Investigating the effect of terminals' service attributes on attracting shipping lines: a stated choice approach

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1. ABSTRACT: Container terminals in the Mediterranean region have a high competition level between them to achieve a greater share of the regional seaborne trade volume. The national container companies in Egypt face low performance and productivity issues because liners prefer other ports/terminals in the East Mediterranean. One reason for this problem is due to policy makers' belief that spending much money on terminal infra- and super-structure is the best practice for attracting more shippers. However, terminal capital investments and yearly maintenance costs are substantial and may not be useful if other factors control port/terminal choice from a shipping company's point of view.

Recently, the Egyptian Maritime Transport Sector went through a number of new projects through the construction of quay walls, yards, and terminals in various Egyptian ports such as Alexandria, Abu Kir, and El-Sokhna in attempt to improve the available freight capacity (i.e. supply)Nevertheless, and as long as shippers insist on choosing a specific port/terminal, such new improvements may not reap their intended benefits.

This research investigates the important factors that control shipping liners decisions when selecting a container terminal by using a custom-made instrument design. Two data collection methods are used; namely, Revealed Preference (RP) and Stated Preference (SP) or Stated Choice (SC). Then, discrete choice models of terminal switching behavior will be used to help policy makers prescribe efficient strategies to alter shipping lines decisions and ensure that each port/container terminal has a fair market share. However, this paper reports only on the first part, while the latter is still work in progress.

The preliminary data analysis showed that port charges and port infrastructure are the most critical factors shipping lines look for when choosing a container terminal. As such, policy makers need to focus on these factors in attempt to promote their terminals and make them more attractive to shipping lines.

Keywords: *Mode Choice, Revealed Preference, Shippers Behaviour, Stated Choice Experiment, Terminal Choice.*

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2. INTRODUCTION

Shipping is the lifeblood of the world economy, without shipping, important intercontinental trade would not be possible. About 80% of world trade volume transported through sea (Fugazza and Hofman, 2017), which makes ports and their hinterlands vital for global trade. Ports are a central and necessary component in facilitating trade. Over the last few decades, container shipping has seen major changes. Liner shipping companies have established globally integrated networks for transporting containers as a result of alliances, mergers, and acquisitions. Trade competitiveness requires governments and key stakeholders to see ports as facilitators of trade and integrators in the logistics supply chain, rather than merely points of cargo loading/unloading.

In addition to enhancing service to shippers, globalization has led to a substantial volume of trade that helped liners to use large vessels and maximize their efficiency. As such, terminal utilization rates are expected to increase over the next few years, putting further pressure on the already congested terminals (Drewry, 2021). Handling volumes will grow by 5% per year between 2020 and 2025, resulting in increasing utilization rates from 67% to over 75%).

In principle, congestion occurs when terminal demand (i.e. cargo volume) exceeds its available capacity (i.e. supply). Other factors contributing to congestion include restricted access to seaports, routine procedures, poor hinterland connectivity, inconsistent government policies, and inability to deal with new technologies (Maneno, 2019).

It has been deeply rooted in planners' minds that spending more on terminal infra and super structure projects is the solution for ending congestion. However, terminal capital investments and yearly maintenance costs are huge and may not bring back their intended benefits. As such, the determination of the extent of integration of container terminals among themselves (horizontal integration), especially if they are owned by the same company, and within the global supply chains (vertical integration) developed as an alternative way to solve congestion (Chen, 2018).

On the one hand, introducing horizontal integration as a business management strategy can aid in keeping up with the dynamic changes of the container market and the service competition (Elsaih and Salem, 2018). Horizontal integration may serve as a solution over resorting to investing unnecessarily in infra- and super-structure, thus; reduces duplication of resources within the integrated terminals as well as lowering costs and increasing economies of scale. Furthermore, it may lead to an increase in market share or even contribute in adding new market segments which consequently increases the terminals' competitiveness (Van de Voorde and Vanelslander, 2010).

On the other hand, vertical integration between terminal operators and shipping lines, for example, increasing port capacity can result in higher market output, consumer surpluses, and fewer delays for the shipping industry. The participation of vertically integrated carriers can increase output at the expense of non-integrating competitors, but research has shown that vertically integrated ports handle a greater volume of cargo and are associated with better infrastructure and equipment utilization. (Álvarez-SanJaime, et al., 2013).

Moreover, and perhaps in the Egyptian context where terminal congestion might not be an issue, given the unprecedented expansion taking place in the supply side (i.e. terminal infra- and super-structure) nationwide, integration will help optimize terminals performance and national market share through transforming the system from a state of "Terminal Equilibrium" in which each terminal performs selfishly (i.e. work against other national terminals to maximize its individual market share on the expense of the others) to a state of "System Optimum" in which terminals deliberately perform in such a way that maximizes their collective market share regardless the fact that individual terminals might experience lower market shares than what they may attain if they perform selfishly. The main drawback in the state of Terminal Equilibrium is that the collective market share of national terminals is not maximized and, hence, the so-called Price of Anarchy is paid. On the other hand, the state of System Optimum is an efficient system-wide approach.

