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Performance evaluation and solutions for port congestion focused on the container terminal: a case study of Khalifa bin Salman Port (KBSP) Kingdom of Bahrain

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Performance Evaluation and Solutions for Port Congestion Focused on the Container Terminal:
A Case Study of Khalifa Bin Salman Port (KBSP) Kingdom of Bahrain

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Dissertation Declaration

We certify that all the material in this dissertation that is not our own work has been identified, and that no material is included for which a degree has previously been conferred on us. The contents of this dissertation reflect our own personal views and are not necessarily endorsed by the University.

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Abstract

Title of Dissertation**: Performance Evaluation And Solutions For Port Congestion Focused on the Container Terminal: A Case Study of Khalifa Bin Salman Port (KBSP) Kingdom of Bahrain**

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This paper contains quantitative and qualitative data analyses where literature review has been carried out to discuss the importance of ports, how ports are significant in the overall supply chain, key/port performance indicators and suggestions to mitigate congestion. Firstly, an analysis of 2 years of key performance indicators (KPIs) for KBSP has been made to measure KBSP container terminal performance. Secondly, the reseachers have used regression analysis to forecast future throughput (the dependent variable Y) of KBSP versus more than 10 (independent variables X1 to X10) followed by an interpretation of the results generated in the E-views software. Thirdly, the stakeholder's voice has been considered, and a minimum of 50 surveys were collected to express port customers' insights in the analysis and final evaluation. SWOT analysis has also been carried out to provide an insight into the Bahrain maritime industry and how internal and external factors are affecting KBSP performance.

The qualitative and quantitative analysis are put together to form a meaningful interpretation for solid terminal performance evaluation. Thus, a discussion was performed to analyze and link the result of the port KPIs, E-views regression, SWOT and the questionnaire for evaluating KBSP performance and coming up with possible solutions. Finally, a recommendation was written upon the completion of the collective analysis to set the suitable congestion mitigation measures in order to cope with the current/future performance trends to meet port customers' expectation.

Keywords: Analysis, APM Terminals, Bahrain, Concession agreement, E-views, Regression, Efficiency, Forecast, KBSP, MSP, Port and Maritime Affairs, Port Congestion, Port performance, KPIs, Questionnaires, SWOT, Port Authority, Ocean Alliance.

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List of Abbreviations

AGBT	Average Gross Berthing Time
AIT	Average Idle Time
AMT	Average Manoeuvring Time
ALOA	The average length overall
APMT	AP Møller Maersk Terminals
AST	Average Service Time
ASTT	Average Ship Turnaround Time
APR	Average Productive Ratio
ATP	Average Time in Port
BOR	Berth Occupancy Rate
BSO	TEU Per Ship Per Berth Hour
CMA-CGM	Compagnie Maritime d'Affrètemen - Compagnie Générale Maritime
CUR	Crane Utilization Rate
CT	Container Terminal
CY	Container Yard
GBP	Gross Berth Productivity
GCP	Gross Crane Productivity
GT	Gross Tonnage
IMO	International Maritime Organization
JIT	Just In Time
KBSP	Khalifa Bin Salman Port
KPIs	Key performance indicators
LPC	Lifts Per Call
LUR	Labour Utilization Ratio
MOL	Mitsui OSK Lines
MSP	Mina Salman Port

MTT	Maritime Transport and Telecommunication
NCP	Net Crane Productivity
NYK	Nippon Yusen Kabushiki Kaisha
OOCL	Orient Overseas Container Line
OPEX	Operating Expense
PMA	Ports and Maritime Affairs
POD	Port Operations Directorate
PPIs	Port performance indicators
PSO	TEU per Ship per Port Hour
REC	Research Ethics Committee
RTG	Rubber Tired Gantry crane
STS	Ship to Shore Crane
SWOT	Strength Weakness Opportunity Threat
TEU	Twenty foot Equivalent Unit
TOS	Terminal Operating System
TPCH	TEU Per Crane Hour
TPSPD	TEU Per Ship Per Day
UAE	United Arab Emirates
UNCTAD	United Nations Conference on Trade and Development
WMU	World Maritime University
WSO	TEU Per Ship Working Hour

