Performance management in port authorities

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Abstract

Performance measurement and improvement are essential activities that ports use to enhance their competitive position in the global market. This study investigates this topic in container ports. The aim of this study is to explore the sensitivity of the performance enablers in the port performance model of Jaffar and Berry [1]. The performance measure that is used in this model for the container ports is the Twenty Equivalent Unit (TEU), and the port performance predictor variables were: leadership commitment to excellence, modern technology, the efficiency of the terminal, port size, and the port hinterland. This paper investigates the change of the TEU over 5 years (start of 1999–end of 2003) using time series analysis. The sample that was used in this study includes container ports in the Middle East, Far East and Europe. Based on the sample used, the paper suggests that the most sensitive enablers in affecting the performance of container ports are the port capacity and the crane productivity.

Keywords: container ports, TEU, performance management.

1 Introduction

The major reference books on ports list around 3500 to 4000 ports worldwide Alderton [2]. This study concentrates mainly on container ports and investigates their performance. Container Ports can be defined as places with facilities for shipping lines where equipment are available to handle container flow from vessels to rail or road, and vice versa. The container port consists of the container yard, which is situated between two demands, one associated with the transfer of containers between the container yard and the containership, and the other associated with the transfer of containers between the container yard and the hinterland (road/rail).

The subject of container port performance measurement and improvement is an important issue facing port management. This paper investigates the port
performance subject using the port performance model in Figure 1 Jaffar and Berry 2004 [1] and explores the sensitivity of the performance enablers. The performance measure that was used in this model for the container ports is Twenty Equivalent Unit (TEU), and the port performance predictor variables were: leadership commitment to excellence, modern technology, the efficiency of the terminal, port size, and the port hinterland.

1. Port hinterland
   1.a- Level of economic activity
   1.b- Accessibility to modern roadwork system
   1.c- Access to wide range of markets
   1.d- Feeder services
   1.e- Free zone around port
   1.f- Transhipment traffic

2. Leadership commitment to excellence
   2.a- The participation of the government in the port projects
   2.b- Adoption of modern management concepts
   2.c- Customers satisfaction
   2.d- Port charges
   2.e- People productivity

3. Port size
   3.a- Geographical position
   3.b- Capacity of the port
   3.c- Master plan
   3.d- Level of congestion
   3.e- The ability to handle mega ships
   3.f- No. of berths

4. Terminal efficiency
   4.a- Crane productivity
   4.b- Technical productivity
   4.c- Yard equipments productivity & planning
   4.d- Gate productivity
   4.e- Equipment utilisation
   4.f- Reefer yard

5. Modern technology
   5.a- Use of the latest port equipment
   5.b- IS department to handle customer requirements
   5.c- Use of modern software in various operations
   5.d- Modern technology to improve communication
   5.e- The integration of port IT system to Custom IT system
   5.f- Use of security technology

Figure 1: Port performance model.

2 Literature review

Previous studies on port performance looked at the performance in a defined year and rarely explored the change in performance over time. This study uses the port performance model (cited above) to investigate the change of TEU over 5 years and to obtain the enablers that facilitated the change in container ports.
Slack [3] investigated the criteria shipping companies employ in selecting the preferred ports. He reviewed the factors considered by exporters and freight forwarders by focusing on the containerised traffic between the North American Mid-West and Western Europe. He provided respondents with a list of 11 possible factors, from which they were invited to select up to five. The factors were: port security, size of port, inland freight rates, port charges, quality of customs handling, free time, congestion, port equipment, number of sailings, proximity of port, and the possibility of intermodal links. He suggested that decision makers are influenced more by the price and service considerations of land and ocean carriers than by perceived differences in the ports of entry and exit. He also concluded that port infrastructures do not play an important role in the routing decisions in the North Atlantic container trade.

In a research by Murphy et al. [4] the main questions of port choice were investigated, (1) what factors will have a bearing on port choice, and (2) how to compare the results from previous studies with their study. The factors that were identified were: shipment information, loss and damage performance, low freight charges, equipment availability convenient pick up and delivery, claims handling ability, special handling ability, large volume shipments, large and odd-sized freight. They concluded that shipment information together with loss and damage performance are the most important factors in port selection.