To contribute to this issue, this research investigates the effect of container terminal's service attributes on attracting shipping lines though a tailor-made survey to address customers' preferences and choices. Then, discrete choice models of terminal switching behavior developed to help policy makers prescribe efficient strategies to alter customer decisions and ensure that each port/container terminal has a fair market share based on the integration of existing capacity. However, this paper reports only on the first, while the latter is still work in progress.

The research focus on the national container companies operating under the supervision of the Holding Company for Maritime and Land Transport (HCMLT), following the Egyptian government, in four main ports over the Mediterranean Sea (Alexandria Port, El-Dekheila Port, Damietta Port, and Port Said Port).

The rest of this paper is presented as follows: Section 3 provides a literature review through previous studies that discussed port/terminal choice models and the factors (i.e. service attributes) that controls the choice of a specific port/terminal from the viewpoint of customers (e.g. shipping lines, cargo owners, etc.), to figure out which factors play the major role in the process. Section 4 and Section 5 discuss the methods used in this research, mainly data collection, survey instrument design, and choice modelling. Section 6 reports on survey design, implementation, and preliminary results. Finally, Section 7 concludes the work done in this paper and gives an overview of next steps.

3. LITERATURE REVIEW

A few studies are published on port competition in Latin America and Africa (Lobo, et al., 2021). Selecting a port of call by shippers and carriers, from a set of several options, is not an easy task. For ports, each element in supply chains has to achieve the highest efficiency in order to compete (Cepolina and Ghiara, 2013).

The reoccurring change in requirements and priorities created a major concern of losing customers amongst Port Authorities (PAs) (Mittal and McClung, 2016). Therefore, PAs are required to understand the factors that play have the greatest effect on the port users' selection process, to stay at the forefront (Tiwari et al., 2003). Different stakeholders that are engaged in the supply chain, are also involved in the selection of the port based on multiple factors (Martínez-Pardo et al., 2020).

The factors impacting a shipper's port choice decision were investigated by Tiwari et al. (2003). The investigation results showed that shipper's distance from the port, the number of ship calls at the port for example (the number of scheduled stops by ships, which determines the value of cargo that can be moved within that port), the efficiency of port infrastructure, and the routes counts offered at the port, have the priority over other factors.

Blonigen and Wilson (2006) developed a port choice model. The study estimated the effect of efficiency of ports, internal transport systems and transport rates through ocean the data used in this estimation were retrieved from sample data on trade volumes between United States of America ports and several foreign countries from 1991 to 2003, economical factors have the highest impact over the shippers choices this presented and supported by strong evidence in the study. The study confirmed the importance of port's efficiency, distance and transport prices.

Through using revealed and stated preference approaches, Tongzon and Sawant (2007), determined liners port choice factors, used on South East Asia selected ports through a survey tool. They found port dues and range of port services to be highest two important factors, port location third most important, and infrastructure came fourth.

Chinonye et al. (2006) determined the characteristics that shippers consider the most while selecting a port. Based on a survey and analytic hierarchy process tool, the study prioritized the characteristics according to their importance. For the analysis, four ports were identified and seven port selection decision criteria. The study found that shippers consider efficiency, frequency of ship stay at port, and infrastructure in their decision-making process before taking into account the quick response time to port users' needs.

While useful, none of the previous studies have looked into the specificities of the Egyptian context. Egypt is located in the North East of Africa (bordered by the Mediterranean Sea to the North and the Red Sea to the East) and has the most important navigation channel in the world (The Suez Canal) that facilitates the transit of global trade. Egypt has 15 commercial ports (six overlook the Mediterranean and nine overlook the Red Sea). Furthermore, the Holding Company for Maritime and Land Transport (HCMLT) has three container and cargo handling companies operating through four container terminals in Alexandria, El-Dekheila, Damietta, and West Port Said ports. The three companies (and the ports they operate at) face numerous challenges that affect their performance. Accordingly, none of the national container terminals is among the Top 50 World Container Ports since 2011 despite the blend that Egyptian ports enjoy. In recent years, other competing ports in the East Mediterranean were among that list (e.g. Port of Piraeus in Greece and Port of Marsaxlokk in Malta).

In attempt to obtain a larger share of sea trade volume, Egyptian Maritime Transport Sector has recently gone through the construction of a number of new projects to increase the offered capacity (i.e. supply); but knowing that many factors other than the availability of capacity may affect the terminal choice behaviour of shipping lines, these projects might not achieve their intended target.

As opposed to previous studies and to ensure the optimum use of these projects, this research is concerned with the Egyptian context. An investigation of the determinants of liners' terminal choice behaviour is undertaken using a twofold approach. First, a survey instrument, mainly a Stated Choice (SC) survey, is designed and used to gather information on container terminals' service attributes (e.g. draft, crane gross moves per hour, handling fees, waiting time, etc.) and customers' (e.g. shipping lines, cargo owners, etc.) terminal choice behaviour by means of in-person interviews. Second, the collected dataset used to develop discrete choice models of terminal switching behaviour that will help:

- Understand customers' choice preferences and the trade-offs that carriers/shippers make while choosing a container terminal of call;
- Prioritize container terminals' service attributes by attaching weights to the various factors affecting terminal choice; and
- Forecast customers' choices in response to service attributes and system changes.

