

## Inter-organization information systems in integrated maritime economy

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### **Keywords**

Ports, Economy, Integration, Information, System, Egypt

### **Abstract**

*The paper reviews inter-organizational information systems (IOIS) in ports and its economic benefits with further study of key performance indicators of technology at ports and different types of IOIS as port community system and port single window with worldwide examples. Due to the importance of IOIS in ports and its impact on trade facilitation and higher economic growth the paper studies the Egyptian ports information systems through structured interviews with number of Egyptian ports and experts in logistics and transport as well as through questionnaire emailed to random sample of 200 logistics and transport companies. The analysis of Egypt case found that the main hindering factors of trade facilitation are institutional bottlenecks, political inference, and cumbersome customs procedures. The main factors require improvements and further investment are, training of ports human resource, modernization of cargo clearance information system, automation of custom clearance procedures, and institutional reforms. The analysis found that the expected benefits of IOIS in Egyptian ports are increasing the rate of cargo clearance, volume of trade, and reduction of cost of doing business which will lead to higher economic growth.*

### **Introduction**

The traditional role of ports has changed, as they become networking sites, gathering supply chain members requiring higher degree of coordination and cooperation between supply chain actors. In the modern economy competitive strength of a port or any maritime players does not depend exclusively on their own infrastructure or organization but affected by other market forces. Inter organization information systems (IOIS) is a must for achieving integration as it constitutes the essential infrastructure of strategic alliances. It allows sharing and communication of information between two ends of the supply chain; the customers interact with company employees and with business partners as suppliers and logistic companies.

The study discussing Inter organization information systems in maritime industry it forms and its economic benefits along some examples. The paper use analysis of literature, qualitative descriptive analysis using secondary data from published reports in addition to primary data from questionnaire and structured interviews studying Egyptian ports, maritime and supply chain actors in Egypt to study the current status of IOIS in Egyptian ports, the required modernization of ports and its expected economic impacts.

### **First: Technology and Economic growth**

Impact of technology at macroeconomic level shown through the main economic growth models which takes technology as main growth factor; starting by Solow Growth model with its principal conclusion that the sole determinant of income other than capital is the effectiveness of labor due to technological progress which was considered as an exogenous variable. Then the models of Aghion and Howitt, Grossman and Helpman, and Romer which are the best providing explicit theoretical models of endogenous technological progress. Endogenous growth theory or the modern growth theory enhanced the traditional growth theory by endogenizing the technological progress by giving more attention for investing in new technologies. In Romer 1990 model the growth rate

depends on the size of the research sector, both in terms of how much labor is used there, and how large the stock of accumulated designs (Romer, 1996). Aghion & Howitt theory is based on Schumpeter's concept of creative destruction. It portrays a free enterprise economy that is constantly being disturbed by technological innovations from which some people gain and others lose, survivors are those that succeed in creating, adopting and improving new technologies. The expected growth rate of the economy depends on the wide amount of research in the economy (Aghion & Howitt, 1992).

### **Second: Evolution of Port and Maritime Industry**

Ships are getting larger and more efficient, shipping lines are deploying larger container vessels targeting cost savings through economies of scale (Nottboom & Rodrigue, 2009). Container terminals have gone through series of innovations with the emergence of global terminal operators as DP World. Productivity gains have become a matter of terminal management skills, software, know - how and hinterland size instead of hardware. To reach sustainable development of shipping and global supply chains, innovations are needed in the logistics management, as smart management of shipping system through networks (Nottboom & Rodrigue, 2008). There are at least three dimensions of the global shift in economic activity, relevant to the economic environment of shipping and ports:

- Growing international economic interdependence
- Growing role of manufactured goods in exports
- Shifts in port activities

With increasing international economic interdependence, ports can develop through either horizontal systems or by integration into a vertical system. The port is part of a global distribution chain which needs a higher degree of coordination and cooperation to be successful. The port needs alliances along the international logistics system (Sletmo, 1999) which facilitate more efficient and effective flows of physical goods or services. Integrated chain maximizes the performance of the entire chain as the whole is greater than the sum of its parts (Christopher, 2010). For achieving supply chain integration, actors should cooperate and coordinate with each other to reach a mutually accepted outcome (Yildrim & Deveci, 2016). Entities act with greater vertical and horizontal integration, increasing concentration with more complex functions, changing from the segmented to an integrated transport (Cortil et al, 2016).

