TRANSPORT CAPACITY ALLOCATION IN ALEXANDRIA PORT, EGYPT, USING BUSINESS PROCESS RE-ENGINEERING

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ABSTRACT

Transportation capacity shortage at seaports is one of the most significant key problems that decision makers face in today's maritime ports, which may cause supply chain management (SCM) failure. Applying business process reengineering (BPR) to get the best allocation of capacity resources may help in solving this problem. This paper aims to optimize a solution to the transport capacity shortage problem of a seaport by using a Solver technique, taking into consideration the capacity allocation of the exports and imports at the port. The proposed technique is applied to data from a real case study of Egypt's Alexandria port, in which the overall supply chain management performance is measured by considering the suitability of BPR. The computational results show the effectiveness of the proposed technique for finding one of the best scenarios for the capacity allocation of the exports and imports, especially two types of goods which have allocation priority: dry bulk goods (imports) and container goods (exports).

***Keywords**: Transportation capacity shortage, Business Process Re-engineering (BPR), Supply Chain Management (SCM), Solver technique, Alexandria port*

บทคัดย่อ

การขาดแคลนความสามารถในการขนส่งถือเป็นประเด็นปัญหาที่สำคัญสำหรับท่าเรือซึ่งอาจก่อให้เกิดความล้มเหลวในโซ่อุปทาน บทความนี้นำหลักการ BPR เข้ามาใช้เพื่อจัดสรรทรัพยากรให้เหมาะสม โดยการใช้เทคนิค Solver ช่วยจัดสรรความสามารถที่มีกับการนำเข้าและส่งออกที่ท่าเรือ วิธีการนี้ดัดแปลงใช้กับข้อมูล ที่ได้จากกรณีศึกษาของท่าเรืออเล็กซานเดรีย ประเทศอียิปต์ ซึ่งใช้ BPR ช่วยในการวัดผลการจัดการโซ่อุปทาน ผลการคำนวณแสดงถึงประสิทธิผลของเทคนิคดังกล่าวในการหาแผนที่ดีที่สุดเพื่อจัดสรรทรัพยากรในการส่งออกและนำเข้าโดยเฉพาะอย่างยิ่งกับสินค้า 2 ประเภท คือ สินค้านำเข้าที่เป็นของแห้งและสินค้าที่ส่งออกไปกับตู้คอนเทนเนอร์

INTRODUCTION

Practically, the efficiency of global businesses relies deeply on the efficiency of their global supply chains, especially in the maritime transport field (Hieber, 2002). Moreover, the increasing significance of the role of seaports in the supply

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chain is making the port a key pillar of adding value for both the stakeholders involved in the process of the port supply chain and generally for its country where the port operates (Song and Parola, 2015). The port, as a logistics node, includes many actors who are sharing many resources and activities and interact together as the basis of a value co-creation process (Botti *et al.*, 2017a).

Traditionally, indicators of efficiency and performance of ports are usually related to the sea, rather than giving adequate importance to landside connections. Today, the activities of ports are generally related more to transportation capacity in terms of exports and imports, the productivity of the overall loading of cargo and the whole series of the production function (Botti *et al.*, 2017b). Capacity shortage has many drawbacks such as an increase in the transit time to transport the containers, which will increase the chance of spoiling goods (e.g. fresh goods) in addition to an increase in cargo handling costs. Also, capacity shortage increases the costs for port users (i.e. shippers, truckers etc.) compared to other ports in the competitive open market. In sum, capacity shortage makes the transportation costs higher than usual and other ports may take better chances and be more competitive and cheaper. All of these problems may cause a failure in the transport supply chain (Islam and Oslen, 2011).

Hence, it is essential to overcome any problems or shortages in transportation capacity through applying proper approaches or techniques. One of these successful approaches is Business Process Re-engineering (BPR) which refers to an efficient and effective change in the manner in which work is performed. It emphasizes radical changes in business structures and processes which need extensive changes in the organizational, technological and human aspects in such businesses. Moreover, it provides more flexibility to conduct business and supports quick transactions that enhance earlier services' delivery with better quality (Zigiaris, 2000).