Eventually, the developed models will be used to identify the reasons for the low performance of the three national companies and how they could maintain advanced positions among their competitors in the Mediterranean, and among the Top 50 World Container Ports.

4. STATED CHOICE EXPERIMENT DESIGN

Developing a model for container terminal choice behaviour requires mainly freight transport demand data collection to obtain customers' (e.g. shipping lines) preferences. Generally, to quantify customers' tendencies two data collection methods may be used: (1) Revealed Preference (RP) and (2) Stated Preference (SP) or Stated Choice (SC) (Ben-Akiva et al. 1994). Through the information collected about actual choices made by customers, RP data can be used to estimate statistical demand models. Nevertheless, this approach to data collection and modelling has a limited ability to analyze the impact of new factors in the supply chain or freight transport system (Gunn et al. 1992). If the tested service is new or not well known by targeted shipping lines, RP survey data collection process faces difficulties (Diana 2010). In such situations, using SC experiments leads to more efficient results through using hypothetical choices/scenarios to collect the required data (Louviere et al. 2000; Arasan and Vedagiri 2011).

Research has shown that RP data may have substantial amount of noise for different reasons such as the measurement error. For example, an individual self-report of an actually made decision (e.g. a choice) is likely to be uncertain. The method uncertainty probably increases as the time between the actual choice and the report of that choice increases. On the other hand, SC experiments are usually generated by some systematic and planned design process in which the attributes and their levels are pre-defined without measurement error and varied to create preference or choice options. Nevertheless, SC responses are stated and not actual, and hence are uncertain because individuals may not actually choose the alternatives that they select during the experiment. While, the two methods may have some potential error. Therefore, using RP and SC data may be more effective (Hensher, D.A. and J. King et al. 2001 & 2007).

This research constructed a survey tool that combines RP and SC surveys to collect information about the factors that affect liners' terminal choice decisions. The design of SC experiments, used at economics and marketing but transportation expertise found it useful to be used in transportation studies especially when it showed its efficiency in data analysis and behaviour forecasting. As a general rule, SC experiments are conducted in order to examine the independent influence of design characteristics (factors and variables) such as container terminal service characteristics on an observed outcome (e.g. terminal choice) made by a sample of liner companies undertaking the experiment (Louviere and Woodworth 1983).

In the SC experiment each respondent receives a number of choices (hypothetical scenarios) to select one or more alternatives from a set of limited options. These alternatives are defined by a number of different factors described by pre-specified factor levels that are pulled from some underlying experimental design. As a concept, experimental design can be looked at as a matrix of values showing factors levels, where the matrix columns represent choices and rows represent factors. The design factors distribution method has an impact over the determination of the independent contribution of each attribute to the observed choices. Different factors allocation may also affect the experiment statistical power and its ability to find the potential statistical relationship among the dataset (Rose and Bliemer 2009; Cooper et al. 2011).

Relating to what stated above, attribute levels allocation in the design matrix has major effect on SC experiment design. Orthogonal experimental designs in various researches used to generate the hypothetical choice tasks to collect data from respondents. To reach the non-correlation between the attributes, orthogonal designs will guarantee this purpose with its characterization of correlated structure between the attributes of the design (Louviere et al. 2000; Bliemer et al. 2008).

Additionally, the transport studies that used stated choice experiment, tested respondents' abilities to comprehend and respond to complex designs involving different alternatives, attributes, and choices. Different studies and experiments, showed that the fewer attributes and attribute levels in the design, the more convenient it is for the respondent. In most cases, model specifications determine the number of attribute levels. If a certain attribute is expected to have nonlinear effects, then it is necessary to assess it at more than two levels in order to capture these nonlinearities. However, in case of using dummy attributes, the number of levels is predetermined. Additionally, the number of attribute levels used, impacts the number of choice situations such that the more levels used, the more choices are available. Mixing levels for different attributes is not a good practice as it may also yield a higher number of choice situations in order to maintain attribute level balance, which will lead the respondent to give a non-realistic answers, from a respondent point of view, if the survey took long time to answer respondent will feel exhausted, board and start giving random answers just to finish the experiment (Rose and Bliemer 2009).

Furthermore, experiment design efficiency can be improved through using a wider attribute level range (e.g. port dues= $2 – $12) having wide attribute level range is statistically preferable than having a narrow range (e.g. port dues= $1.5 – $2) wider range will lead to better parameter estimates (i.e. smaller asymptotic standard error). On the other hand, using extremely wide ranges would affect the choice probabilities obtained from the design because it may create choice tasks with dominated alternatives, if a too narrow attribute level range used this will results in alternatives that are largely indistinguishable from each other. Consequently, this balancing will not be an easy task on one hand, there is the statistical preference for a wide range and on the other hand, the practical limitations for narrow range that may limit the attribute range but maintaining attribute levels in a reasonable limits to the respondents, a trade-off between wide range and narrow range has to be done to reach the required attribute level balance (i.e. all attribute levels appear in the dataset in an equally manner) and to improve design efficiency. Although, achieving a balance between attribute levels may lead to sub-optimal designs, it is still desirable in such an approach. This balance between attribute levels ensures that the parameters are estimated over the whole range, rather than having only a few data points at a few levels, so that a good estimation can be made (Caussade et al. 2005; Scarpa and Rose 2008).