1. INTRODUCTION

1.1 Background

In recent years, more port authorities and administrations are moving towards implementing policies geared towards improving port performance and efficiency. Many countries and port authorities have seen privatization as an effective tool towards reducing port congestions, improving efficiency and reducing the financial burden on the governments, in the form of wages and capital-related expenditure, while bringing an onboard wealth of technical and commercial expertise in port management and operations. After the successful privatization in the Kingdom of Bahrain, terminal congestions increased and challenged the main commercial port in the country Khalifa Bin Salman Port (KBSP). This resulted in a huge backlash from the port stakeholders as always is the case where privatization is involved at the port.

Figure 1: Location of KBSP

(Source: MTT, 2018)

Figure 2: Container terminal of KBSP
(Source:MTT, 2018)

The new Khalifa bin Salman Port (KBSP) is a multipurpose port and considered as the primary trade gateway according to Almahmood (2018). The KBSP facilitates the import of all type of cargoes that are required by the consumers; it also handles some raw materials required by industries for production (MTT, 2016). The terminal is equipped with a limited number of equipment namely (4 STS and 12 RTGs) to handle the incoming containers and general cargo vessels. The table below shows key port information and the breakdown of the main port handling equipment at the terminal:

Table 1: KBSP main terminal information

Khalifa Bin Salman Port – General Information	
UN Locator No.	BHKBS
IMO ID No.	219377/ 3
Coordinates	Latitude: 26 deg 10.9' North, Longitude: 050 deg 43' East
Quay	4 Berths (1,200 Meter)
STS Cranes	4 ZPMC Max Lifting Capacity 65 tons
RTGs	12 ZPMC Max lifting capacity 50 tons
Mobile Cranes	2 Zoom line maximum lifting capacity of 35 tons
Reach Stackers	2 Zoom line maximum lifting capacity of 45 tons
Empty Handler	2 Zoom line maximum lifting capacity of 8 tons
Shuttle Carrier	2 Noell maximum lifting capacity of 40 tons
Terminal Tractors	59 Mac towing capacity 65 tons

(Source: APMT, 2018)

This research is, therefore, focused on Khalifa Bin Salman Port (KBSP) to analyze the container terminal operation, in order to understand and evaluate current KBSP performance, privatization and make recommendations in order to tackle the congestion issue raised by the trade in Bahrain and recommend possible ways of improvements accordingly. According to Undata (as cited by Alhameedi, 2017), the maritime industry in the Kingdom of Bahrain is a critical element for the national economy; as maritime shipping is considered as the main transport mode where most of Bahrain's import and export are being handled. According to Atlas (2018), Bahrain's import value by money increased by 739% from 1.43 billion USD in 1995 to reach 12 billion USD in the year 2016. China, Saudi Arabia, Japan, and the UAE are the main trade partners and import origins for cargoes imported by Bahrain by sea. Figure 3 shows that the import values are within 1 to 2 billion USD during the year 2000 when emerging economies started to develop and removed all trade barriers globally. The government of Bahrain had been operating the previous commercial port Mina Salman Port (MSP) from 1962 until 2005; thereafter APM Terminals took over the operations in 2006 after obtaining the 30 years concession agreement to operate MSP and then KBSP (Almahmood, 2017).