Ha [5] evaluated the performance factors at 15 container ports using interviews and questionnaires to ship operators and logistics managers. The factors that he identified were: ready information availability of port-related activities, port location, port turnaround time, facilities available, port management, port costs and customer convenience. The study implication was mainly for North Asian ports and Korean ports. Ha suggested that these ports should redefine their corporate missions and specifically improve the quantity and quality of information flows and data availability.

With respect to the mentioned studies, the methods and techniques used in these studies largely ignored the aspect of performance change factors over time in container ports. This study fills this gap in the literature by investigating the enablers affecting performance change over five years in eight container ports worldwide. In addition to that there is lack of academic materials using ports in the Middle East. This study has investigated 3 ports in the Middle East region.

3 Methodology

This study uses the port performance model (cited above) to explore the sensitivity of the performance enablers in the model. The model is a performance measurement and improvement model. It identifies all the enablers of port performance and manages them separately according to the five mentioned predictor variables. Optimally managing the performance predictor variables should facilitate successful performance of a port in the ports global competitive market.

The sample used includes 8 ports in the Middle East, Europe and South East Asia to give the study a global validity. In addition to that the data confidentiality
in port authorities restricts the number of the sample used. Data were collected using questionnaires, interviews and the available literature about the sample ports. The questionnaires and interviews were facilitated by contacts made by Dubai Ports Authority. The performance model predictor variables and their enablers were the basis used in constructing the questionnaires and interviews. The time frame for the study was decided to be 5 years, because it was confirmed by the interviews and the literature [6] that ports build their short-term strategies depending on 5 years data.

Data were analysed using time series analysis. Time series can be defined as an ordered sequence of values of a variable at equally spaced time intervals. It was used because it monitors processes and tracks corporate business metrics. The time series analysis obtains an understanding of the underlying forces and structures that produce data, in this case the enablers that facilitated the change of TEU over 5 years. In addition to that, the time series analysis can be used as a tool for forecasting, but this is out of this paper’s scope and further work is going on to assess the port performance model statistically.

TEU annual change figures in percentages were plotted over 5 years and the data collected from the questionnaires and the interviews were used to analyse the TEU change. In addition to that the literature available about the sample container ports was used to support the analysis.

4 Discussion: performance change over time

TEU average annual increase is 9.2% worldwide since 1980 Derwey Shipping [6]. Although this study uses a small sample over 5 years only, the annual mean of the TEU change was calculated to be 8.74% and the standard deviation was 10.12. The slight difference between the annual increase in TEU worldwide (9.2%) and the calculated annual mean of the sample ports TEU (8.74%) gives additional confidence in the validity of the data collected. On this basis, the paper considers any change over one standard deviation, 18.86% (8.74 + 10.12) as a significant change. The discussion will concentrate on these significant changes in TEU and will attempt to investigate the enablers of the significant changes studying the sample ports TEU annual change. In addition to that, the paper will explore the main changes within individual samples and will attempt to explain them even though they were significant only within the context of the individual sample. The discussion has been divided as per the sample ports regions and the enablers in the discussion are referenced as per the model in figure 1.

4.1 Ports in the Middle East, figure 2

4.1.1 Port (1) main changes

2002 - increase of 17% in TEU, the analysis revealed that this was due to:
The port government signed a contract to privatise the port with a major port operator, which facilitated:
Improved crane productivity and reducing delays (4.a)
Increased people productivity by using the major port experts in the port operation to train the sample port people (2.e)
The establishment of a freezone (1.e)

2003 - increase of 27% in TEU (significant change), the analysis revealed that this was due to:
Port capacity: The capacity was increased by 50% (3.b)