In light of the above, the orthogonal design is adopted in this research to develop the stated choice experiment. The Ngene software is used to generate the design that maintains the utility balance and maximizes the information gained from each hypothetical scenario.

5. MODE CHOICE MODELLING

The planners concerned with transportation field tend to use demand transportation modelling methods mostly over the years, while trying to evolve these methods by time. Unimodal used at the beginning of using models for transportation demand analysis to predict vehicular traffic. A shift happened in the late 1960s, from unimodal to multimodal approaches which take in consideration infrastructure renewal, prices for services and operational polices. Travel demand models have a phenomenal improvement since modellers start to use discrete choice models (Ben-Akiva and Lerman 1985). (Warner 1962) was the pioneer in the field of transportation planning by using discrete mode choice model for the first time to predict the behaviour of users through including binary mode choice between car and transit for a certain trip.

Measuring the levels of the satisfaction for customers dealing with container terminals utilities, a wise study for the factors that affects their choices will be required from the behalf of transportation planners to help them in the behaviour forecasting process. Random Utility Maximization (RUM) Theory state that choice strategies are vital from a customer's point of view while it is random for the planners.

Choosing a terminal decision can be demonstrated through RUM framework as the following: parameters (weight) representation for different factors related to each terminal (utility) the shipping company will face this while a shipping line have a set of available terminals (choices), This can be presented mathematically as follows:

$$V_m = ASC + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n,$$

where:
V_m : Utility associated with terminal (m)
ASC: Alternative Specific Constant
β : Parameter value
X : Explanatory variable

Finally, the shipping line selecting the terminal that achieve the higher benefits for the liner preferences, putting in their consideration the attributes and advantages of other terminals (Ben-Akiva and Bierlaire 1999). Discrete mode choice models are important well known modelling tools that give an economical evaluation for the data through predicting customer's behaviour and forecasting the travel demand for customers (Ben-Akiva and Lerman 1985). Mode choice models have been presented over many researches with different types and various mathematical formulations. Multinomial Logit (MNL) model, which is the simplest shape of RUM framework, considering error terms to be independently and Identically Distributed (IID), follows the double exponential Gumbel Type1 extreme value distribution (Ben-Akiva and Bierlaire 1999). The previous statement leads to a closed form that presenting the probability of terminal selection:

$$P_m = \frac{e^{V_m}}{\sum_{m \in C} e^{V_m}},$$

Where:
P_m : Probability of choosing terminal (m)
V_m: Utility associated with terminal (m) (m= 1, …, M)
C : Choice set of feasible alternative terminals (M)

In this research, the MNL modelling approach is used for developing models considering multiple different factors that influence liners terminal choice. These developed models will provide recommendations to help policy makers in the country.

6. SURVEY DESIGN, IMPLEMENTATION, AND PRELIMINARY RESULTS

The survey instrument designed for this investigation is composed of two parts. A Revealed Preference (RP) and a Stated Choice (SC) components were used to gather information on shipping lines container terminal choice behaviour through utilizing in-person interviews (Idris et al., 2015). In order to ensure reliable parameter estimates, a small-scale pilot survey was conducted among a group of researchers at the Maritime Research and Consultation Center (MRCC) before launching the full-fledged questionnaire to a list of 20 shipping lines that operates in the region. To date, only two major shipping lines responded to the questionnaire, while data collection is still in process. The names of the two companies will not be disclosed for confidentiality of information; however, the two lines will be referred to as the Blue Line and the Red Line throughout this study.

Part number one of the survey identified the revealed preferences of shipping lines based on their actual experiences. In specific, shipping lines were asked to rank a given list of 12 factors that attract them to a port of call (i.e. the most preferred/frequently used port by the shipping line), from the most important to the least important. This would indirectly reveal the key factors which have affecting the port choice of the liner's when they selected their ports of call. Using a similar procedure, the survey also gathered information on 13 factors that attracts shipping lines to a container terminal, as shown in Table 1.

Table 1: Factors that attract a shipping line to (a) a port of call and (b) a container terminal

Factors attracting liners to a port of call	Factors attracting liners to a container terminal
Approach channel	Berth length and draft
Guidance	Quay cranes
Towage	Terminal performance
Port information systems	Service time
Port dues	Terminal Information System (TOS)
Administrative procedures and systems	Service tariff
Waiting time	Administrative procedures and systems
Service time	Customer service
Connectivity to other ports	Terminal traffic volume
Connectivity to hinterland	Safety and security
Customs procedures	Labour/human factor
Safety and security	Connectivity to rail transport
	Marketing policy

Figure 1 depicts preliminary analysis of the factors that attract a shipping line to a port of call for each company individually. As shown, while there is a mutual agreement on the importance of some factors, such as port dues, the importance of other factors, such as safety and security, vary greatly among the two companies.

