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Integrated Port Management Systems in the Evolution of an Efficient Port Policy

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Abstract

The paper reviewed the various efforts made in recent years at integrating activities in the port system. Among these include vessel traffic management systems, vessel traffic management and information systems, simulation systems, supply chain management systems in the harbour environment and other systems management techniques. The work identified the following agents as active participants in the port system. The ship agent, the berth agent, the yard agent, the gate agent with the transtainer agent and the transport agent acting as sub agents. Other classification terms for agents found in the work includes the identification of physical agents in the port system and their interactive relationships. The physical agents thus identified in the port system includes: the supplier, the Harbour, the ship, the distributor and the customer, while, the logical agents includes the order agent, the logistics agent, the scheduling agent, the resource agent and the transportation agent. The identified agents were then applied to study the interactions between the following port system components of: port approach management, quayside/ Berth operations management, Documentations/information systems management, Marshalling area/ Land transport management and then ware housing/ cargo release management. Performance measurement techniques leading to the evolution of efficient port policies were applied in the study of the Nigerian port system. Areas requiring additional policy measures were identified. Applied measurement techniques includes container dwell time analysis, cargo through put forcasting based on historical data, ship berthing time analysis, equipment availability studies, cargo in-transit-time analysis and their contribution towards the development of efficient port management policies.

Key words: port integration, berth agent, yard agent, logistic agent

1. Introduction

Process integration has resulted in efficient systems behaviour in recent years. This concept of integration has found wide application in various industries, in most cases often described as supply chain management. One of these industries is the manufacturing industries where materials flow integration at the shop floor has resulted in efficient policy promulgations. The port industry is not left out in the application of this concept. To this end a number of studies have been carried out, some of which will be reviewed in the next chapter.

Different approaches applied in the study of the integrated port system includes the artificial intelligence approach of multi-agent modeling and the logistics and supply chain approach often applying performance measurement techniques.

The findings of the integrated port system studies are no doubt of vital importance in the evolution of an efficient port policy. This is rooted on the fact that a port policy derived from empirical research findings will no doubt do better than one based on ad-hoc or rule of thumb approach. To this end, efforts should be geared towards identifying bottlenecks to port operational efficiency using scientific research instruments.

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These findings should on the long-run be perfectly integrated in the formation of port operational policies of individual port systems.

Objectives

The objectives of this research includes inter alia:

(a) To integrate activities in the port system thereby determining the place of integrated management systems techniques in the evolution of efficient port policies

(b) Apply some of these analytical techniques to a named port (in this case the Nigerian port system) and obtain results.

2. Literature Review

Integrated port management deals with the procedures of integrating the various activities involved in a port system in an efficient and profitable manner. Such activities will include: movement of ships, containers and other cargo; the loading and unloading of ships and containers, customs activities, human resources management efficient allocation of berths, anchorages, channels, lighters, tugs, warehouses and other storage spaces. A study of the integrated management of port systems using domain analysis has been carried out resulting in specifications for the following sub component systems:

(a) Vessel traffic management

(b) Container traffic control

(c) Cargo management information

See UNU/IIST (1998).

Vessel traffic management refers to the set of efforts (measures, provisions, services and related functions) which, within a given area and under specified circumstances, intend to minimize risks for safety and the environment, whilst maximizing the efficiency of waterborne and connecting modes of transport. The term vessel traffic management and information service (VTMIS) is an umbrella concept for all activities to improve vessel traffic information. VTMIS usually functions via an Authority or service provider. It can be used for vessel traffic management, fleet management and cargo flow management. VTMIS is characterized by both horizontal and vertical electronic information exchange. Along the horizontal line, information is exchanged with the neighborhood, region or distant locations. Along the vertical line however, official or commercial information is exchanged with other maritime services e g logistical services

Vtmis when applied to ports results in considerable increase in operational efficiency and return on capital invested, since several organizations benefit from it. Good examples of vtmis based program includes comfortable and poseidon, movit,vtmis-net, the Greek system, the Portuguese system, waterman etc. Vtmis systems have always brought visible increase in the efficiency of maritime operations wherever it is installed.

Ingo Harre (2001).

