204	807	265	556	457	296
12	861	607	663	580	975	1292	2382	2216	315		427	96	330	2363	982	175	734	659	525
415	453	908	245	162	618	1528	2616	2450	654	427		327	669	2596	1238	438	997	964	846
84	776	600	575	488	909	1270	2358	2192	339	96	327		354	2338	958	133	710	642	332
318	1142	405	941	824	1253	1149	2239	2073	15	330	669	354		2219	822	280	571	472	311
2351	2912	1864	2779	2729	2939	1068	522	522	2204	2363	2596	2338	2219		1415	2198	1666	1778	1976
970	1620	465	1465	1390	1678	350	1434	1268	807	982	1238	958	822	1415		830	275	379	577
163	869	472	674	591	986	1127	2217	2051	265	175	438	133	280	2198	830		582	512	415
722	1380	203	1218	1150	1462	601	1685	1519	556	734	997	710	571	1666	275	582		116	320
647	1358	90	1176	1099	1442	713	1797	1631	457	659	964	642	472	1778	379	512	116		213
513	1285	134	1089	1001	1396	911	1995	1829	296	525	846	532	311	1976	577	415	320	213	

Containerized cargo - TEU Import & Export Region from Mauritania to Angola

Accurate information for each country is unavailable, but it can be estimated that close to 650 thousand TEUs (full and empties) are imported into the region annually.