Business Process Re-engineering

Business Process Re-engineering (BPR) aims to achieve crucial improvements in business performance through radical change in organizational and management processes. It brings about essential restructuring of jobs, responsibilities, and skills through applying physical, mathematical, computer or structural models in order to predict the performance or to understand the behavior of devices used (Zigiaris, 2000). The idea behind BPR is that in the current turbulent business environment, the major challenge for managers is to eliminate non-value adding work rather than implementing advanced technology for automating it. Hence, the fundamental reconsideration and radical redesign of the organizational process - considering that the current one is no longer relevant – has become an essential element in achieving distinguished improvement of performance in terms of cost, quality and speed.

There are many different methods and approaches for implementing BPR as it is difficult to identify a single approach precisely matched to a specific business's needs. Therefore, the main challenge is to determine what method to use when and how to apply it appropriately (Bahramnejad *et al.*, 2015). Generally, BPR is required urgently in the following two cases (MSG, 2017):

1. More advanced methodology is discovered which will drastically reform its processes to be more productive and efficient and consequently the whole process needs to be changed.
2. When it is the only way to save a business which has failed to cope with the recent technologies, and essentially, BPR has to be applied to aid in integrating the best practices into the processes.

Actually, there are six main steps for BPR to be implemented (Bahramnejad *et al.*, 2015; UN, 2012):

1. *Pre-processing*: this step is applied as a preliminary stage before starting the initial BPR. It aims to find out whether the organization needs to apply BPR, its problems and challenges as well as the readiness of staff to apply it.
2. *Analyzing current processes*: this step shows the current status and how the system really works and its deficiencies.
3. *Selecting processes which need to be reengineered*: after analyzing the current system, this step comes next according to BPR budget and priorities in order to define new business processes analyze and document the required organizational changes.
4. *Redesigning the processes*: in this step the system is designed and tested before implementation.
5. *Implementing BPR*: actual implementation comes after approving the redesigned processes.
6. *Evaluating BPR*: Continuous evaluation i.e. monitoring and control, is an essential element to measure the improvement caused by BPR. After applying BPR, a continuous improvement process is the actual starting point for achieving BPR goals in business.

From these steps, it is concluded that BPR focuses on processes rather than departments, functions, or tasks. It aims at implementing radical changes for the whole process and not just for isolated phases. Second, changes have to be set by top management; this means that successful BPR is fundamentally designed, controlled and supported by a high commitment of the top management team, who are therefore concerned with the continuous improvement process and link it to the strategic goals to maintain competitiveness. Although this is a significant role of top management in applying its principles, BPR must be learned company-wide, and training and education programs have to be implemented to teach employees their responsibilities in the new process design since BPR is people-centered and driven by business needs. It relies heavily on the interaction of the participants who provide value to the redesigned processes according to their understanding and objectives with respect to the culture and social context of an organization. This requires a high degree of communication and evaluation. In conclusion, to implement BPR successfully, both technical and human factors must be taken into consideration as it needs radical changes supported by IT systems and by people who are affected by and participate in such changes. (Chen, 2001; Benito, *et al.*, 1999; Kettinger & Tengm, 1998).

Risks Associated with BPR

As referred to above, although BPR's major gains are reported and it has experienced drastic improvements in terms of cost reduction, time optimization, better service quality and growths in productivity, BPR implementation may be one of the reasons behind SCM failure since it may be subject to different types of serious risks. There are many sources of such risks in implementing (BPR) projects and associating them to SCM, as follows;

- *Financial risks***:** BPR radically change the processes along the supply chain which requires more cost, effort and time. However, it does not necessarily yield the expected results (e.g. returns on investment) which are often intangible and not quantifiable.
- *Technical risks:* BPR depends mainly on IT applications, and it may happen that such applications are either unavailable or their results do not work to as desired.
- *General project risks:* An organization that applies BPR may not have the competence to implement it properly, or the BPR team may not perform to the required level.
- *Functional risks*: Process re-engineering that needs drastic changes in terms of reorganizational plan may not be applicable to the kind of business in which the organization is engaged.