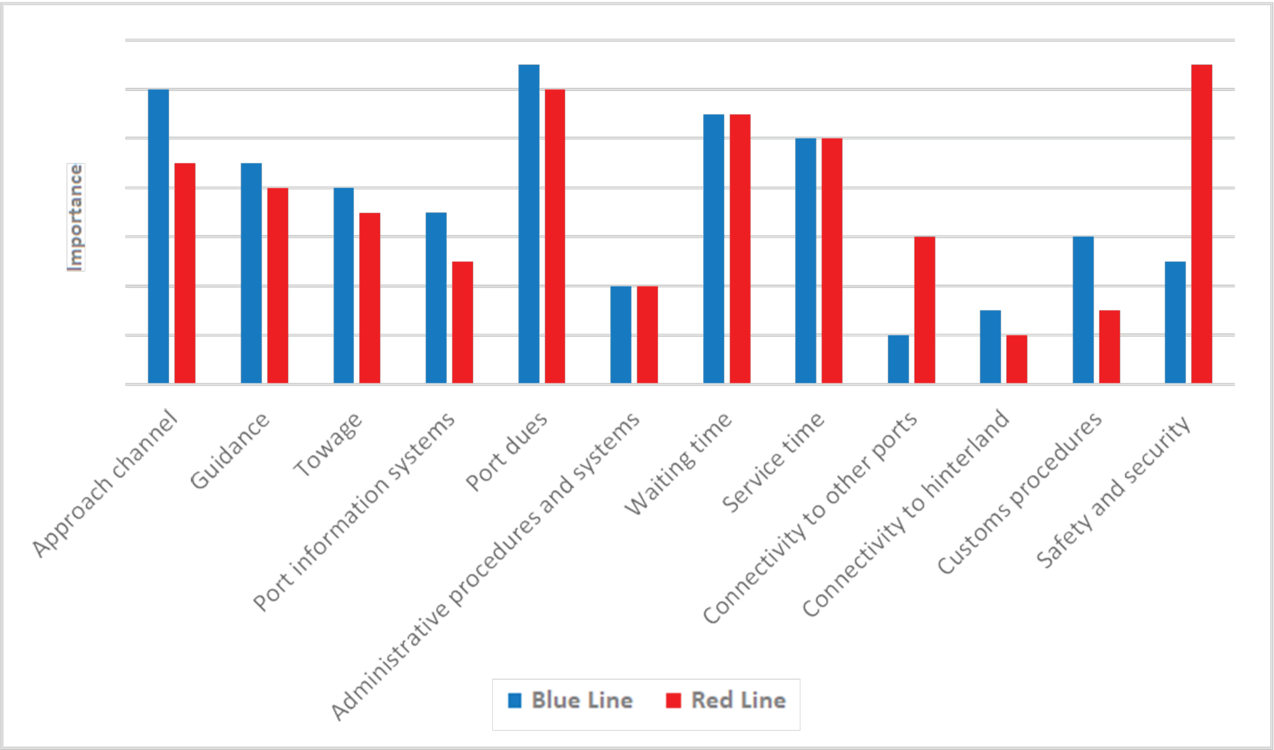

Figure 1: Factors that attract a shipping line to a port of call ranked by importance

By combining the responses of the two companies, as shown in Figure 2, port dues, waiting time, and service time are the top three important factors that attract shipping lines to a port of call. As such, policy makers should focus on improving these factors in attempt to attract shipping lines to Egyptian ports. On the other hand, the analysis showed that connectivity to hinterland is the least important factor from a shipping line's view point, which is an early indication to the way liners view Egyptian ports (being points of cargo loading and unloading rather than integral parts of the total supply chain).

Figure 2: Factors that attract shipping lines to a port of call

Figure 3 depicts preliminary analysis of the factors that attract a shipping line to a container terminal for each company individually. As shown, while there is a mutual agreement on the importance of some factors, such as port dues, the importance of other factors, such as berth length and draft, the importance of other factors, such as connectivity to rail transport, vary among the two companies.