### **Third: Inter-Organization Information Systems (IOIS)**

Kumar and van Dissell (1996) argue that inter-organizational information systems (IOIS) constitute the essential infrastructure of strategic alliances (Monge et al, 1998). IOIS is a group of two or more organizations linked by a computer, telecommunications and agreed standards (Vukmirovic et al, 2013). Haiwook (2001) defined (IOIS) as a "collection of IT resources, including communications networks, hardware, IT applications, standards for data transmission, and human skills and experiences. It provides a framework for electronic cooperation between businesses by allowing the processing, sharing and communication of information" (Haiwook, 2001). IOIS is an extranet used by two ends of the supply chain; the customers interact with company employees and with business partners as suppliers and logistic companies (essay UK, 2017). IOIS enhance the competitiveness of a firm as well as the competitive position of the organizations' network connected through the system, both vertically and horizontally linked organizations. IOIS provide services covered by two inter-organizational systems for example; Portbase system in port of Rotterdam facilitates communication of business community with port authority and with customs. Hong Kong Oneport system enables communication between business community and port authority while Tradelink system assists the link between business and customs (Romochkina, 2011). IOIS enable the development of organizational capabilities to support strategic goals of integration. Literature found that IOIS increase information sharing, improve coordination, minimize risk, and reduce transaction costs (Nicolaou, 2011). All shipping portals support vertical links between freight forwarders or shippers. The customer can submit the order and instructions via the system and track the shipment status. Shippers and

freight forwarders use network connection, as well as web-based tool or a computer based software to create shipping documents and bookings (Romochkina, 2011).

#### **Fourth: Economic Impacts of IOIS**

**Economic Growth:** as discussed by Marshall 2004, innovation contributes to economic growth through providing new institutional frameworks and practices. Innovation doesn't depend any longer on how firms perform on individual basis but on how they work in inter-organizational relationships (IOR) and inter-organizational information systems (IOIS) (Marshall, 2004). Firms have to continually be innovative through investing resources in research and development for collaborations and inter-firm networks. Bellussi, 2004 states "if ICT adoption and implementation are aimed at reinforcing intra-cluster and inter-organizational relationships then they contribute towards integration of the economic actors operating along global supply chains" (Mindila et al, 2008).

**Economies of Scope:** is a lower average cost by offering multiple complementary services. Through IOR and IOIS companies are able to cope with lower freight rates, and the problems of excess capacity through integration. If shipping companies are not able to use ships, entry in different markets along the supply chain is the solution as the company will replace the low demand in business area with other services and activities (Dragomir, 2011).

**Economies of scale:** IOR and IOIS cause economies of scale because of diversity and spreading of fixed costs; which increase productivity of variable inputs, as a consequence of specialization; joint purchases, marketing, and R&D (Van de Voorde & Vanelslander, 2009). Economic theory justifies integration for sake of efficiency, since it creates benefits for both providers and recipients of services, as it is reducing cost and time and benefits all agents (Corti et al, 2016).

**Reduction of transaction cost:** Transaction costs include the expenses of searching and getting information, cost of establishing, monitoring and enforcing the implementation of contract (Rossignoli, 2015). IOIS expected to minimize transaction costs, reduce operational time for goods or cargo handling, ensure security and service quality standards (OECD, 2011). Minimization of transaction costs due to alliances because of information acquisition, and lower capital investment (Panayides & Wiedmer, 2011).

**Operational Efficiency:** IOIS increase frequency of services, vessel planning and coordination on a global scale (Panayides & Wiedmer, 2011). Reduction of congestion in ports, since vessels are coupled and shared together. Reduction of the risk of empty containers, as the load is divided between the members of the alliance (Notteboom, 2004). IOIS offers customers option of buying more services from a single provider, cargo handling activities as well as hinterland delivery can be obtained from the same service provider (Dragomir, 2011).

**Higher market share:** IOIS enhance higher frequency, flexibility, reliability, network expansion and offer greater variety of routes and destinations. Higher market share gained by taking part in a multi-company giant alliance rather than functioning alone (Cariou, 2000), which, enhances competitive position (Van de Voorde & Vanelslander, 2009), wider geographical scope, increase in purchasing power (Panayides & Wiedmer, 2011). Larger market is served, and the consumer network is expanded, as new and attractive products can be offered (Harrigan, 1985) through providing door-to-door services (Frémont, 2008).