Multi-agent simulation have been used to model ship-to shore operations of the container port complex. Thursten and Hu (2002). However, the focus of Artificial intelligence has been on the application of market-based control in container management. The basic reason for this approach arises from the fact that the container port system is a complex system that is difficult to be structured quantitatively. Davidson, Wernstedt and Henessy (2003) proposed a market-based multi agent system for container terminal management. Moving across the four main subsystems of a container terminal, viz:

(a) Ship- to- shore
(b) Transfer cycle
(c) Storage and
(d) Delivery/Receipt,

he identified the active agents involved in a container terminal. They include:

(i) The ship agent who initiates the planning of an arriving vessel in a cost effective manner. The model projects this agent as gaining revenue when discharging/selling containers and having expenses when loading/buying containers.

(ii) The berth agent responsible for the allocation of resources at a dynamically changing part of the quay. It can calculate the current price for the berthing of a vessel with an indicated loading manifest.

(iii) The yard agent who manages a dynamically changing storage space in the terminal. It responds to a bid by calculating container value, space availability, container lorry transportation cost, transtainer (equipment) availability. It also request for revenues from the storage area for dispatching containers.

(iv) The gate agent, which allocates containers to the terminal storage by awarding the containers to yard agents while requesting for, stored containers when transferring containers to land transport.

Three other agents help these agents. They are: the crane agent, the transtainer agent, and the transport agent.

Dong Won Yi, S.H.Kim & N.H.Kim (2002) argued that the Harbour management system consists of the following:

(a) Ship operation system,

(b) Cargo moving system,

(c) Storage system,

(d) Receipt and delivery system,

(e) The gate system and,

(f) Management and operation information system.

Identified activities found in the Harbour management system include: berth allocation; yard planning, storage planning and logistics planning. W.Y.Yun and Y.S. Choi (1999), C. Onyemechi 2003

Yi et al (2002) pointed out that full utilization of resources and proper management of operational policies are major concerns in the harbour supply chain. He developed different management policies to govern each of the identified port activities using the simulation mathematical model.

The multi-agent approach divides objects and service units into individual units with capability and capacity known as agents. These agents subdivided into physical agents carry out different functions. While for instance a physical agent represents a tangible object such as ship or harbour, a logical agent will represent a logical object with an information function, such as logistics agent ,or order agent. Yi et al 2002) identified the following logical agents in the port system viz:

(a) The order agent whose responsibility is to acquire order from the customers, negotiate with them about prices, due dates, as well as confirm or cancel the orders.

(b) The logistics agent who coordinates the supplier, harbour, and distributor , to achieve the best possible results with the scheduling agent , including on time delivery , cost minimization etc.

(c) The Transportation agent who assigns and schedules transportation resources to satisfy inter-harbour movement requests as specified by the logistics agent.

(d) The scheduling agent who schedules and re-schedules activities in the harbour, exploring for potential new orders, and generating schedules.

(e) The resource agent who manages resources minimizing costs and maximizing delivery. It generates purchase orders and monitors the delivery of resources.

Interaction among these agents produces material and information flow within an entity and to other entities existing adjacent to them in the supply chain. A three-fold performance measurement system, which assesses the variables of resource use, desired output and flexibility, has been suggested for use in supply chain management. Yi et al (2002), Beamon (1999).

The multi-agent approach simply measures these variables at the individual agent levels and then evolves a combined result output to determine the operational and strategic policies of a system.

3. Methodology

The methods applied in this study are not a single uniform analytical model. Rather, a set of multiple analytical models suitable for the analysis of operational assessments at different levels of the integrated port system is utilized for the analyses. A set of analytical models were applied to the Nigerian port system .The models include cargo dwell time analysis, trend analysis using the least squares approach, port productivity assessment, ship turnround analysis, berth occupancy assessment and labour gang hour studies.

For the purpose of this study, the port is sub-divided into five principal parts viz;

