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Role of Port Management in Global Shipping

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Abstract

A nation's marine transportation system provides an efficient means of moving large quantities of cargo with the least environmental impact. For example, a single 1000-foot ship can move the same quantity of cargo as 2800 trucks, or seven 100-car unit trains. Nevertheless, ships consume the least amount of fuel while resulting in lower air emissions, and a fewer accidents. The role of ports is crucial in the shipping industry. Due to their historic development, unique geographic characteristics, local political infrastructure, constituent commodities, and ever-changing trade patterns, no two ports are the same. In intercontinental shipping, cargo passes through at least two ports. The first port belongs to the source continent and the second to the destination continent. The management of ports plays a significant role in the management and control of transportation cost, total delivery time from the source to the final destination and its variability, cargo security, and reliability of the logistics company, and eventually its throughput. In this paper, we describe various components of the supply chain of the intercontinental distribution with an emphasis on the seaport role and its management techniques. We also describe and analyze various processes that cause delays, and suggest management techniques that help increase throughput of the supply chain. A business process mapping is employed for the analysis of various seaport activities.

Keywords: Global supply chain management; Business process mapping; Global shipping

Introduction

In a global context, the role of seaports as centers for trade activities contributes to strengthen the development of the multimodal transportation system by fostering the increase of cargo networks. The international transportation gives special attention to competitive factors such as ports' infrastructure, quality and spectrum services provided, ports' capacity to manage large cargo volumes in a timely manner, cost, and efficiency. Furthermore, hubs and transshipment terminals continuously improve their network to fulfill new roles in global supply chains due to the tremendous growth of containerized cargo at main transportation routes.

It is well known that logistic activities provide the link for the efficient flow of the traffic of goods and smooth the operations and handling of cargo. Ports are the main nodes in the maritime transit network. Ports are competitive if they are capable of facilitating international trade to shipping lines and providing flexible, efficient and secure services. Based in our knowledge on port management and distribution, we can affirm that from a logistic and supply chains' integration perspective, the maritime activities that are performed at a port not only impact the port environment, but mostly influence the transportation activities beyond the port boundaries, have an effect on the manufacture facilities located in the surrounding areas and also impact the market access at the point of destination.

Today, the top world-class ports consider the capacity of intercontinental distribution as a critical factor for attracting businesses. In that regard, a network model will have a direct impact on cargo flows and supply chains, and suggested evaluations include taking into account the economic potential of the region and hinterland, the port growth previsions, revisions of transportation systems including infrastructure, analysis of modal shifts connectivity, and other system integration. In recent time, ports have extensively and structurally transformed to adjust the new economic environments. This has triggered the introduction of new concepts to understand their integration in supply chains. It leads to exploring and conducting more research and also challenges with respect to the organization of research in port economics, policy and management.

A port management analysis involves an understanding of the port conditions, including intra-port distribution, and routes and hinterland connections outside the port. We study network solutions to access and routing in order to assess most effective means to improve the efficiency in the supply chain. Moreover, our understanding of global distribution allows us to see beyond the boundaries of the port and address issues related to movement through the entire distribution system. Analysis of cargo growth trends, inbound and outbound flows, efficiency of the transportation system, and institutional and regulatory influences are all keys to identifying opportunities for improvements to the logistics activities. Other factors, important in our consideration, are traffic congestion, integration of supply chains, information processes, and cargo security.

Business Process Modeling (BPM) has been utilized for analyzing business operations and optimizing them [1]. An important part of BPM is developing and using process models of fields of activities as a basis for re-engineering, training, communication, working routine descriptions, improvement initiatives, quality control, system development, etc. Modeling business processes helps to identify fundamental aspects of existing processes that should become the

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basis for improvement and optimization.

In this paper, we develop Business Process Modeling (BPM) for port operation and management carryout an analysis and suggest ways to improve port operations. Section 2 includes a literature review and Section describes port criteria. Section 4 deals with and lists basic port activities that are represented by schematic networks. Section 5 describes some usual problems and issues and Section 6 suggests solutions to the problems and issues, whereas the conclusion is in Section 7.

Literature Review

Lyridis et al. [1] describe and suggest optimizing shipping company operations using process modeling. They built process models of various port operations and functions, including shipping of cargo units, at different levels using a hierarchical approach. They further apply their approach to a real-world scenario of a European shipping line.