**Information Availability:** IOIS enhance information visibility and supply chain flexibility (Irina Romochkina, 2011). Increase the amount of vertical interactions between the companies and increase the amount of information available in the distribution channel, facilitating the development of more efficient coordination structures (Clemons and Row, 1993). Integrated IT infrastructures enable firms to develop better supply chain process integration. This allows firms to share information with their supply chain partners to create information-based approaches for superior demand planning, and for the movement of physical products (Patnayakuni et al., 2006).

**Risk sharing:** IOR and IOIS cause share of financial risks, resources and all types of risks (Dragomir, 2011). Lead to profit maximization, and increase in shareholder wealth (Panayides & Wiedmer, 2011).

#### Fifth: Key Performance Indicators of Ports Technology

As found by the project of European Regional Development Fund the main key performance indicators (KPIs) of ports technology are:

- **Wireless and wire line communications:** ports are relying more on wireless technologies to enhance the flexibility of operations and improve efficiency, as wireless connections can achieve significant cost savings and faster operations.
- **Radio Frequency Identification RFID:** for identification and tracking of assets, processes automatization, improvement of operational productivity and equipment utilization and safety of people, assets and containers.
- **Optical character recognition OCR:** for asset identification and process automation in ports and terminals. It enables automated 'hands free' identification and locating of assets, as well as recording of an object's visual condition. It also provides a device less method of identification, without requiring the application of any tag or device.
- **Global Navigation Satellite System GNSS:** the backbone of traffic management and modernization at seaport container terminals. One of the most important properties of GNSS-enabled systems is the ability of tracking container arrivals and their docking at the terminal.
- **Terminal operation systems TOS:** are key part of the supply chain aim at controlling the movement and storage of various types of cargo in and around a container terminal or port.
- **Port Community System PCS:** facilitate more efficient movement of cargo across international borders. Facilitating the most efficient movement of goods, allowing Customs and other government departments to maintain effective controls. It reduce the overall amount of clerical work by providing some means of capturing information at once and allowing controlled access by all appropriate members of the port community.
- **Logistics Collaborative Systems and B2B systems:** private companies, shipping lines, terminal operating companies, forwarders, hinterland transport providers, and inland terminal operators are involved in hinterland transport. The integration of different companies back-end applications with each other to enable data exchange (European Union, 2015).

#### Sixth: Port Community Systems

The main IOIS in ports that is common for all port clusters is Port Community System PCS which is very important for efficiency and competitiveness of ports due to providing effective communications among port users. The increased growth in international trade needs a faster movement of goods which require a faster authorization and clearance procedures, which lead to substitution of electronic communication instead of paper. PCS requires a strong relationship between customs and other public and private organizations. A PCS system can be defined as an information hub that integrates a heterogeneous collective of port-related actors electronically into a global transportation network in order to enable the efficient exchange of relevant logistics information to ensure the smooth flow of shipments from cargo origin to destination, reducing personnel and paper work, harmonization and automation of the port-related systems.

PCSs focus on automating and integrating information flows for smoothing and improving the physical flow of goods (Srour, 2008). Connecting the multiple systems operated by a variety of organizations, the interacting stakeholders and authorities entities include customs, port authorities, importers, exporters, railway operators, quay operators, maritime police, ship owners, veterinary office, port health, and terminals, providing the required B2A (Business to Administration) and G2A (Government to Administration) transactions from existing B2B transactions. The transactions supported by PCS include:

- Cargo declaration
- Central Help Desk
- Creation and printing of all current versions of Single Administrative Documents
- Customs clearance procedures
- Dangerous goods notification
- Transshipment processing
- Vehicle booking
- Transportation and process of containers operations as; Transport orders and clearances, comparison and calculation of tariffs, calculation of distances for road and rail, freight and vessels taxes declaration.
- Railway operations as receive and process waybills, transport orders, status information, maritime statistical declarations, organization of hold and examination facilities for Government agencies (European Commission, 2014).

### **PCS of The port of Rotterdam**

In Rotterdam, coordination and the exchange of information take place efficiently and easily via the Port Community System (PCS) of Port base which was created by a merger between Rotterdam's Port info link established in 2002 and Amsterdam's PortNET established in 2000. The PCS of Portbase now covers nearly all of the Dutch ports, aiming to make the logistics chains of the Dutch ports attractive by offering a one-stop-shop for logistic information exchange. All services merged into a single system offering more than 40 services cover all links in the logistics chain which increase efficiency, lower costs, better and transparent planning, faster handling, fewer errors, faster throughput times, fewer mistakes and optimal re-use of information.