4.1.2 Port (2) main changes
2002 - increase of 22% in TEU (significant change), the analysis revealed that this was due to:
Accessibility to modern roadwork system: A better accessibility to roads comparing with competitors congested roads (1.b)
Port charges: The port used this factor to market itself comparing with competitors (2.d)
Transhipment traffic: The port won most bids for transhipment traffic in the nearby hinterland (1.f)

2003 - increase of 33% in TEU (significant change), the analysis revealed that this was due to:
Port Capacity: The capacity of the port was increased by 50% (3.b)
Crane and yard productivity: The port purchased new cranes and reach stackers to enhance its terminal productivity (4.a, 4.c)

4.1.3 Port (3) main changes
2002 - increase of 17% in TEU, the analysis revealed that this was due to:
Free zone: A contract was signed with 150 neighbouring country companies to be established in the free zone. The free zone was a sensitive factor in this port performance because the port claimed that the freezone was accounted for 36% of the port throughput and made this port ahead of competitors in its region (1.e)
2003 - increase of 19% in TEU (significant change), the analysis revealed that this was due to:
Port Capacity: The port increased its capacity in this year to handle the congestion (3.b)
The use of modern port equipment and crane productivity: The port purchased 2 Super Post Panamix cranes (4.a)

![Figure 3: Ports in Europe.](image)

### 4.2 Ports in Europe, figure 3

#### 4.2.1 Port (4) main changes
2003 - Increase of 11% in TEU, the analysis revealed that this was due to:
Port capacity: The capacity of the port was increased (3.b)
The ability to handle mega ships: The port dredged its channels to enable handling ships of 17m draught (3.e)
Accessibility to modern roadwork system: A new roadwork connection was constructed which enhanced the port hinterland (1.b)
People productivity: New initiatives were introduced to labour which led the sample port to claim that it had the most productive stevedore workers in Europe in 2003 (2.e)

#### 4.2.2 Port (5) main changes
2000 - increase of 13% in TEU, the analysis revealed that this was due to:
Port capacity: The port capacity was increased during 2000 (3.b)
Customer satisfaction: The transfer of South American traffic from a competitor to the port (2.e)
People productivity: Productivity bonus was introduced at the beginning of the year (2.e)
4.2.3 Port (6) main changes
2000 - increase of 7% in TEU, the analysis revealed that this was due to:
Crane productivity: the port enhanced its crane productivity by purchasing a new Super Post Panamix crane (4.a)

4.2.4 Port (7) main changes
2002 - increase of 22% in TEU (significant change), the analysis revealed that this was due to:
Port charges: The port used this factor to market itself comparing with competitors (2.d)
Transhipment traffic: The port won most bids for transhipment traffic in the nearby hinterland (1.f)

2003 - increase of 33% in TEU (significant change), the analysis revealed that this was due to:
Port Capacity: The capacity of the port was increased by 50% (3.b)
Crane and yard productivity: The port purchased new cranes and reach stackers (4.a, 4.c)
Feeder services: This was increase because the port launched a campaign to encourage feeder operators to establish services to the port (1.d)

![Figure 4: South East Asia port.](image)

4.3 South East Asia port

4.3.1 Port (8) main changes
2002 - increase of 17% in TEU, the analysis revealed that this was due to:
Crane and yard productivity: The port purchased 1 crane and 9 RTGs (Rubber Tyre Gantry Cranes) (4.a, 4.c)
People productivity: The port introduced a program to improve labour productivity. The program included both the strategic and operative human resources modules (2.e)

5 Results: the sensitive factors

The above analysis shows that there were 6 changes above 18.86%. These changes are considered to be significant changes. When attempting to explore the sensitivity of the significant change enablers, it was noted that port capacity was
associated with 4 significant changes, and crane productivity was associated with 3 significant changes. These 2 enablers are considered to be the most sensitive enablers in affecting the port performance. It was also noted that all changes within the sample ports were explicable using the port performance model enablers, which suggest that the model has global validity.