Mondragon et al. [2] describe the importance of Information and Communication Technology (ICT) to improve the level of visibility, responsiveness, and efficiency in supply chain relying in multimodal transport operations and emphasize that with the use of wireless vehicular networks, Intelligent Transport Systems (ITS) have the potential to shape the future of multimodal logistics. They further investigate the role of vehicular networks play in handling bulk material transported by sea that is further unloaded into haulage vehicles.

Rana and Vickson [3] describe a ship chartering scenario, develop a ship scheduling model to evaluate various ships available for chartering and make informed decisions based on profits accruing from each vessel. Rana and Vickson [4] further develop a large mixed integer non-linear programming model, decompose it into several linear sub-problems and solve it by Lagrangean relaxation. Rana [5] also developed a solution technique to solve mixed integer linear problems and exemplified it with aircraft scheduling problems. Rana [6] describe maritime operations, the importance of containerization, and developed a complex ship routing and scheduling mathematical programming model that can be used by a shipping company operating several ships.

Ronen [7] conducted a survey of cargo ship routing and scheduling models formulated and published until 1982. Sun and Tan [8] modeled a probability distribution of cargo throughput. According to them, gross cargo throughput is a function of time spent by cargo ships at a port and the operating efficiency of the cargo handling equipment. Since cargo ships spend different times at a port depending upon the size of the cargo, it leads to the variability of the gross cargo throughput.

Xiang [9] determine the most critical factors that impact a port throughput and utilized a method factor analysis for forecasting port throughput. He selected indicators that influence the cargo throughput, including GDP, population, output values of the primary, secondary, and tertiary industries, rail freight, highway freight, total import and export, total freight, etc.

Stahlbock and Voss [10] present an extensive overview of conceptual and practically oriented papers on the optimizations of logistic operations at port container terminals. They identified nearly 200 papers dealing with the application of OR-techniques to container terminal planning and optimization. Much discussed topics in OR include berth allocation, stowage planning, crane assignment, crane split (e.g. dual hoist systems), storage and stacking logistics and landside gate operations also studied by Steenken et al. [11].

Tongzon [12] applied factor analysis to assess the efficiency of leading container terminals, but according to Ashar [13] with little success. Earlier, Song and Cullinane [14] used SFM method for those kinds of studies. Hayuth and Roll [15] were the first to suggest DEA for comparing port performance, but it took some years before other scholars picked up the technique. Some studies of this group have a thin dividing line between OR studies and research in economics and management. Some OR-based techniques are often used to address economic issues.

Goss [16,17] outlines six sets of factors that influence port competitiveness: port tradition and organization, port accessibility by land and sea, state aids and their influence on port costs, port productivity, port selection preferences of carriers and shippers and comparative locational advantage. They also provide with a method to calculate value added on the basis of the throughput of a port. Black [18] describes the importance of ports in international trade and Heaver [19] describes the evolution in port design and management and also enumerates future challenges.

Criteria for Port Competitiveness

A key factor of international competitiveness is the efficiency of the intermodal transportation system that allow connections that increase the advantages of free trade areas and regions, and enhance the advantageous location of ports. Furthermore, as technology advanced and ships size increased, the need for large investments in port infrastructure became evident. Few ports can modify their physical, technological and organizational conditions to efficiently serve post-panamax generation ships. This kind of vessels navigates through the principal international trade corridors, calling at the main world ports.

Within the global maritime and multimodal transportation network criteria, only major ports can handle enough cargo volume to make the ship operation profitable. Faster and bigger ships benefit shippers, shipping lines, and multimodal operators because in-transit inventory costs decrease, and smooth the progress of global production. The time saved due to ease of container handling and ships' increased velocity allowed lesser ships rotation time in ports. In accordance with this, larger and faster ships meant reduced fleet size and economies of scale as in [20].

In spite of the great cost efficiency of larger container ships, their physical productivity depends on economic issues that influence cargo availability and determination of profitable minimum cargo factors. Only a high volume of cargo can satisfy the expectation of reaching scale economies. This requires a careful selection of calling ports on every single route.