PCS focus on all port sectors; containers, break bulk, dry bulk and liquid bulk. All the links in the logistics chain can easily and efficiently exchange information through these services. All the necessary information exchange regarding transport now runs efficiently through a single hub. Problems with Customs are avoided in advance as 95% of customs documents relating to export containers can now be dealt electronically, it is not necessary to stop at the terminal to submit documents. Exporters and freight forwarders send pre-notification of the documents electronically via the Port base service Notification Export Documentation. The documents will then be released automatically when the container arrives at the terminal. (Rotterdam web site, visited in February 2017).

### **Port of Singapore IOIS**

Singapore consider one of the most modern and efficient ports in the world, used its resources, expertise, skills, organizations, (Welsh, 2009), artificial intelligence and state of art information, equipment technologies and expert systems (Toh, Phang & Khan, 1995) to build a port of high productivity, efficiency and global presence (Welsh, 2009). Port of Singapore Authority (PSA) uses the most advanced information technology.

- **Computer Integrated Terminal System (CITOS):** a program integrates main operations and supports all planning requirements such as berth allocation, ship and rail planning and resource allocation. The system keeps track of all activities related to terminal operations and movements in yard as well as regulation of gate operations, equipment maintenance, performance reporting, invoicing, and container number recognition.
- **Computer Integrated Conventional Operations System (CICOS):** manage operations of break bulk terminal.
- **PORTNET** a web based IT software and a community network (Welsh, 2009). PSA offers integrated services to shipping lines, freight forwarders, shippers, and local government agencies through Portent, via Internet. The system enables the following services:
  - Online ordering of berth application

- Online ordering of yard crane booking
- Online ordering of pilot or tug
- Tracking the location and status of cargo
- Regulatory documentation such as electronic delivery order (EDO)
- Container store and release orders
- Subcontract functions
- Government permits applications
- Financial functions such as online charges and billing
- Easy access of data such as detailed schedules, ship planning data, reefer containers temperature, and dangerous goods containers condition
- Online connection with custom services supplied through Trade net (Kim et al, 2006).

### **OnePort Hong Kong**

In February 2003, OnePort Limited has been founded to strengthen the competitiveness of Hong Kong as a logistics hub through provision of information and related services. It serves the port community by providing electronic services tailored to operational needs and facilitates collaboration of various groups of port users by connecting and helping them attune their complex operations processes. OnePort's EDI center connects three major Hong Kong container terminals, a vast majority of shipping lines and a considerable number of freight forwarders. In 2015, it supported a substantial number of registered customers including all Hong Kong container terminals, over 100 shipping lines, 24,000 shippers & freight forwarders, over 4,000 trucking companies and about 300 barge operators. The available service includes the following:

- **Booking Solutions:** begins with an appointment submission, followed by an application approval, an appointment confirmation and a notification. Including berthing requests and container declaration system and empty appointment system. Shippers benefit from obtaining the container and seal numbers in advance for cargo declaration.
- **Information Delivery System Solutions:** deliver timely information to users and enables logistics community users to process and transmit information in an efficient manner. Includes Electronic Terminal Receipt System, Terminal Zone Tracking System. Operating efficiency is ultimately enhanced as users are enabled to monitor container status during the import/export cycle.
- **Billing and Payment System Solutions:** the system serves as a payment collector and a central clearing agent. It enables terminals to collect payments of port security charge from over ten thousands port users. Consolidated bill for business customers which covers fees charged for multiple services which benefits business customers by minimizing their administrative works.
- **Data Integration and Interchange Solutions:** The solution provides enterprises and their respective logistics partners with a cost-saving strategy to achieve efficiency in the long run.
- **Fleet Management Solutions:** enables users to oversee fleet operation and monitor overall performance on real-time basis. Efficiency is boosted through optimizing trip arrangements and minimizing wasted trips (oneport.com, visited march 2017).

### **Seventh: Port Technologies in Egypt**

This section will study Egypt maritime inter-organizational information systems as found from secondary data that according to World Bank Egypt stands at 168th of 190 economies in ease of trading across borders globally as the time to import needs 240 hours while it needs only 121 hours in MENA region and 9 hours in OECD high income countries (World Bank, 2017). Ports and custom operations in Egypt are facing several challenges as delays in the clearance of goods due to bureaucratic processes which affect negatively ports efficiency which requires an inter-organizational system between ports and customs as it face delays due to manual processing of clearance.