Most Recent Available Information

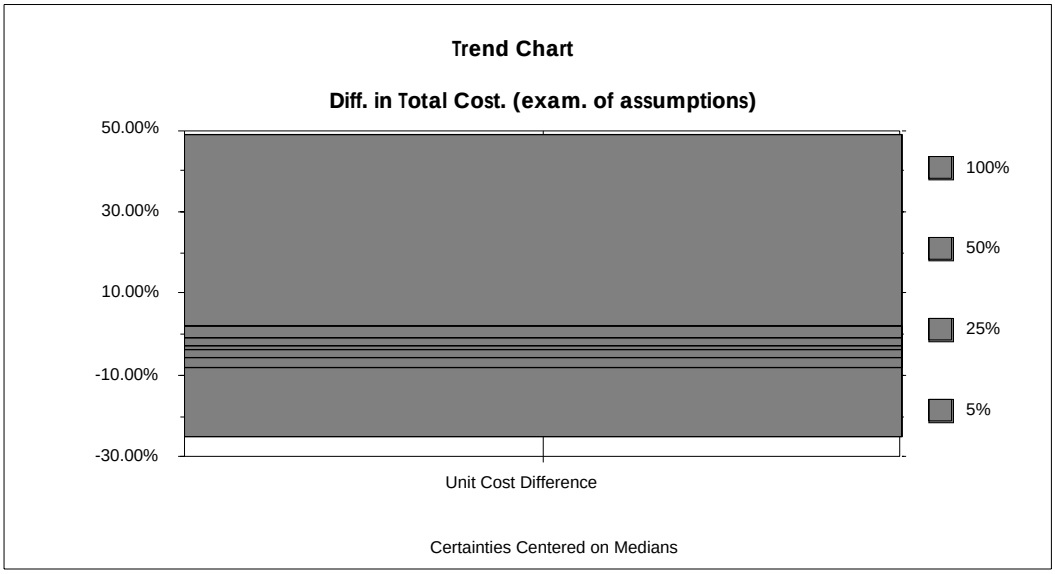
		Import				Export				
		Full TEU	Empty TEU	Total TEU	Tons	Full TEU	Empty TEU	Total TEU	Tons	Note
Cape Verde	Porto Grande	1,978	0	1,978	27,730	55	1,554	1,609	771	Dir - '95 figures
	Porto Praia	3,430	0	3,430	49,242	0	2,960	2,960	0	Dir - '95 figures
Mauritania	Nouadhibou	1,500	1,000	2,500		200	300	500		CV - '88 figures
	Nouakchott									
** Mali*										
Senegal	Dakar			52,772	422,174			34,228	280,182	Dir - '95 figures
The Gambia	Banjul	12,007	46	12,053	144,575	597	11,440	12,037	28,704	CIY - '93 figures - Tonnage incl. tare weight
Guinea-Bissau	Bissau									
Guinea	Conakry			14,000				12,000		Com - '93 figures
** Burkina Faso*										
Sierra Leone	Freetown	7,200	40	7,240	98,100	1,200	6,000	7,200	24,000	CIY - '94 figures - Tonnage incl. tare weight
Liberia	Buchanan									
	Monrovia									
Cote d'Ivoire	Abidjan	68,655	64,617	133,272		78,208	49,844	128,052		Ann. '95 - '95 fig. - transhipm. assume full in/empty out
	San Pedro									
Gana	Takoradi	2,781	5,744	8,525	33,525	10,411	1,547	11,958	133,972	Dir - '95 figures
	Tema	49,918	4,245	54,163	514,800	18,193	30,453	48,646	221,144	Dir - '95 figures
Togo	Lome	17,309	1,256	18,565	198,285	8,546	10,692	19,238	86,452	Dir - '95 figures
Benin	Cotonou			22,511	286,000	5,146	17,365	22,511	84,500	CIY - '94 figures - Tonnage incl. tare weight
** Niger*										
Nigeria	Calabar	1,728	230	1,958	11,566	8	155	163	76	CIY - '94 figures - 34% 40'units
	Lagos/Apapa	51,344	666	52,010	697,009	19,688	24,978	44,666	282,522	CIY - '94 figures - 3% 40'units
	Port Harcourt	3,590	0	3,590	48,106	732	2,846	3,578	11,576	CIY - '94 figures - 18% 40'units
	Tin Can Island	78,576	643	79,219	1,061,918	30,932	37,911	68,843	443,873	CIY - '94 figures - 20% 40'units
	Warri	3,453	520	3,973	43,754	594	1,060	1,654	12,550	CIY - '94 figures -
**C.A.Republic*										
Cameroon	Douala	21,261	16,706	37,967	196,383	26,259	11,254	37,513	491,652	CIY - '94 figures -
Eq. Guinea	Bata									
Sao Tome	Sao Tome									
Gabon	Port Gentil									
	Libreville									
	Owendo									
Congo	Pointe Noire	12,070	4,000	16,070	152,309	6,042	10,000	16,042	71,675	Dir - '95 figures - fig for empty cont are estimates
Zaire	Matadi	19,948	12,335	32,283		1,261	7,246	8,507		CV - '89 figures
Angola	Lobito	6,444	0	6,444	84,792	0	3,312	3,312	8,676	CIY - '92 figures - Tonnage incl. tare weight
	Luanda									
	Mocamedes									
Total	Mauritania to Angola	363,192	112,048	564,523	4,070,268	208,072	230,917	485,217	2,182,325	
	Senegal to Cameroon	317,822	94,713	501,818	3,756,195	200,514	205,545	452,287	2,101,203	
	Mauritania to Liberia	19,207	86	86,065	664,849	1,797	17,440	65,465	332,886	
	Cote d'Ivoire to Cameroon	298,615	94,627	415,753	3,091,346	198,717	188,105	386,822	1,768,317	
	Equitorial Guinea to Angola	38,462	16,335	54,797	237,101	7,303	20,558	27,861	80,351	