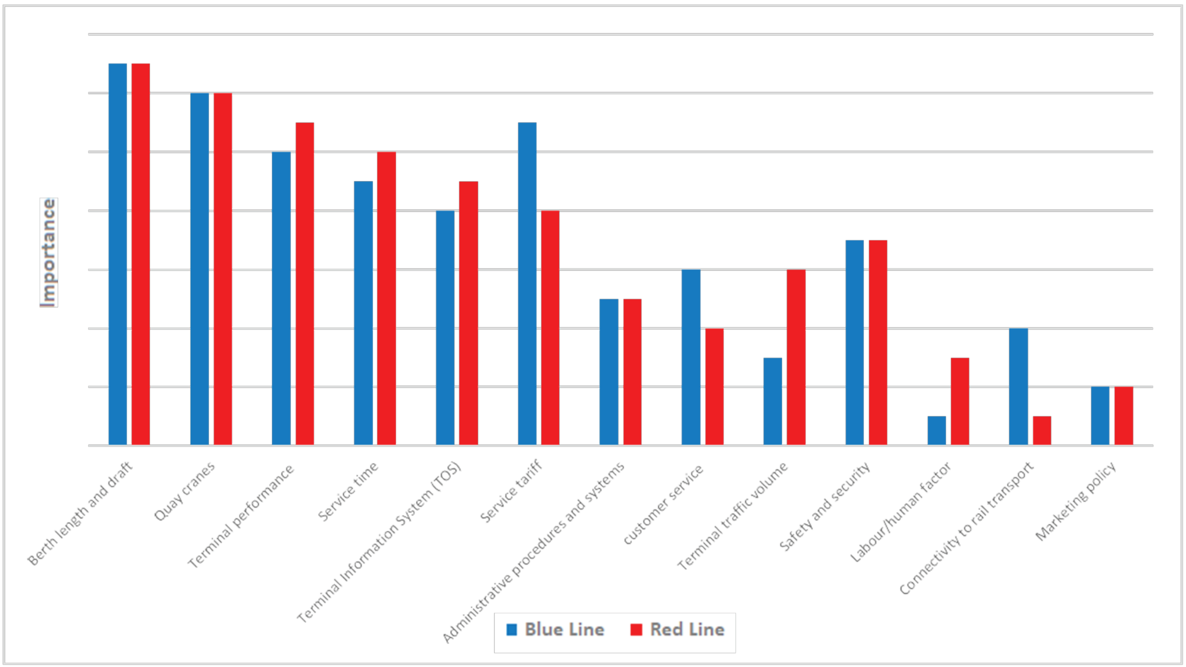

Figure 3: Factors that attract a shipping line to a container terminal ranked by importance

By combining the responses of the two companies, as shown in Figure 4, berth length and draft, quay cranes, and terminal performance are the top three important factors that attract shipping lines to a container terminal. As such, policy makers should focus on improving these factors in attempt to attract shipping lines to national container terminals. On the other hand, the analysis showed that labour/human factor is the least important factor from a shipping line's view point, which might be an early indication to the transition towards automation.

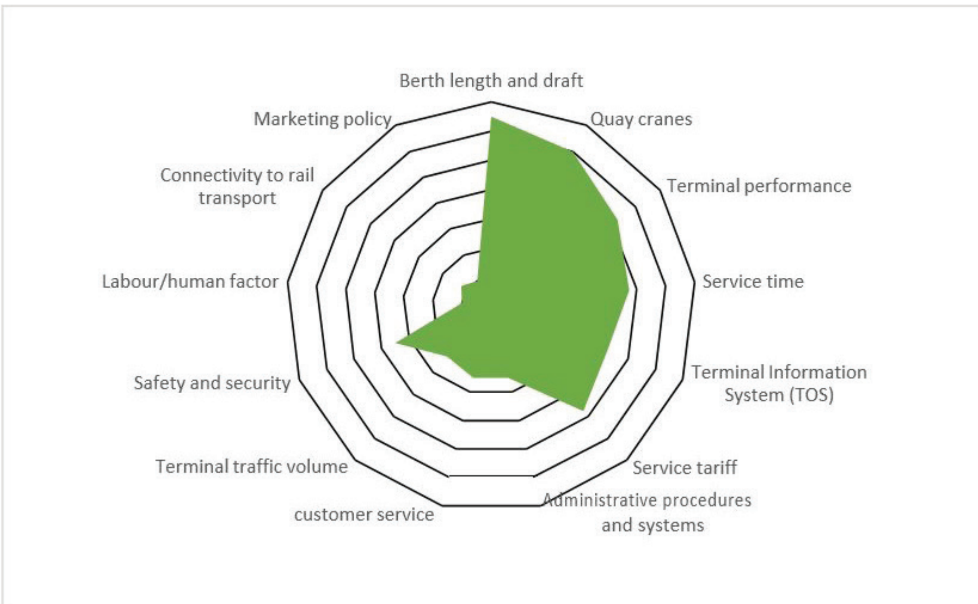

Figure 4: Factors that attract shipping lines to a container terminal

The second part of the survey identified the stated choices of shipping lines based on their response to some hypothetical scenarios characterized by a wide range of terminal operation/service properties (i.e. attributes) considered in the study as determinants of terminal choice. Terminal attribute values (i.e. levels) were changed to make different scenarios and understand which attributes affect terminal choice more. Shipping lines faced a number hypothetical terminal choice tasks (of the same operational attributes and different attribute levels) where they were asked to choose the most suitable option (i.e. container terminal) from their viewpoint.

As discussed in Section 4, research has shown that respondents have limited abilities to comprehend and respond to complex designs involving many alternatives, factors, and choices (treatments). Accordingly, the number of factors (and their levels) that are presented in the SC experiment needed to be kept at minimum to maintain a more convenient design for respondents.

Mittal and McClung (2016) identified the following list of factors that influence shipper's port choice decisions based on reviewing the literature and interviewing local shippers.