The analysis carried through structured interviews with three main ports and questionnaire emailed to random sample of 200 logistics and transport companies and structured interviews with experts in logistics and transport companies which considered a pilot test for the questionnaire. Only 25% of the emailed companies have responded. The questionnaire combined of five sections.

### **Factors Hindering Gateway Projects and trade flows**

The analysis found that almost 83% of the responders chosen that the most hindering factors to gateway projects and trade flows are misplaced objectives, cumbersome customs procedures, incompetitiveness of ports facilities followed by institutional bottlenecks and political interference. At port level all interviewed ports found that the main hindering factors are institutional bottlenecks, political inference, cumbersome customs procedures, bribery and corruption, numerous trade regulations and requirements, low level of competence among trade official human resources and physical cargo inspection.

### **Required Improvement and Investment**

The analysis found that almost 85% of the responders chosen that the most factors require improvement and investment are improvement of railway, training of ports human resources, training of officials and stakeholders, modernization of cargo clearance information system, automation of custom clearance procedures, institutional reforms, port dwell time reduction and improvement of ports facilities.

At port level the most improvement required are improvement of roads and railways, training of officials and stakeholders, institutional reforms, automation of custom clearance procedures and modernization of cargo clearance information system.

### **Required Improvement of Information Systems in Ports**

The analysis found that almost 95% of the responders chosen that the most systems need improvement in Egyptian ports are vessel notifications, entry and exit customs declaration, transit documents, and integral track and trace followed by shipping instructions, export and import manifests, pre-load information, load confirmation, and discharge documentation.

At port level the systems needs modernization and improvement is entry and exit customs declaration, export and import manifests and discharge documentation. All ports facing same problem they can't reach Port single window PSW because of Department of Customs, which operates under the Ministry of Finance, responsible for clearing merchandise into Egypt as they refuse to be a part of the port integrated information system.

### **Expected Impacts of Information system in ports**

The analysis found that almost 91% of the respondents companies as well as interviewed ports expect that if the previous improvements taken place this will increase the rate of cargo clearance, make custom clearance procedures less cumbersome, increase volume of trade, and reduction of cost of doing business which will lead to facilitation of IOIS towards higher economic growth .

### **Evaluation of Technologies in Egyptian ports**

Evaluating available technologies in Egyptian ports according to the KPIs mentioned in the fifth section of the paper the analysis found that Egyptian ports have developed technologically as shown from the table. Technologies improvement required as:

- Applying GNSS for tracking container arrivals and their docking at the terminal which will allow integral track and trace and vessel notifications.
- A strong relationship between customs and other public and private organizations should be established to be able to apply successful PCS and TOS.
- Wireless communication should be available for ports' customers to facilitate flexibility and faster operations and higher port operations efficiency.

- RFID should be implemented for processes automatization, improvement of operational productivity.
- OCR for automated identification and locating of assets.

Technology	Available	Not Available
Wireless and wireline communication	available for port staff not customers	
Radio Frequency Identification RFID	Available in some ports	
Optical character recognition OCR		NO
Global Navigation Satellite System GNSS		NO
Terminal operation systems TOS	Yes (EDI)	
Port Community System PCS	Yes (EDI not complete PCS)	
Business To Business B2B systems	Yes	
Business To Government B2G systems	Yes	
Government To Government G2G systems	Yes	
Government To Business G2B systems	Yes	

#### **Technologies Available at Egyptian Ports studied**

Source: Collected by researcher from ports officials

#### **Discussions and Conclusions**

Based on the current study and literature, applying and continuous upgrading of information systems is required for economic growth as seen IOIS is a must for maritime integration which is needed for facilitation of international trade and economic growth which requires:

- Coordination between public and private community members to invest in the new system
- Upgrade port personnel language and technical skills including ICT skills as well as understanding of new technologies to be able to use the IOIS efficiently

The analysis found that Egyptian ports went through much port modernization but the obstacle towards port single window is complete automation of customs procedures which requires cooperation between ministry of finance and ministry of transport towards facilitation of electronic customs procedure includes:

- Electronic submission of manifests and entries
- Payment of duties online
- Sharing of files by custom officials through the system
- Transferring of electronic messages between Customs and Importers

#### **Research Limitation**

Research is limited for analysis of the current situation and recommendations further research is needed to design the future upgraded integrated information system in ports.

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