Integration Between SCM and BPR

SCM needs BPR for reorganization purpose, since companies may seek for new ways to respond to any organizational challenge internally or externally. SCM by itself represents a radical transformation from internal functional integration with a traditional logistics system to an external integration with a logistics network which extends either upstream to suppliers or downstream to customers (Wattky and Neubert, 2005). Hence, SCM and BPR are interrelated concepts applied to re-engineering the organization's own processes. Once businesses have integrated their SCM process with the radical changes derived from BPR, the greatest benefits will be achieved.

In other words, a generic model of SCM is enhanced through combining it with BPR characteristics being added to apply essential changes with respect to a continuous search for new ideas of change improvement (Bac and Erkan, 2013; Evans, *et al.*, 1995). Furthermore, integration between BPR and SCM can provide an organization with the most appropriate methods of minimizing inventory and increasing throughput, by pursuing reengineering procedures, managing supply chain processes more effectively, and exploring management of on-going improvement and best practices (Imaoka, 2012).

BPR and Capacity Shortage in Seaports

A seaport is considered as an integrated logistics center which is the main component of the global transport system. It is the key contributor to accomplishing the functions and services necessary for efficient supply chains through its final element that includes the distribution of goods from the places of production to places of consumption. Compared to a logistics center which covers the distribution function only, a seaport covers the transport, logistics, distribution and spatial functions which highlight the main multi-functional role it plays in the transport supply chain (Montwiłł, 2014). Since the seaport is considered to be an important part of a supply chain (Panayides and Song, 2008; Bichou and Gray, 2005; Tongzon and Heng, 2005; Wang and Cullinane, 2006), process reengineering practices can be optimally utilized to widen the services, increase their quality (Hu *et al.*, 2011) and handle many problems related to seaports such as the problems of capacity shortage of terminal management and the container transportation system.

For such purposes, most authors have developed many innovative ideas in order to improve the performance of seaports. For example, Carbone and Martino (2003) suggested a maritime tri-dimensional model based on the supply chain's structure as a series of many parties, key business processes, and links between them. Hence, they consider the port as a group of interrelated entities in which different logistics and transport operators are involved to add value to the final consumers and satisfy their needs. Others emphasized technology as a main pillar of the re-engineering process. There are various cases that illustrate what can be achieved. Choi *et al.* (2006) developed an idea of an automated gate system based on radio-frequency identification (RFID) technology to improve the effectiveness of seaport gate operations. Islam *et al.* (2013) claimed that empty container trucks may cause a severe deficiency in transport capacity and contribute in severe problems such as the crowding level, waiting time, and emissions rate in a port's surrounding area. Their study explored a dynamic truck-sharing facility using a computer-based matching system to assign probable export containers to available empty slots of a container truck. Hence, they emphasized the importance of process re-engineering of the container truck shipping process through a "truck appointment system" which aims to reduce the number of empty-truck trips and increase container transport capacity around seaport gates.

Lyridis *et al.* (2005) applied a Business Process Modeling (BPM) methodology in order to identify the core elements of service quality. To do so, the company operations have first been identified and then analyzed in order to measure the overall performance of service elements, to compare the actual service performance with the user requirements, and recognize the gap between both.

Also, due to high requirements in the logistics sector, such as costs, efficiency, security, and sustainability, seaports are mainly affected by technological change. Ferretti and Schiavone (2016) stated that the Information Technology infrastructure is one of the most important elements in redesigning the business processes. They discussed the usage of the Internet of Things (IoT) in business processes redesign in seaports. IoT is a system which consists of interrelated digital devices that are provided with unique identifiers to transfer data over a network without requiring human interaction.

The results show that the implementation of IoT technologies can improve the performance of all the main business processes of the port. Also, Heilig *et al.* (2017) argued that digital innovation is essential to stay competitive as it can shape the modernization of ports. As one of the BPR initiatives, they provided an extensive analysis of digital transformations in seaports and identified important aspects and challenges to implementation.

Moreover, Islam (2017) simulates the truck-sharing idea in a port and assesses the positive impact of the changes made. The study develops simulation models for the proposed idea of truck sharing in the current context of the truck arrival process in a seaport. The simulation results conclude that the truck-sharing idea improves the port transport capacity and contributes effectively in handling the potential problems arising from increased future truck volume in the port. Consequently, it helps also in reducing emissions released from trucks in the port area.