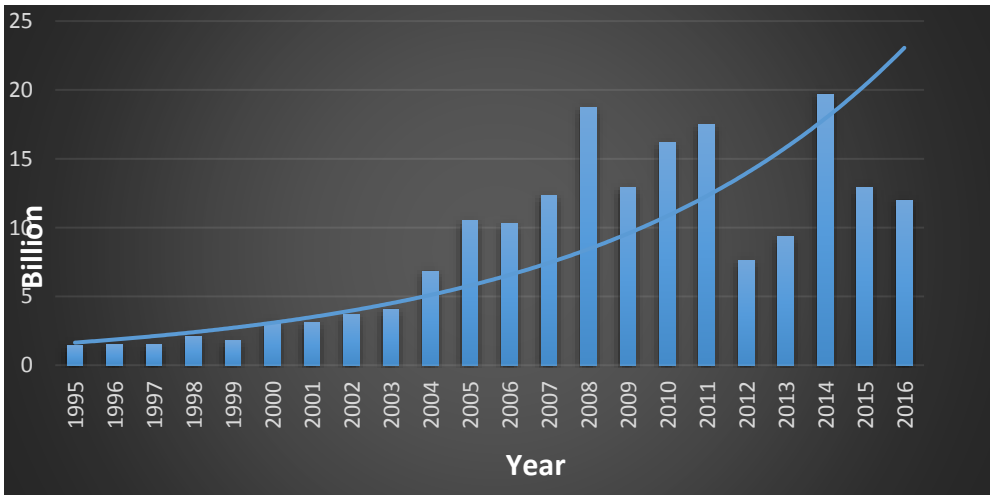

Figure 3: Bahrain Import Value by Billion USD from 1995 - 2016
(Source: Atlas, 2018)

However, by early 2000 the MSP superstructure and infrastructure were aging and deteriorated due to the high utilization caused by the increased traffic that led to port congestion (Obg, 2007). By then, the government had plans underway to develop the privatization plan for Bahrain port industry. This led to ceasing any port investment projects especially infrastructure maintenance including the acquisition of new port handling equipment (Almahmood, 2018).

The government was keen on building and developing an integrated port facility and logistics zones to cater for the increasing size of ships as a result of the growth of global shipping demand (Obg, 2008). As a result, the government decided to privatize the port and develop KBSP, allowing it to be operated by an experienced global port operator to improve the port industry and its infrastructure, hence serve port customers better and at the same time be able to cope with the continuously growing imported cargoes. According to the U.S. Department of State (2013), in 2001 the first step that was taken by the government to develop the port sector was to develop the required legislation in order to include privatization as part of the national law. This was to remove the legal barriers and call upon international companies to invest in Bahrain ports through developing an

agreement that would allow for world class management and operation of the port. The government announced the privatization of Bahrain ports (KBSP) and called upon global port operators to participate in the port tendering process. As a result, several global leading port operators including PSA Singapore, DP World from the UAE and APM Terminals from Denmark participated in the bidding (Almahmood, 2017). APM Terminals was eventually selected as the winning bidder and given the exclusive rights to operate KBSP for 30 years through a concession agreement (Almahmood, 2017).

KBSP began operations officially in 2009 (MTT, 2016). According to MTT (2016), APM terminals was selected to operate, manage and develop the port because it was classified as one of the top ten global operators that possesses expertise in port operations. The government believed that the appointment of APM Terminals would result in a significant development for the port and maritime industry that would lead to positioning Bahrain as key player in the maritime industry regionally (Legalaffairs, 2006). The investment that was made by APM Terminals in KBSP was equivalent to sixty-two million USD to equip the port with the best available technology for providing port-related services to port customers. Among the key acquisitions made by APMT included port equipment, such as four ZPMC gantry cranes or shore-to-ship cranes (STS) and twelve ZPMC rubber-tired gantry cranes (RTG), which were procured brand new from the manufacturer in China (MTT, 2016). The KBSP yard design was improved to suit the RTG operations as the old port MSP was operated with different port handling equipment (straddle carriers) which had the disadvantage of losing ground slot capacity per TEU (Alsalem, 2017).

Initially, the old port was operated with a container stack of two high which is a straddle carrier container stack, while KBSP is now operated with RTGs and are able to stack up to four containers high as a method of increasing capacity hence improving port performance. The reason for designing KBSP for RTG operation is that the TEU capacity is currently 1.1 million TEU at phase one and expected to reach 2.5 million TEU with phase 2 (Almahmood, 2018). Despite the significant achievements made by the

government in developing the port and maritime industry through privatization, the shipping sector in Bahrain is still unsatisfied with the services provided by APM Terminals at KBSP because of the unreliable performance (Albastaki, 2018). The stakeholders have claimed that there are delays caused by port congestion in delivering and receiving cargoes from/to the port. The port stakeholders voiced their concerns to the government and sent several letters and petitions complaining about the port congestion issue (Albastaki, 2018). The apex body which represents traders in Bahrain and the Bahrain Chamber of Commerce (BCCI) approached the port authority and addressed the port congestion issue in several meetings.