(i) Port sea approach management

(ii) Quayside/Berth planning &ship control

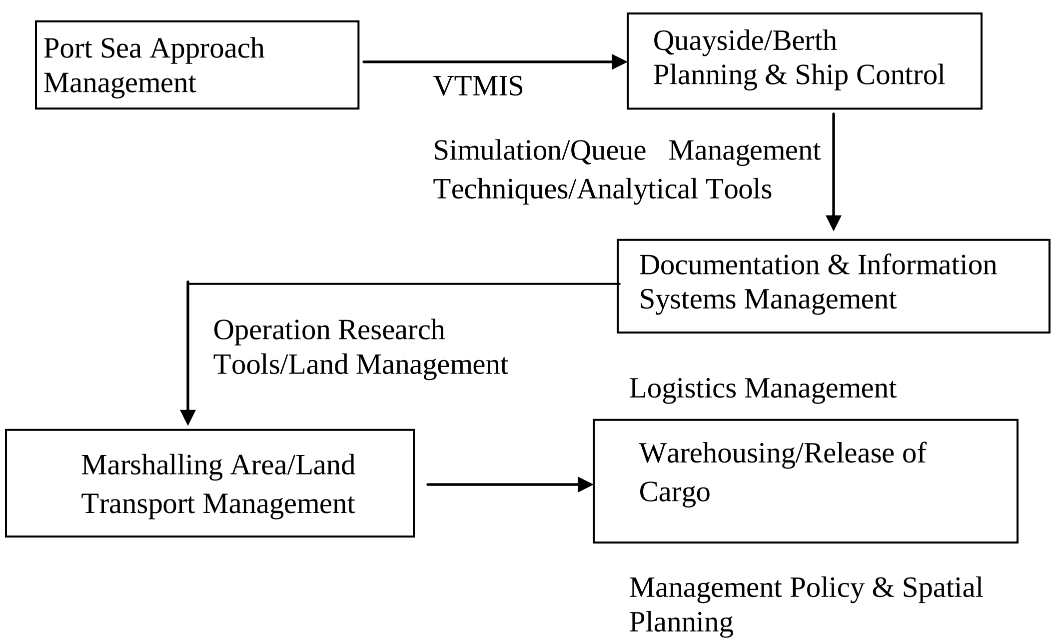
(iii) Documentation & Information systems management

(iv) Marshalling area/Land transport management

(v) Warehousing/ cargo release.

The five categories above can be further reduced into two categories: ship management at the ports, and cargo management at the ports. While the first two affect ship management, the last three are concerned with cargo management operations.

4. Result of Findings



System components of the integrated port management system

The Integrated Port Concept- Classified

This study divides port operations into two major categories:

(a) That of managing ships at the ports and:

(b) Cargo management at the ports.

The Management of ships at the ports consists mainly of two components

(i) Port sea approach management and

(ii) Quayside/Berth planning and ship control

While the first can be viewed as the responsibility of the harbour master, the second is strictly a port operations planning responsibility, requiring prior availability of all ship details and information.

Cargo management at the ports commences from the completion of the quay transfer operation and will pass through the following other operations

(a) Documentation and information systems management

(b) Marshalling area/ land transport management; and

(c) Warehousing/cargo release to the consignee.

An interface occurs at a point where the ship management operations ends, and the cargo management operation commences. This interface calls for efficient management skills if block stacks are to be avoided, especially in a container yard. This calls for efficient quay transfer equipment in perfect working conditions, skilled and experienced port labour and application of tested management analytical tools.

Due to the high level of inter-relationships between activity groups involved in the port system, integrated management systems can be perfectly applied in analyzing port activities. When effectively applied, this will result in the evolution of efficient port policies.

Mathematical techniques applied in the study of integrated port management systems and supply chain management can be classified as any of the following; deterministic, probabilistic (or stochastic), simulation techniques, fuzzy, hybrid or even economic. Beamon (1998), Yi et al (2002).

In this work an optimal modeling approach is adopted. Best choice models for each situation under review will be adopted. Our integrated port, which consists of five sectors, which includes;

(i) Port sea approach management

(ii) Quayside/Berth planning & ship control

(iii) Documentation & information systems management;

(iv) Marshalling area/land transport management; and

(v) Warehousing/cargo release shall be reviewed.

Port Sea Approach Management

The journey of a ship into a port commences from the point where the sea-leg of a vessels journey ends, and permission is sought by the master of the vessel from a point outside the compulsory pilotage district, from the Harbour Master for an in-coming vessel to proceed inwards towards the port.

This whole district, which commences from the compulsory pilotage point of a port to the port loading and discharge area, is known as the port approach.

An efficient management regime for this area has some contributions to make to an integrated port system. The management regime or port policy in this zone should consist of such parameters as

(a) Quick wreckage removal

(b) Availability of experienced pilots and pilot vessels

(c) Efficiently dredged port approach

(d) Vessel traffic management and information services (VTMIS)

(e) Vessel traffic management and safety systems, introduced to manage sea-lane traffic.

For an efficient port policy, an integrated port management system should perfectly analyze the above variables to categorize a particular port. A deterministic analytical tool or even a stochastic tool will do well in this place.