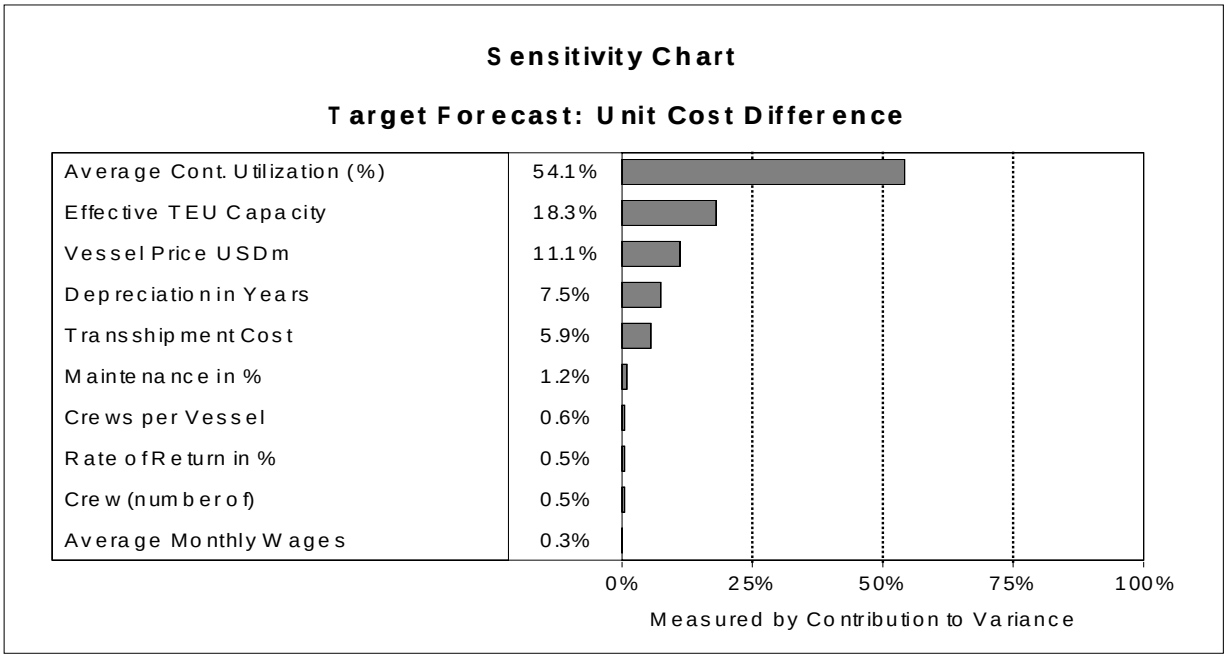
Ann. *Rapport D'Activities 1995 - Port Autonome D'Abidjan*
CIY *Containerisation International Yearbook 1995*
Com *Competitivite Du Port D'Abidjan Etude Comparative, Avril 95*
*** *Landlocked - included in cargo figures of other countries*

CV *Cape VerdeTranshipment study - May 1992*
Dir *Information obtained directly from port authority, Sep-Nov 96*
IMS *Ghana Inter-Modal Transport Study Vol. 2 May 1996*

Annex D: Sensitivity Analysis

Crystal Ball Report
Simulation started on 10/28/96 at 17:09:09
Simulation stopped on 10/28/96 at 17:25:46



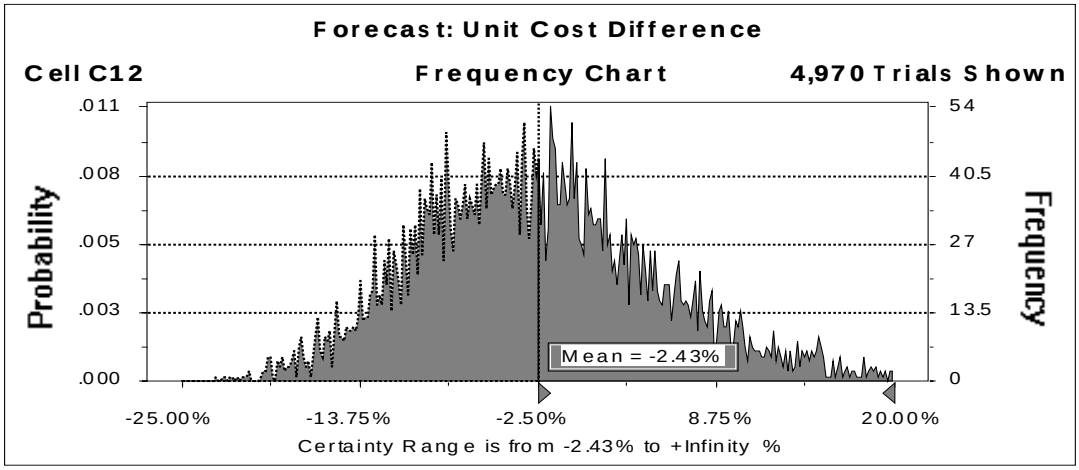


Forecast: Unit Cost Difference

Summary:

Certainty Level is 47.47%
Certainty Range is from -2.43% to +Infinity %
Display Range is from -25.00% to 20.00% %
Entire Range is from -25.07% to 49.74% %
After 5,005 Trials, the Std. Error of the Mean is 0.11%

Statistics:	Value
Trials	5005
Mean	-2.43%
Median (approx.)	-2.99%
Mode (approx.)	-1.51%
Standard Deviation	7.82%
Variance	0.61%
Skewness	0.56
Kurtosis	3.88
Coeff. of Variability	-3.22
Range Minimum	-25.07%
Range Maximum	49.74%
Range Width	74.81%
Mean Std. Error	0.11%