The BCCI representative said that clearing import containers and vessel turnaround time exceeded some two to three days due to the shortage of laborers and equipment (BCCI, 2015). This prompted, the researchers to conduct a survey by questionnaires which were circulated to all the relevant stakeholders including Government agencies, shipping lines, freight agents and customs brokers in order to gauge the satisfaction level of the industry. The low productivity caused port congestion and delay of the cargoes at the terminal, therefore, claims were raised against APM Terminals by port stakeholders due to the delay of clearing imported containers (Albastaki, 2018). As a result, several industries, stores, and retailers increased the price of the imported commodities and merchandise, due to limited inventory and extended lead time caused by port congestion and consequently, passed on the additional cost incurred due to port delays to be paid by the ultimate end users. APM Terminals received several complaints and claims to this effect and had to compensate the affected parties due to the delays and inconveniences caused by slow clearance of imported shipments (Albastaki, 2018).

Due to its critical role as the only port, any disruptions at KBSP such as congestion may subsequently affect Bahrain maritime industry as well as the end consumers. It is, therefore, crucial to appreciate the importance of providing reliable port services to the country to sustain the businesses as reliable port services will eventually lead to the development of the national economy. It is, therefore, imperative to have a holistic picture

of the supply chain, and to fully consider the importance of all nodes and links in order to realise supply chain theories such as Just In Time (JIT). The motivation of the researchers to conduct this research is coming from the importance of the maritime sector of their respective countries. The maritime industry provides their communities with various types of essential commodities.

The researchers also believe that any delays in the clearance of cargoes from the port can have a detrimental impact on the entire industry. This may lead to losing its reputation and competitiveness in the region. It is also important to mention that one of the researchers works for the port authority of Bahrain (The Ports and Maritime Affairs – PMA), and part of his responsibilities is to periodically monitor and report KBSP performance to the PMA's Management (MTT, 2016). The importance of the issue at hand comes from the researcher's responsibility as a government official; to examine the problem and come up with the best possible solutions to help in resolving the port congestion issue.

Port performance is one of the most important issues to be looked into at any port as it may impact port competitiveness, reputation and hinder ports from reaching a competitive edge (Moon, 2018). Being a state-of-art facility, KBSP is a developed port and operated by one of the leading port operating companies, which is capable of overcoming the port congestion issue. The congestion issue at KBSP should, therefore, be examined from a theoretical perspective through reviewing literature to know what the authors and the industry practitioners have said about the port congestion issue and what are the best available tools that can be used to analyze and resolve port congestion issues.

1.2 Aims and Objectives

Based on the background above, this study aims to provide overall insight into the container terminal performance and in particular mitigating port congestion issues. Furthermore, the specific objectives of this research include:

a. To evaluate the current container terminal performance of KBSP.

b. To analyze the issues and problems that gave rise to the congestion of KBSP.
c. To make specific, urgent recommendations to mitigate KBSP congestion.
d. To provide insight and contribution to the port authority (PMA) and the management of APMT and related stakeholder in particular, and for other ports that face similar problems across the world.

1.3 Methodology

This research utilized mix methods of qualitative and quantitative data collection that has been employed for analyzing the KBSP container terminal performance. The results of the analysis for the current port condition will be synthesized through a literature review, questionnaires and Bahraini maritime industry experts. The resources of the study and the literature review will include port statistics, WMU materials, academic resources, and correspondence with Bahraini government officials. In addition, the Assistant Undersecretary for Port Affairs will also be interviewed, and a copy of the questionnaire will be provided to him to participate in this research. Port stakeholders will also participate in the questionnaire to have their opinions in this respect.