Transportation capacity shortage is one of the problems currently facing many ports in the world (Paul and Maloni, 2010). If an exporting country sends its containers to an importing country via a seaport which suffers from capacity shortage, then problems of increasing "transit time", cargo handling costs" and "risk of damaging the cargo" will occur. So, capacity shortage causes supply chains to be ineffective in many ways. Moreover, capacity shortage causes a port to increase the price of its service. This, in turn, increases the transport costs for the use of such ports which make them less in demand by shippers (Islam and Oslen, 2013; Dekker, 2005). All these potential drawbacks oblige many port authorities to work on handling it through building new facilities and infrastructure for the container terminals. Brasca (2011) clarifies six steps to overcome transportation capacity shortage**;**

- The main driver of the transportation capacity is customer demand. Hence, concentrating on actual demand signals may help in identifying any obstacles in capacity on time before they impact critically on customer relationships or profits.
- Fully utilizing the existing investments, and maximizing then to their greatest capacity, can help in avoiding transportation higher spending and capacity shortage.
- Continuous assessment of the actual performance of all collaborative trading partners is essential to improve relationships and results, as well as to ensure the right assignment of shipments to the lowest-cost and highest-service carriers.
- Good preparation for facing unexpected capacity issues by running "what if" transportation scenarios together with looking at market trends on a long-term basis.
- Learning from mistakes to enable the business to assess what went wrong in past performance, and applying these lessons in the future. In other words, transportation management must consist of set of standardized processes focused on planning and assessing results then adjusting such plans in real time after taking the most suitable corrective actions.
- Establishing a culture of continuous learning to be able to face sudden capacity shortages, by leveraging new tools and techniques to attack the capacity challenge proactively.

Problem Statement

The capacity shortage at ports is a challengeable problem that requires a complete infrastructure to increase its capacity (Henesey, 2006). Additionally, the current condition of container shipping in many ports is not able to satisfy all demand, although many projects for the construction of new terminals and upgrading handling facilities are being carried out continuously. Therefore, derived from all of these considerations along with the literature review illustrated above, this research has been formulated to address the following problem: *How can the transportation capacity shortage problem be alleviated in maritime transport through Business Process Reengineering?*

Research Objectives

This paper aims to alleviate the transport capacity problem at ports. Accordingly, it has set the following objectives;

(1) it examines the capacity shortage problem by reviewing the literature on the subject of overcoming such capacity problems along with representing different cases of business process reengineering in seaports.

(2) it further investigates the usefulness of applying the business process reengineering concept in dealing with capacity shortage problem in Egypt's Alexandria port as a case study.

(3) ultimately, it aims to add the proposed process to make the maritime transport more robust and integrated with features in the future to overcoming transport capacity shortage in many container terminals, identifying the consequences of such shortage at seaports on the corresponding supply chains. To comprehend these objectives, the following research questions have to be addressed.

- What is the Alexandria port's transport capacity problem?
- By using BPR, what is the best allocation scenario for transport capacity - in terms of imports and exports – to be implemented in Alexandria port?

RESEARCH METHODOLOGY

As a research strategy, a case study in the seaport context is selected because it gives an opportunity to produce a full picture of an identified situation through studying the current status compared to the desired optimal condition. Moreover, the case study approach is appropriate since a holistic and in-depth investigation is needed (El-Miligy, 2013; Tellis, 1997) to focus on the capacity shortage problem in Alexandria port.

This enables the researcher to determine the missing parts which, when realized through applying BPR - in terms of the Solver technique- change the actual condition into an optimal one, focusing on understanding the dynamic present within a single setting (Wu, 2007).

A solver tool (what-if analysis) has been applied in this paper as it helps solve linear and non-linear optimization problems, allows integer or binary restrictions to be placed on decision variables, and can be used to solve problems with up to 200 decision variables. Also, the Solver tool provides three algorithms or solving methods in the Solver Parameters including; Generalized Reduced Gradient (GRG) Non-linear, linear Simplex, and Evolutionary for non-smooth problems.