The performance of a port sea-lane approach is very important as part of the overall integrated port systems management.

Quayside/Berth Planning & Ship Control

Berth allocation requires pre-arrival planning for expected vessels, discharge and loading planning for vessels at berth, allocation of mobile units for quayside transfer of import and export cargo to transit sheds, gang allocation and shore labour management, yard planning etc. All these activities involve a good extent of interactions among different units of the port organization as well as outside agencies.

The integrated approach will require constant information flow among all interacting units. In most cases a forum for the meeting of all agencies concerned would be necessary. Here, latest information concerning ship's activities at the berth is released to all parties. Areas requiring improvement would then be pointed out for necessary corrections to be applied. In some ports like those found in Nigeria, this gathering already exists, commonly referred to as "Berthing meeting". The integrated approach seeks to modify the representations in this berthing meeting and the goals thereof, towards achieving complete representation of all parties involved in our integrated modern port, in a manner to achieving efficient port policy in this area.

A measure of performance at the quayside/berth planning & ship control area will have two major variables in view:

(a) That of maximizing ship turn round time; and

(b) That of maximizing berths output.

The above objectives have often been sought using several study techniques some of which include deterministic techniques involving direct measurement of parameters, and direct interpretation of results, popular and direct interpretation of results. Popular ones include use of UNCTAD approved performance indicator measures which defines formula for measurement of the following indicators: berth output indicators, ship output indicators, gang output indicators, ship turn round time, berth occupancy, berth working time etc. Besides the above, simulation, queuing theory, and fuzzy logic techniques have also been applied to explain interrelationship in this area.

Documentation & Information Systems Management

The existence of multiple units in the processing of the ships documents and cargo documents calls for a coordinated approach to paper handling. On time arrival of ships & cargo documents prior to vessel arrival is the key to efficiency in this area. Evidence for payment of ship dues and port charges should be submitted well ahead of time to relevant authorities for on - time processing of such documents, to enhance vessel's inward clearance into the port area. Information flow in this respect is between the shipowner/charterer and his appointed agent at the country of ship's call. Information flow between the relevant sectors of the port Authority, the shipowner's agent, the shipowner and the ship should be unhindered. Fax, e-mail, radio – message and use of logistics companies for document transfer, are all parts of the information flow network.

For the cargo itself, the processing of cargo clearance from the ship's agent, the customs and the port Authority should be completed once the ship completes her cargo discharge, to enable prompt removal of such cargo from the custody of the wharf. The use of bonded warehouses should be encouraged to facilitate quick exit of goods from the port premises.

The port policy in this area should be geared at reducing the stages of flow of these documents to permit quick processing. Again, cooperation among the inspection agencies and relevant authorities in terms of information transfer should be encouraged. This will reduce congestion and cargo queues at the port premises. A means of monitoring the efficiency of these agencies should be devised so that their activities can be evaluated in terms of their contribution to port efficiency. The application of port operations benchmarking will be of use in this area. This involves a study of ports with best practices being carried out by personnels of ports that are less efficient.

Marshalling Area/Land Transport Management

The management of land space immediately between the waterfront and the transit shed, primarily known as the quay is very important to efficient port perform once. The land reserved for lorries, container carriers waiting for on-ward call into the port area to receive discharged cargo is also very important to efficient port performance. Stacking areas reserved for storage of containers and heavy materials not under shed cover are also very important.

The amount of space allocated to these activities should be directly related to the size of vessels expected to visit the port. Since this variable is subject to change due to improvement in technology, space for expansion should be made available outside the port area. Use of forecasting tools to determine expected annual cargo in a port area should be a continuous exercise. This will help determine when expansion is necessary, and when congestion and other bottlenecks sets in.

A specialized transport unit who should work jointly with the gate and release section should control the movement of vehicles within the port area. Documents required for cargo pass should be with this section well ahead of time prior to the vehicles time of call. Activities in this section should be properly integrated with those in the Accounts, cargopass, custom's seat and release sections. Continuous operational study is also a necessary requirement.

Ware Housing/Cargo Release

Temporary storage of goods prior to its release to the cargo-owner or permanent transfer to a government warehouse is part of the overall responsibility of an integrated port. Storage of goods in the warehouses should be done in line with general safe stacking procedures. Light goods in light packages should be stacked on top of heavy ones and not vice versa. Dangerous goods should be stacked in line with IMO segregation requirements in the IMDG code.

Space should be made available for the movement of mobile vehicles used in the stacking of cargo.