5.1 Port capacity

The capacity can be considered from the above analysis as the most sensitive factor in performance change. The literature [7] gives several definitions for capacity; some of them are completely individual from others which could be confusing. This paper has considered the quayline (measured in meters) as the most relevant definition for capacity. This is justified as in most ports berth availability rather than yard space is the critical constraint in the longer term. Ports can solve yard storage problems by higher stacking, using off dock facilities or by penalty pricing on long stay boxes; however, they seldom can change quayline (in the short term).

Many decision regarding ports have to be seen in the context of port expansion plans. In the past it was mostly argued that capacity should be extended proportionally to the predicted growth of traffic. Yet this is only economically sensible when the starting point is optimal capacity utilization. If the starting point is an overcapacity, this overcapacity will be continued.

In the sample ports investigated, the capacity was associated with 6 changes in TEU including 4 significant changes.

In can be noted that capacity contributed in affecting the 3 Middle Eastern ports. In sample 1 increasing the capacity by 50% in 2003 led to a significant increase of 27%, in TEU. Also, in sample 2 increasing the capacity by 50% and improving the crane and yard productivity caused a significant increase of 33% in TEU. In sample 3 a significant increase of 19% was noted when the capacity was increased by 20% combined with improving the cranes productivity. This shows the vital role capacity has in affecting the TEU in the Middle East. Increasing the capacity of container terminals in Europe has more obstacles when comparing with the Middle East. This is because of the pressure terminals face from environmental groups when planning for capacity increase. However, the increased capacity was associated with 3 changes in the 4 European sample ports. In sample 4 and 5 the changes were relatively low comparing with the Middle Eastern ports, but in sample 7 increasing the capacity by 50% and enhancing the cranes productivity and bringing more feeder business to the port facilitated an increase of 33% in TEU

5.2 Crane productivity

The crane productivity is also a key factor in any terminal development. The crane productivity reflects how well working time is being used within the terminal from top management to the workforce level.

Crane productivity can be measured in two ways: crane hours per working hour and effectiveness of crane operation. Crane hours depend on the number of
cranes used to load/unload a vessel. Usually ports use 2 to 3 cranes per vessel. However, up to 7 cranes could be used in some cases. So, this measure is not consistent in all ports. The paper considers the alternative measure, which is the average cranes move per hour.

A modern container berth with 4 gantry cranes can handle about 400,000 moves annually (Typically 600,00 TEU). The increased size and the modern Technology of container ships have affected the design of cranes. Container terminal management has to plan that the future containerships will require increasingly larger container cranes.

In the sample investigated the cranes productivity was associated with 5 changes in TEU including 3 significant changes.

In the Middle East the crane productivity was associated with 3 changes within the 3 samples used. In sample 1 the TEU was increased by 17% by improving the cranes productivity, improving the people productivity and establishing a freezone. In sample 2 there was a significant increase of 33% in TEU after enhancing the cranes productivity and increasing the capacity by 50%.

There was no significant change in sample 6 in the investigated time frame, but the highest change in TEU for this sample was in 2000 because of improving the cranes productivity by having a new Super Post Panamix cranes. In sample 7 there was a significant increase of 33% in 2003 by improving the cranes productivity and increasing the capacity by 50%. It should be noted that this case for sample 7 in 2003 is very much similar to sample 2 in 2003 when increasing the capacity by 50% and improving the cranes productivity caused a TEU increase of 33%.

In South East Asia sample the cranes improved productivity with the yard productivity and people productivity facilitated an increase of 17% in TEU.

6 Summary and conclusion

The study has shown that in the 8 sample ports investigated the mean change in the TEU was 8.74%, which is consistent with other studies. The sample included ports in the Middle East, Europe and South East Asia. Any change over one standard deviation above the trend line of average growth (i.e. 18.86%) was considered as a significant change in TEU. The data analysis revealed that the most sensitive enablers in affecting the container port performance appear to be: the port capacity and the crane efficiency. In addition to that, all changes within the sample ports were explicable using the port performance model enablers, which suggest that the model has global validity.

This study is believed to be one of the few academic studies that investigated the performance of Middle Eastern ports. However, further work is going on to assess the port performance model statistically.

References