Table 2: Initial list of factors with description for each

Factor	Description
Port Infrastructure	Availability of Equipment and port facilities adequacy.
Cost/Port Charges	Delivered price and pilotage, customs, towage and costs.
Port Efficiency	Turnaround time and Facilities for cargo loading, unloading, grouping, and consolidation.
Port Congestion	Time of getting through ports and labour problems.
Cargo Volume	Total TEUs handled at the port and current volume at the port, number of sailings, average size of vessel handled at the port.
Advanced Port Management	The port has a strong health and safety management plan, environmental profile of the port.
Information Conveyance	The action or process of transmitting and communicating information from one place to another, concerning shipments, availability of technology, and communications systems.
Intermodal - Connecting Links	Sailing frequency of deep-sea and feeder shipping services (the service that transports shipping containers from different ports and brings them to a central container terminal where they are loaded to bigger vessels).
Empty Container Management	Distribution and Storage.
Quality and Reputation of Terminal Operators	Their efficiency of cargo handling, and the internal competition (the nature of competition that exists among the different terminal operators within a given port).
Port Services	On-site custom clearance, assistance in claims handling and loss, and damage performance.

While comprehensive, the above list of factors needed to be refined to keep the number of hypothetical choice tasks each survey participant face in the SC experiment between 6 to 8. Otherwise, survey participants may decline to complete the survey due to fatigue. As such, an expert opinion interview was conducted among a group of experts from the Egyptian Maritime Transport Sector (MTS) and national container and cargo handling companies to select a subset of the above list containing the six most important factors that affect liners' terminal choice. Such factors were identified as follows: Port Infrastructure, Cost/Port Charges, Empty Container Management, Cargo Volume, Port Congestion, and Port Efficiency.

Further, these factors were presented in terms of seven measurable attributes to appear in the SC survey and allow for data processing and modelling. The list of factors that were used in the SC experiment and their equivalent measurable attributes and measurement units are shown in Table 3.

Table 3: Parameters for (SP) experiment

Factor	Measurable Attribute	Unit of Measurement
Port Infrastructure	Water draft	m
Cost/Port Charges	Terminal Handling Charge (THC)	$/Full 20' Container
Cost/Port Charges	Terminal Handling Charge (THC)	$/Full 40' Container
Empty Container Management	Free dwell time on empty containers	days
Cargo Volume	Import/Export cargo balance	Import %/Export %
Port Congestion	Actual/Scheduled Service Time	%
Port Efficiency	Terminal productivity per crane	Gross Moves per Hour (GMPH)

Furthermore, it was found that the factors presented in Table 3 are also in line with the findings of the RP data analysis performed earlier in the study. In particular, Port Infrastructure, Cost/Port Charges, Empty Container Management, Cargo Volume, Port Congestion, and Port Efficiency are the six most important factors that affect shipping lines' terminal choice; having Port Infrastructure and Cost/Port Charges on top of the list, as shown in Figure 5. As such, policy makers need to focus on these factors in attempt to promote their terminals and make them more attractive to shipping lines.

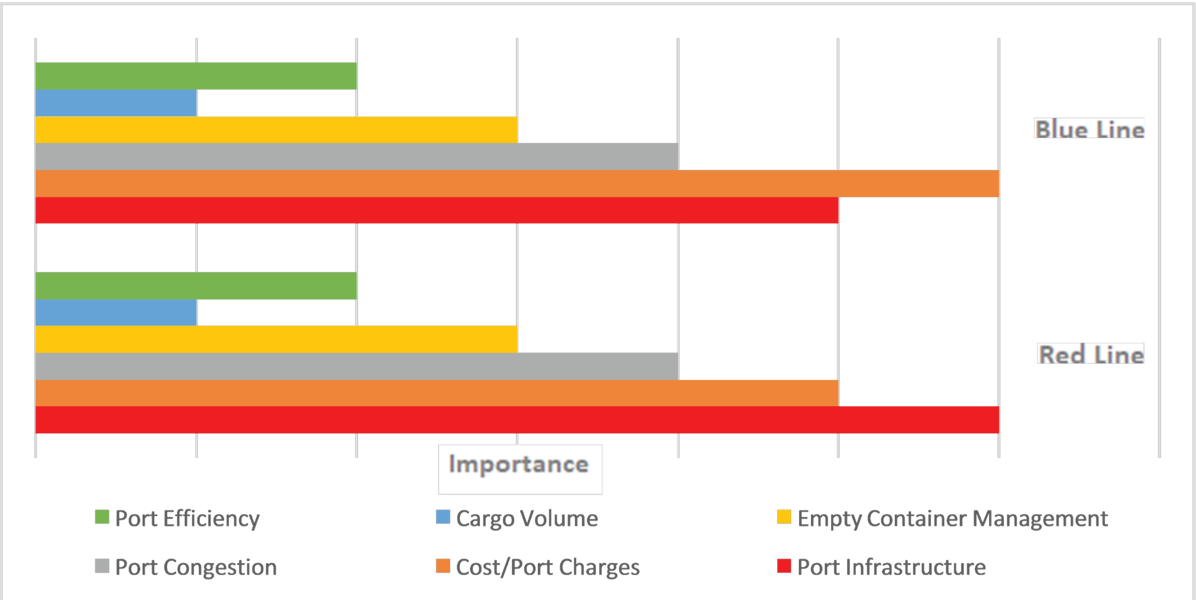

Figure 5: RP survey sample results

Another issue in SC experimental design is the trade-off between the statistical preference for a wide range and the practical limitations that may limit the range to maintain attribute levels within limits that make sense to the respondents. In more specific terms, the experiment should avoid choice tasks with dominated alternatives due to extremely wide ranges and alternatives that are largely indistinguishable due to too narrow ranges.