The main factors for shipping lines to consider in the selection of calling ports along main routes are listed in [21]:

a. Port Location: The geographical position of a port determines

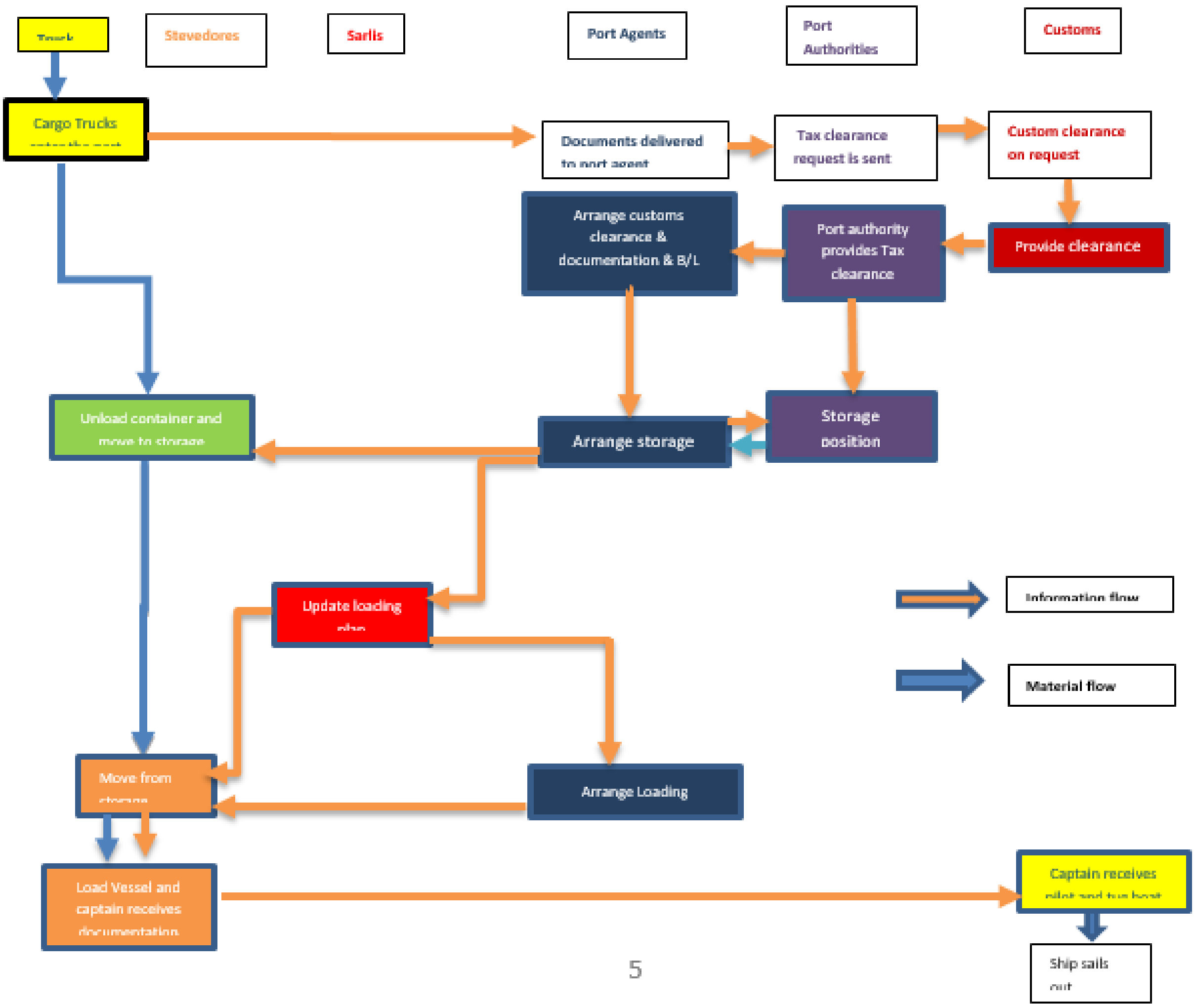

Figure 1: A Schematic network of Operation I, loading cargo onto ships.

the hinterland or area of Influence of this port.

b. Cargo volume: Allows intermodal connections at lower costs.

c. Terminal fees: Have a decisive influence on expected profits.

d. Handling efficiency: Reduced time means lower cost.

e. Water depth: The possibility of larger vessels mooring at the port.