Alexandria Port

Alexandria port is considered the main gateway for Egypt's imports and exports since it represents about 60% of Egypt's foreign trade. It aims to foster and stimulate the waterborne commerce and shipment of freight through its docking and cargo handling/storage facilities. Also, Alexandria port contributes to tourism's promotion through its provision of appropriate arrival and departure facilities for cruise ship passengers to Alexandria. Moreover, it promotes and facilitates the global maritime trade and imports by sea, especially with European countries, through providing competitive port services and enhancing the port capacity to meet customers' future needs. However, its performance needs more improvements in facilities and services to cope with the turbulent competition worldwide. Accordingly, the port authority has started to enhance the efficiency of the port in accordance with the international criteria (APA, 2017)*.

Business Process Reengineering at Alexandria Port

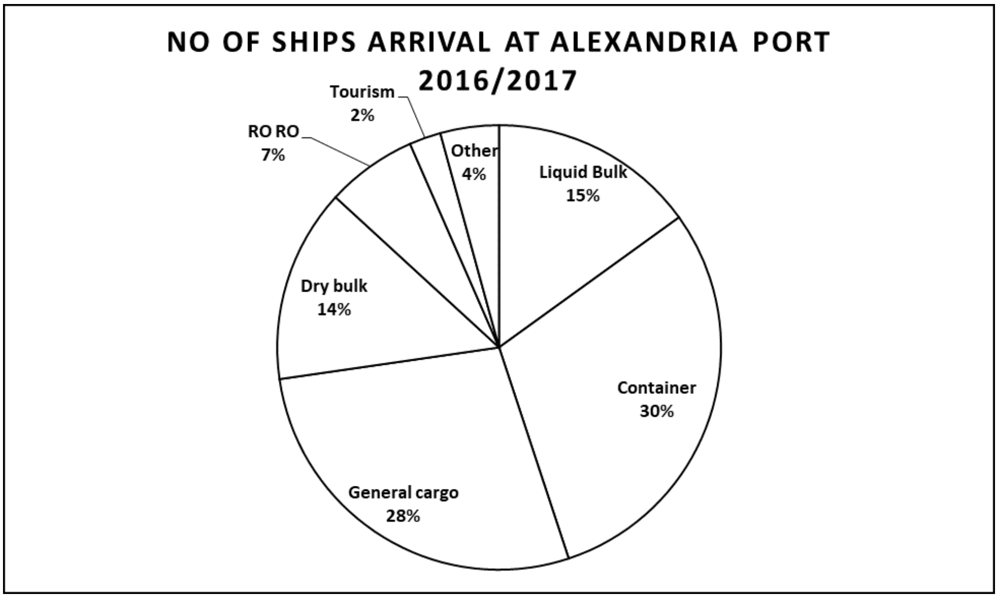
In 1999, the Egyptian government had invested for the full automation of state-of-the-art at its ports. From the business process reengineering perspective, the government commenced with Sokhna port, the first PPP port, covering all the Information and Communication Technology (ICT) facilities within the port area including the network and security infrastructure, radio communications and process workflow, in addition to advanced information systems. The purpose was to provide innovative, reliable, and high-quality solutions for governmental organizations as well as enterprise customers.

This process reengineering aims generally to afford executing solutions for the portfolio of products and services at different layers, from physical security, data centers construction and operations, to enterprise resource management and process reengineering. Since approximately 55% of the total number of ships incoming to the Egyptian ports on the Mediterranean passes through Alexandria port, the Egyptian government was stimulated to work on developing this port through applying key management concepts such as BPR. Here, BPR helps in analyzing business information to produce smarter decisions. It is applied within an overall strategy for developing Alexandria port to cope with the revolution in port management witnessed worldwide (El-Miligy, 2013).

Recently, the Alexandria Port Authority (APA) has started to develop and implement a new system (PORT IV) for the Port's operations. The business software helps companies aspire to become more agile. However, the Alexandria port is still facing a challenge in terms of how the transportation capacities shortages can take place in maritime transport.

In this paper, the Solver technique has been applied to allocate the transportation capacities in Alexandria port. In order to find the best scenario for the transport capacity allocation, there is a need to understand the flow of cargo at Alexandria Port. The following figure displays the flow of cargo in the year 2016/2017.