As such, experts from the Egyptian Maritime Transport Sector (MTS) and national container and cargo handling companies were also consulted about best practices in terminal service design to select reasonable attribute level ranges, as shown in Table 4.

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Table 4: Attribute level ranges from the (SC) survey

Factor	Alexandria Container & Cargo Handling Co. **Alexandria Terminal**	Alexandria Container & Cargo Handling Co. **El-Dekheila Terminal**	Damietta Container & Cargo Handling Co. **Damietta Terminal**	Port Said Container & Cargo Handling Co. **West Port Said Terminal**
Water draft	14	14	14	14
(m)	18	18	18	18
Terminal handling charge (THC)	85	85	99	80
($/Full 20' Container)	77	77	89	72
	68	68	79	64
Terminal handling charge (THC)	160	160	198	150
($/Full 40' Container)	144	144	178	135
	128	128	158	120
Free dwell time on empty containers	0	0	0	0
(days)	5	5	5	5
	10	10	10	10
Import/Export cargo balance	30/70	30/70	30/70	30/70
(Import %/Export %)	50/50	50/50	50/50	50/50
	70/30	70/30	70/30	70/30
Actual/Scheduled Service Time	0.5	0.5	0.5	0.5
(%)	1	1	1	1
	1.25	1.25	1.25	1.25
Terminal productivity per crane	35	35	35	35
(Gross Moves per Hour - GMPH)	25	25	25	27
	15	15	15	15

Based on the number of chosen attributes, their levels, and ranges, an orthogonal design for the SC experiment was created. A total of 72 rows were generated to ensure attribute level balance (i.e. all attribute levels appear equally in the dataset; another important property that significantly impacts design efficiency). Giving all 72 choice situations to a single interviewee is too large. As such, the orthogonal design was divided into 12 blocks of 6 choice tasks each (although each block is not orthogonal by itself, the combination of all blocks is orthogonal). This way, each interviewee was faced with a random block of 6 choice tasks instead of 72.

The following is an example for one of the 6 scenarios that the shipping lines answered within the survey.

Please choose the appropriate container terminal from your point of view according to the following service parameters and operating characteristics. Please study the situation carefully before making a decision. Please, choose only one container terminal:

Table 5: Example from the (SC) survey

Factors	Alexandria Terminal	El-Dekheila Terminal	Damietta Terminal	Port Said Terminal	Another Terminal (Please state its name or specify its operation/service properties)
Water draft, (m)	18	14	14	14	
Terminal handling charge (THC), ($/Full 20' Container)	85	85	79	80	
Terminal handling charge (THC), ($/Full 40' Container)	160	128	178	120	
Free dwell time on empty containers, (days)	5	10	5	10	
Import/Export cargo balance, (Import %/Export %)	50/50	50/50	70/30	30/70	
Actual/Scheduled Service Time, (%)	0.56	1	1.25	1	
Terminal productivity per crane, (Gross Moves per Hour - GMPH)	25	35	35	15	
Which terminal would you choose?	□	□	□	□	□

As opposed to common SC surveys, respondents were also asked to express their confidence in their stated choices using a Likert scale that will be used to minimize measurement error of response.

How confident are you in executing your terminal choice in the future?	I will execute immediately	High	Moderate	Low	I doubt

7. CONCLUSIONS

This study is concerned with investigating the effect of container terminal's service attributes on attracting shipping lines, with focus on only survey instrument design and preliminary analysis of RP data.

The study combined RP and SC methods of data collection to make use of their advantages and reduce their individual drawbacks. In particular, RP questions were used to collect factual information on shipping lines' preferences. In addition, SC experiments were used to study the main factors that attract (repel) the most important shipping lines to (from) the Egyptian container and cargo handling companies.

Preliminary data analysis showed that Port Infrastructure and Cost/Port Charges are the most important factors shipping lines look for when choosing a container terminal, while Port Efficiency and Cargo Volume come least in importance. Further data analysis will be represented as soon the targeted sample size complete the survey to show the full image of shipping lines' preferences regarding their terminal choice behaviour.

Further, the complete dataset, when collected, will be used to develop discrete choice models of terminal switching behaviour. Forecasting shipping lines' behaviour will play a major role towards port resilience strategies to adapt to changing conditions, and recover positively from unexpected circumstances like the Covid 19 pandemic. Furthermore, the developed models will help policy makers prescribe efficient strategies to alter customer decisions and ensure that each port/container terminal has a fair market share based on the integration of existing capacity.

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