All main ports that concentrate large flows of merchandise destined to various continents and regions of the world are located at the top of this global port network. This kind of port is called a 'hub' because of its characteristics as logistics centers of concentration, processing, consolidation and distribution of flows of merchandise and information.

This scheme implies that many ports be excluded from direct services and can only be integrated into a global network through indirect or feeder routes. This transport operation would move cargo in smaller motor vessels toward some main port node, where cargo would be transshipped bound for its final destinations. Therefore, global hubs are fed by flows from maritime and terrestrial networks, and so those types of ports are logically the best example of intermodal development and main concentration points for intercontinental distribution.

There is an impact of the efficient port management and the transportation and distribution of goods. Such effect is determinate by the international trade operations. For example, the transactions involved for goods entering or leaving the country; or when processing activities happens; when custom clearance processes take place at a Foreign Trade Zone; when multiple modes of transportation are integrated because they have attributes that complement the transportation corridors and when value-added services are provided.

Other criteria makes reference to the integration of logistics. As supply chains become more complex, companies look for ways to reduce the number of links in the production or distribution chains to reduce costs. The reduction of the links can only be accomplished at when warehousing, manufacturing and distribution processes are optimized as in [22].

Currently, there is an explosion in customer direct deliveries. Mail order companies ship many products directly from manufacturers and