Figure 1: Number of Arrival Ships at Alexandria Port in 2016/2017



Source: Alexandria Port Authority

The following Table shows also the total tones handled at Alexandria Port for both imports and exports in the same years 2016/2017. It is clear that the total quantity of containers handled is greater than the other types of goods for both exports and imports. In addition, the Table shows that total imports constitute about 80.3% of total volumes handled, while the exports constitute about 19.7%.

Table 1: Total Tones Handled at Alexandria Port 2016/2017

Type of Goods	Imports	Exports	Total	% of Total Cargo
Non-containerized				
General Cargo	4789952	1371143	6161095	11.65037706
Dry Bulk	21709773	1333016	23042789	43.5729656
Liquid Bulk	7527325	2426912	9954237	18.82305247
Containerized	8426724	5298379	13725103	25.95360487
Total	**42453774**	**10429450**	**52883224**	**100**

Source: Alexandria Port Authority

Regarding the available warehousing capacities available at Alexandria Port, which constitutes about 544770.3 m_2, it is evident that the port is facing a transport capacity problem as the port can handle one million TEUs for containers and 37.9 million tonnes for other types of cargo in the year 2018. By using Solver technique to find one of the best scenarios for the capacity allocation of the exports and imports at the port, the Solver result for the maximum total of allocation that is 665,104 tones, as displayed in the following Solver report (Table 2). Also, it is evident that the largest two types of goods which have priority to be allocated, as a Solver result, are the dry bulk (imports) and the container (exports).

Table 2: Solver Results Report

Objective Cell (Max)					
Cell	**Name**	**Original Value**	**Final Value**		
$E$27	Total Tones Imports (Tones)	665,104.00	665,104.00		
Variable Cells					
Cell	**Name**	**Original Value**	**Final Value**	**Integer**	
$E$19	General Cargo Imports (Tones)	0	0	Contin	
$F$19	General Cargo Exports (Tones)	0	0	Contin	
$E$20	Dry Bulk Imports (Tones)	544770.3	544770.3	Contin	
$F$20	Dry Bulk Exports (Tones)	0	0	Contin	
$E$21	Liquid Bulk Imports (Tones)	0	0	Contin	
$F$21	Liquid Bulk Exports (Tones)	0	0	Contin	
$E$22	Containers Imports (Tones)	0	0	Contin	
$F$22	Containers Exports (Tones)	544770.3	544770.3	Contin	
Constraints					
Cell	**Name**	**Cell Value**	**Formula**	**Status**	**Slack**
$E$23	Total Imports (Tones)	544770.3	$E$23<=$E$24	Binding	0
$F$23	Total Exports (Tones)	544770.3	$F$23<=$F$24	Binding	0

Source: the authors

This may justify an increase in the containerized goods (exports/volumes) in recent years by 10% and also it can justify a decrease in the containerized goods (imports/number of containers) by 7%. In addition, the Solver Slack shows that there is no available space for any future intention to maximize more volumes of cargoes. There is a high need to extend the warehousing spaces as well as transport capacity infrastructure at Alexandria port in the future.

CONCLUSION

Essentially, the transportation capacity of a seaport ensures both efficiency and effectiveness of maritime transport supply chains as it directly affects the flow of goods (imports and exports). Hence, in order to avoid its supply chain management failure, the current status of Alexandria port is analyzed, and radical changes derived from BRP for any capacity shortages have to take place to identify the best scenario for capacity allocation of goods at the port.

Recommendations

Actually, it is never enough to measure numerical performance of the capacity shortage to avoid supply chain management failure and to maintain the alignment between the supply chain’s design and the ports' changing needs. It is essential to determine the root causes of any shortages in order to ensure that the same problems will not occur in the future. In other words, with a better understanding of why this capacity shortage occurred, planning becomes possible, keeping a business on top of the problem. Hence, to explore the capacity shortage problem, business process re-engineering along with other innovative tools and proactive processes have to be applied in order to reach more valid decisions and have better sound foundations, to gain meaningful advantage over competitors and to avoid supply chain management failure. Moreover, for ports to be successful it is essential to calculate the predicted customer needs along with developing the port's facilities throughout an integrated institutional framework which encourages collective actions in the port community.

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