The cargo release officer in the warehouse should be properly furnished with all necessary information to enable him release the cargo to the right owner.

The time spent by goods in the transit shed/warehouse should be limited by a pronounced policy, say maximum of 4 to 5 days, after which a compulsory rent charge begins to count against the cargo. This will encourage the consignees remove their cargo from the port premises quickly. Cargo dwell time of goods in this section should be calculated for the various permanent customers, while notices/advice are sent to them to inform them about their performance in a particular year.

The use of bonded warehouses should be encouraged to facilitate quicker transit time of cargo through the ports.

Performance Assessment of the Nigerian Port System

Various aspects of the integrated port are subjected to studies and scientific investigations to determine areas that need improvement, thus suggesting areas for policy improvement.

Performance measurement techniques have been applied to evaluate several sectors of the integrated port in Nigeria with the following results obtained.

Container Dwell Time Analysis

This analytical tool was suggested as a good measurement instrument for the Warehousing/Cargo release section of our integrated port.

The research instrument was used to study activities in the Apapa/Lagos port of Nigeria. The findings were compared with results from adjacent private bonded warehouses in the adjoining Lagos hinterland. The results were amazing. Mean dwell time of containers at the government owned warehouses in the port premises were higher than those in the private owned warehouses located in the Lagos hinterland. For the individually owned private port, the container mean dwell time was 18 days whereas that for government warehouses located in the port premises was found to be 26 days.

The dwell time is a paradigm, which measures the average time imported, or export cargoes spend at temporary storage areas or warehouses pending completion of customs formalities and its subsequent delivery to the consignee.

The larger parameter of mean dwell time of containers and goods is a measure of inefficiency of the port concerned. This proves that bonded warehouses when properly managed are more efficient than government warehouses. Other factors found to contribute to the efficiency of a warehouse includes inter alia:

(a) Security of the good

(b) Rent chargeable on the good

(c) The time taken for the physical examination of the good

(d) The sufficiency of handling equipment

(e) The delivery/clearance process; and

(f) The performance of the different inspection agencies present.

Cargo Throughput Forecasting

Forecasting techniques are not new to studies in port management. One popular way is to follow an existing ports historical trend and therefrom, produce an estimation of future expected cargo for the port. This method will however need constant repetition since very distant future expectations of cargo cannot be perfectly forecasted from the past. Constant revision of trend analyses of expected cargo flow will reduce estimation errors and produce better forecasts**.**

A trend analysis was applied in this case to estimate future expected cargoes in three West African ports yielding substantial results. The line of trend for both inward and outward cargo for the ports of Apapa/Lagos (Nigeria), Abidjan (Ivory coast) and Douala (Cameroon) were established. A trend formula using the method of least squares was developed for calculating the expected future cargo in each of these ports using their respective historical trends.

Other Performance Measures

Performance indicators were used to determine the berth occupancy, ship turnround time, port productivity, berth effectiveness and gang hour effectiveness at specified Nigerian ports for the periods ranging from 1999 to 2003.

The result showed a port productivity of 56.21 Tonnes/hour for Apapa port, 21.51 tonnes/hour for Calabar port; 43.79T/H for federal lighter terminal Onne and 33.81 T/H for Port Harcourt port, respectively. Average ship turn-round time for vessels entering and leaving Nigerian ports for the period was 127.74 hours (5 days). Turn round time for ships visiting Apapa/Lagos port was 166.20 hrs (7 days), while that for Port Harcourt port was 126.22 hours (5 days).

Berth occupancy on the average was 30% for all the Nigerian ports indicating low utilization. Berth occupancy was highest for Port Harcourt with 49% and least for Calabar port with 0.9%. The berth occupancy for Apapa/Lagos port was 33% while that for federal lighter terminal Onne was 24%.

Gang hour effectiveness was highest for Apapa port with 49.80 tonnes per hour and least for federal lighter terminal Onne with 20.84T/H. Tincan Island port had a gang hour effectiveness of 31.26T/H while Port Harcourt port had 31.18T/H for the period.

5. Conclusion

This concept as revealed from our study concentrates on functional dependence of sub-units in a given port system for optimal performance. It also insists on performance measurement of different arms of the integrated port as a means of achieving overall efficiency in policy making.

The integrated approach should therefore be insisted upon by a management that aims at achieving better port productivity, optimal ship turn round time, and the improvement of other efficiency variables.

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