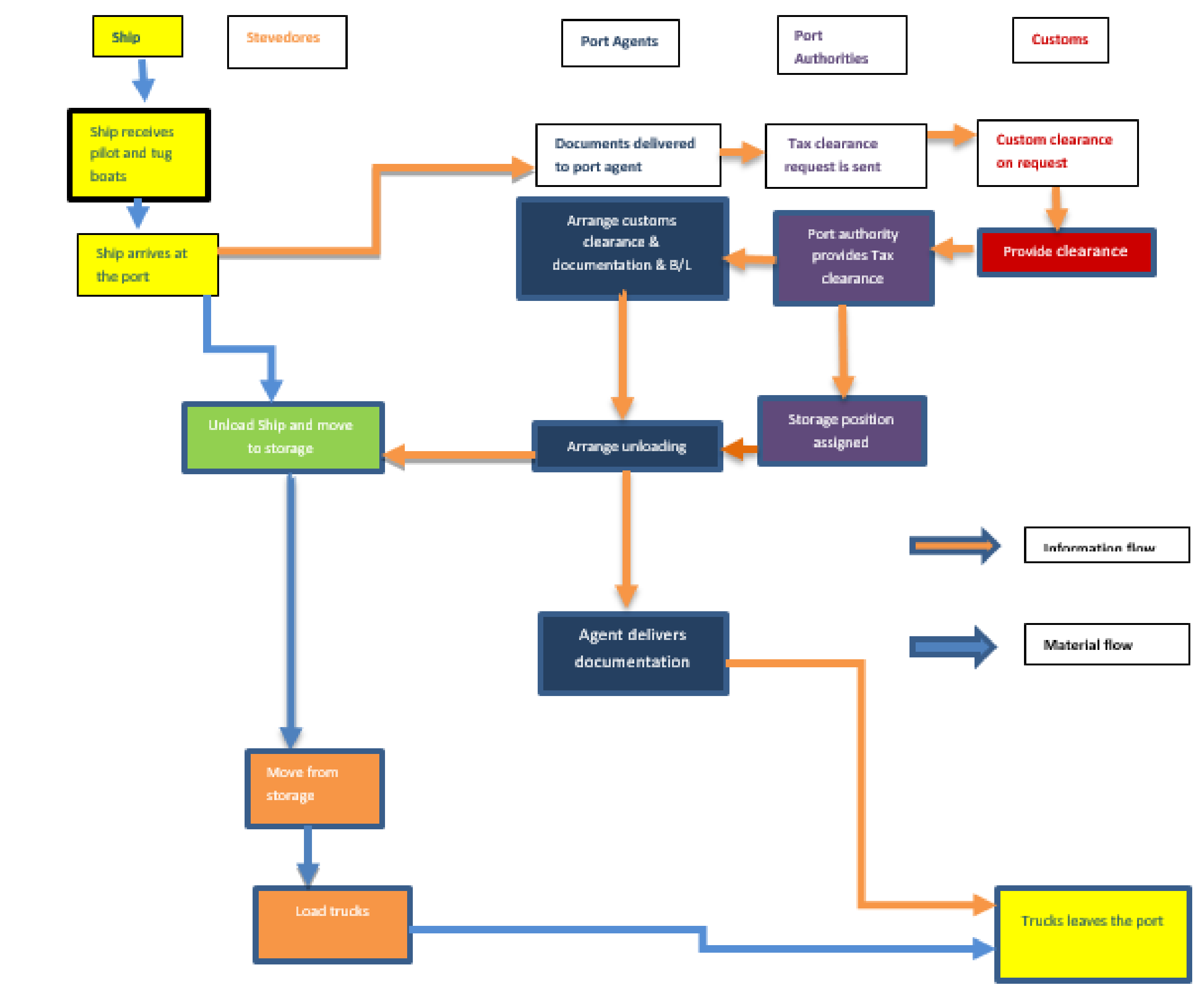

Figure 2: A Schematic network of Operation 2, unloading cargo from ships and loading onto trucks.

may eliminate intermediate warehousing. One possible distribution model has goods moving directly from a plant to a home delivery consolidation centers or cross-dock center, and hence to residences or businesses. However, another trend appears to be rooted in inventory reduction and supply chain programs, and in the rapid growth sector of B2C, retailers are constructing large distribution centers proximate to freight hubs in high demand areas. Pull logistics model through the reduction of inventories and the elimination of safety stocks rely heavily upon carriers to perform timely replenishment of products and avoid stock-outs. Then, 3rd and 4th party logistics companies often build themselves around information systems platforms that permit greater pipeline visibility and lower transaction costs than most shippers can attain by themselves.

On the other hand, the combination of transportation modes may provide opportunities to eliminate inefficiencies at the supply chains. This happens because the diverse transportation capabilities take the form of connections to interstate highways, intermodal rail facilities, air or maritime terminals, and therefore, the provision of different modes allows business to choose the best alternative for cargo transportation. In that sense, a critical factor to evaluate is the logistic management component that seeks for the integration of supply chains. As it is known, global trade increased the demand for efficient services and the reliability of the transportation depends on the seamless distribution and maximization of transport modes. Then, the efficiency of the freight movements is procured thanks to the supply chain network as in [14].

A Typical Port Scenario

In a typical port scenario, there are two types of operations:

Operation I: Cargo containers arrive at the port from inland sources by trucks. There are certain activities that must be completed before cargo containers are loaded onto ships. A port agent for the company arranges custom clearance, pays port taxes, prepares necessary documentation such as Bill of Lading go through custom clearance etc. And arranges cargo-loading onto ships. After these formalities and loading of cargo onto ships, ship leaves the port for another continent.

Operations II: Containers arrive by ships from another continent, unload it, store, taxes paid, custom clear, loaded onto trucks and leave for inland destination.

The important activities of Operation I are listed below:

1. Container arrives at the port of loading by trucks.

2. Arrange delivers paper to an agent.

3. Arrange custom clearance.

4. Arrange tax clearance.

5. After receiving clearance agent arranges documentation and bill of lading.

6. Port agent requests storage from port authorities.

7. Port authorities provide instructions for storage.

8. Agent arranges storage and instruction to driver.

9. Container unloaded and moved to storage.

10. Contractor prepares a loading plan.

11. Loading plan is rent to port agent.

12. Port agent instruct stevedores to move cargo from storage.

13. Load cargo on ships.

14. Ship is lashed and secured.

15. Ship is ready to leave the port.

16. Unbreathing-Pilot and tug boats are needed.

The above activities are depicted with a schematic network as shown in (Figure 1).

The important activities of Operation II are listed below:

1. Ship enters the seaport- needs pilot and tug boats.

2. Documents are received by port agent.

3. Customs clearance requested.

4. Instructions from port authorities for storage.

5. On receiving instructions for storage Agent arranges unloading of cargo by stevedores.

6. Truck driver collects documents from agents.

7. Stevedores either unloads ship and move to storage or load on to trucks.

8. Truck leaves for inland destination.

The above activities are depicted with a schematic network as shown in (Figure 2).