Forecast: Unit Cost Difference (cont'd)

Percentiles:

Percentile	% (approx.)
0%	-25.07%
10%	-11.86%
20%	-9.09%
30%	-6.90%
40%	-4.93%
50%	-2.99%
60%	-1.07%
70%	1.01%
80%	3.74%
90%	7.76%
100%	49.74%

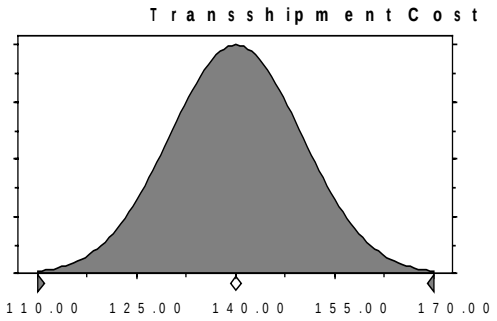
Assumptions

Assumption: Transshipment Cost

Normal distribution with parameters:

Mean	140.00
Standard Dev.	10.00

Selected range is from -Infinity to +Infinity
Mean value in simulation was 140.01

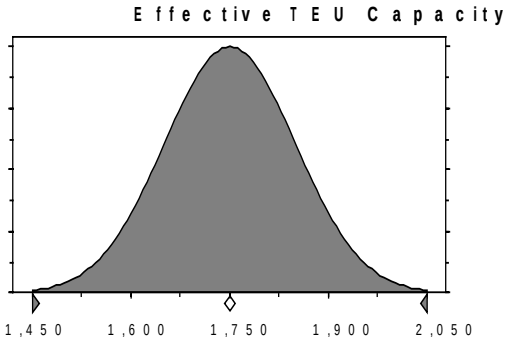


Assumption: Effective TEU Capacity

Normal distribution with parameters:

Mean	1,750
Standard Dev.	100

Selected range is from -Infinity to +Infinity
Mean value in simulation was 1,748

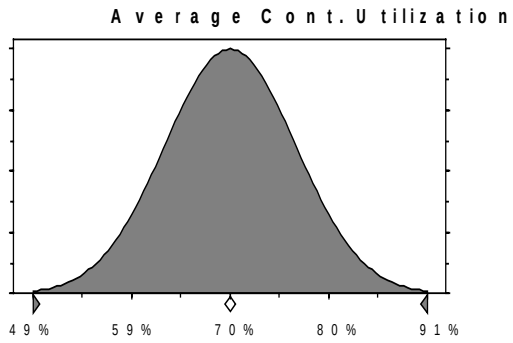


Assumption: Average Cont. Utilization (%)

Normal distribution with parameters:

Mean	70%
Standard Dev.	7%

Selected range is from -Infinity to +Infinity
Mean value in simulation was 70%

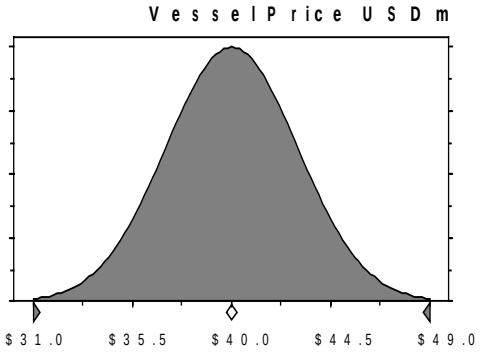


Assumption: Vessel Price USDm

Normal distribution with parameters:

Mean	$40.0
Standard Dev.	$3.0

Selected range is from -Infinity to +Infinity

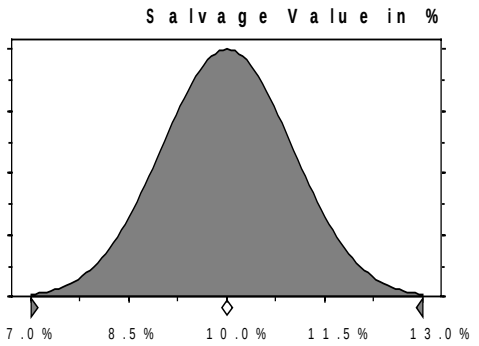


Assumption: Salvage Value in %

Normal distribution with parameters:

Mean	10.0%
Standard Dev.	1.0%

Selected range is from -Infinity to +Infinity
Mean value in simulation was 10.0%

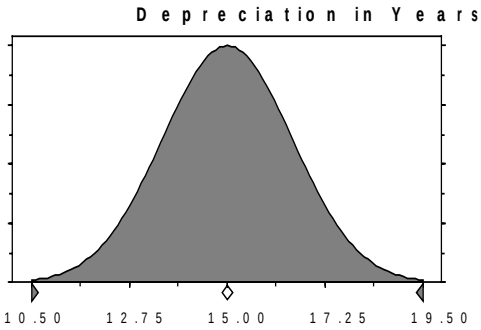


Assumption: Depreciation in Years

Normal distribution with parameters:

Mean	15.00
Standard Dev.	1.50

Selected range is from -Infinity to +Infinity
Mean value in simulation was 15.04



Assumption: Rate of Return in %

Normal distribution with parameters:

Mean	12.0%
Standard Dev.	1.2%

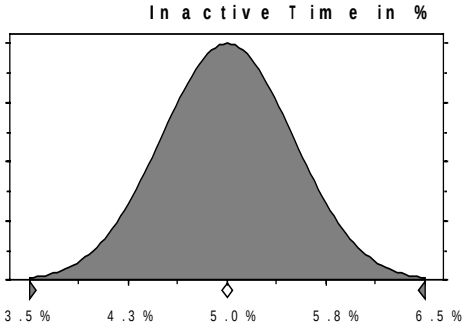
Selected range is from -Infinity to +Infinity
Mean value in simulation was 12.0%

Assumption: Inactive Time in %

Normal distribution with parameters:

Mean	5.0%
Standard Dev.	0.5%

Selected range is from -Infinity to +Infinity
Mean value in simulation was 5.0%

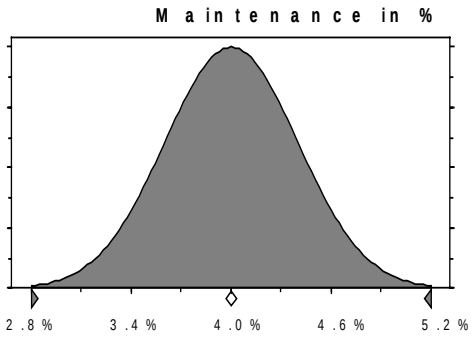


Assumption: Maintenance in %

Normal distribution with parameters:

Mean	4.0%
Standard Dev.	0.4%

Selected range is from -Infinity to +Infinity
Mean value in simulation was 4.0%

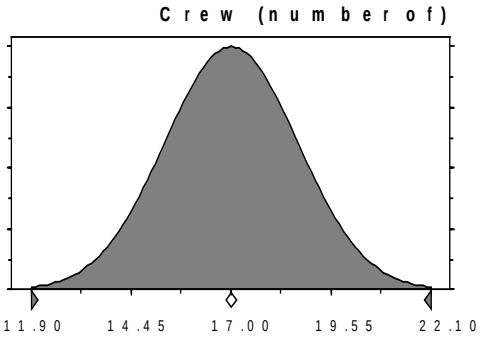


Assumption: Crew (number of)

Normal distribution with parameters:

Mean	17.00
Standard Dev.	1.70

Selected range is from -Infinity to +Infinity
Mean value in simulation was 16.97

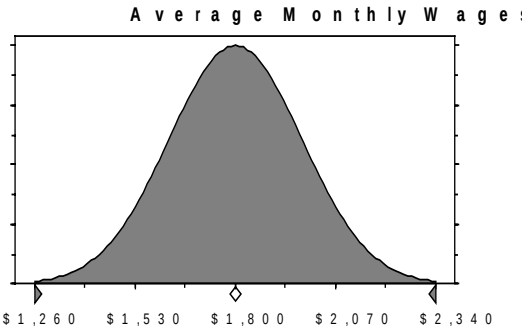


Assumption: Average Monthly Wages

Normal distribution with parameters:

Mean	$1,800
Standard Dev.	$180

Selected range is from -Infinity to +Infinity
Mean value in simulation was $1,801



Assumption: Crews per Vessel

Normal distribution with parameters:

Mean	1.50
Standard Dev.	0.15

Selected range is from -Infinity to +Infinity
Mean value in simulation was 1.50