It is worth noting that material and information flow takes place simultaneously or in a sequence. The information flow is shown by green lines and the material by blue lines.

Problems and Solutions

In recent years, research in ports has gone through a metamorphosis, caused by progress in important research domains such as geography, econometrics, welfare economics, operations research, logistics, strategic management, etc. Multidisciplinary studies have also come to the foreground. In many cases, tools of strategic management are deployed to give an extra dimension to port studies (e.g. port clusters, competitive advantage, etc.). Our study of port operations made evident that the research on ports is continuously expanding: almost 400 studies are published in the last decade Pallis et al. [23]. In recent time, ports have extensively and structurally transformed to adjust to new economic environments. This has triggered the introduction of new concepts to understand their integration in supply chains, Machari and Bontekoning [24]. Pallis et al. [25] classified the port studies published during the period 1997–2008 in seven research themes.

Based on the analysis of the port activities and schematic networks, it is noted that the documentation and the information passes through several hands, which delays the process of cargo-clearance from port authorities. The following are the main activities that need to be taken care of:

1. Number of berths available can cause longer waiting lines and hence duration and variability of ships time in port.

2. Most times, trucks wait outside the port and that increases the variability and unloading time for cargo.

3. Documents pass through several hands of port authorities and customs departments.

4. Stevedores are highly unionized and they work at their own pace in loading and unloading cargo.

5. Ships need pilots and tug boats to leave harbors. Non-availability of tugboats and pilots delays ship's departure.

6. Incoming ships get delayed when tug boats and pilots are not available in time and consequently ships have to wait outside the harbor.

7. Security checks and clearance also cause delays in loading and unloading ships.

8. Inadequate availability of loading and unloading equipment such as gantry cranes increases ship's time in ports.

9. Faulty loading plans increase the duration and variability of the loading-unloading time.

10. Congestion or heavy traffic on roads leading to a port delays the arrival of trucks carrying cargo for export and consequently, ships stay in the port longer.

In view of our knowledge of marine operations and research, we suggest the following solutions to the above problems.

1. Port authorities need to evaluate on a regular basis, the adequacy of berthing facilities and loading-unloading equipment. It's an application of the queuing theory that can help to solve this problem. Research has found that it's the perception of shippers and the shipping companies that plays an important role, because they don't want to visit a port that make their ships await long times.

2. Agents need to work with port authorities and shippers so that documents are available at the port before cargo arrives by trucks from inland sources or from other continents by ships. A

good planning using critical path method will help to save time in paying port taxes, custom clearance and issuing the Bill of Lading and other documentations expeditiously. Submission of documentation online or through a web based system that links port agents with port authorities, custom offices, etc. will also save considerable time for all parties.

3. The use of RFID technology and similar container tracking systems will decrease the accumulation of containers at the port.

4. Employment of information and communication systems will reduce the variability of all operations.

5. Several marine management software packages are available these days, generally turned as Ship Management Information Systems (SMIS) or Vessel Traffic Management Information Systems (VTMIS) are available these days. Use of such software will considerably reduce the ship approach, queuing, and departure times and enhance the security and safety of cargo.

The main objective of the above suggestions is to increase the cargo throughput, reduce ship's time in port, variability of various activities, increase the efficiency of loading-unloading operations, enhancing the productivity of all agencies.

Conclusion

With the establishment of leading ports and regional hubs their competitiveness increased their need to modify its role in the ports' structure. This means, more and more competition has forced them to elaborate strategies to be part at the global transportation network. This is due to the shipping lines requirements that function under a world-wide basis and so, select a port is less particular than the supply services that can be integrated in the chain as in [20]. More important factors are the transit time, quality services, and the capacity to respond to customer needs.

Thus, structural changes in the transportation system and the concepts of total logistics and intercontinental distribution are being developed and evolved. The integration of logistics and its interrelation with the maritime industry has redefined the role of ports. New patterns of cargo distribution have generated new approaches to the global transportation network. His paper describes intercontinental distribution scenario that employs multi modal transportation system. Various port activities are listed and they are depicted by schematic networks. Based on analyzing the activities, problems and issues are highlighted and solutions suggested. Further research involves collecting data from the real port operations to estimate the delivery time of cargo through the network, variability of various activities and duration of ships time in ports.

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