The research carried out also involved empirical tests where quantitative data of two years' port statistics were collected and analyzed and the main KPIs/PPIs calculated. In addition, a regression in E-views software was carried out using independent variable (Y=throughput) and dependent variables (X_1 to X_{10}). The regression and forecast in E-views were made to identify, using thirteen years data, the variables affecting the port performance (Y) and estimate the KBSP future throughput. The regression and forecast results are interpreted in order to understand the inferences of the final results and hypothetically test the problem and come to a logical conclusion of the evaluation (Alhameedi, 2018). The forecast was carried out in order to predict the future throughput of KBSP to help in coming up with the appropriate solutions for the congestion issues. Key port statistical data were been analyzed in the aforesaid analytical tools to calculate

KPIs/PPIs, identify variables affecting throughput, predict the future container throughput and arrive at the best congestion mitigation measures according to the trend concluded.

In order to help to analyze and understand the factors affecting the port's performance internally and externally, a preliminary SWOT analysis was developed on this research in order to create a comprehensive approach and address internal and external factors that are contributing to the port congestion (Alhameedi, 2018). After that, the quantitative data interpretation was made as generated from the analysis output by the analytical tools. The comprehensive SWOT analysis interrelation was made to understand the relation between the possible causes of the problem and therefore come to a conclusion to make the best possible recommendations (Alhameedi, 2018).

The research ethics guidelines set by WMU are adhered to because any research should consider the ethical matters when conducting any research that involves questionnaires and/or interviews (Alhameedi, 2018). In this regard, the Research Ethics Committee's (REC) approval has already been sought for and obtained to enable the researchers to conduct the research according to WMU's guidelines in coordination with the Port Authority of Bahrain. Besides, WMU's official REC's consent form was embedded into the questionnaire form that was sent to the port stakeholders prior to the beginning of the research (Alhameedi, 2018). Furthermore, the researchers have strictly adhered to the preliminary timeline developed for the research as agreed and approved by WMU. The researchers appreciate the academic procedure as stated by the WMU and therefore followed the dissertation writing guidelines in particular.

The interpretation of the quantitative and qualitative analysis helped the researchers in developing the best possible solutions for KBSP congestion. Furthermore, various port congestion solutions were addressed in the recommendations such as investing in human resources and port laborers, investing in new technologies, equipment, digitalization, and port re-planning to help mitigate KBSP congestion. The results of the research will form a basis for further discussions and consultations with the Assistant Undersecretary of PMA to determine the way forward and any cost involved in implementing these solutions. The

role of the port authority is to regulate and monitor the performance of the port operating company. This relationship between PMA and APM Terminals is regulated as per the port concession agreement (Legal affairs, 2006). The contract between the government and APM Terminals may limit the implementation of the solutions mentioned in this research because of the cost involved for some of the measures. There is a need for improving KBSP performance in order to retain the main port customers (shipping lines) calling the port and attract more shipping lines in this fierce competition industry.

1.4 Dissertation Workflow

In order to achieve the objectives of this dissertation, the research is divided and organized into the following five chapters:

Chapter one covers the background of the research and the congestion problem at KBSP. Besides, the motivation of the project, aims and objectives have been addressed in this chapter to indicate the importance of the study and how it is affecting the country in question. The expected results, assumption and potential limitations have also been concluded in chapter one.

Chapter two contains an in-depth literature review that is related to the port performance and congestions to have a better insight into the problem at hand. The literature has also clarified how ports can measure performance and enhance productivity and efficiency. A comprehensive literature review was made to address the port congestion problem; and also this chapter has examined and provided a better understanding of the problem from a theoretical/academic perspective.

Chapter three provides the research methodology and the conceptual framework deployed in investigating the research topic. In addition, this chapter has covered the research design and how the data was collected and analyzed using the analytical tools explained in chapter one.

Chapter four presents the result obtained from the analytical tools that have been used in the research with the interpretation of different information as per the statistical data, questionnaires, interviews and port statistical reports. This chapter discussed the potential solutions that can be utilized in order to enhance the port performance and mitigate port congestion for KBSP.

Chapter five contains the summary of the study according to the result obtained from the analysis and the conclusion of the evaluation of KBSP whilst highlighting possible limitations.

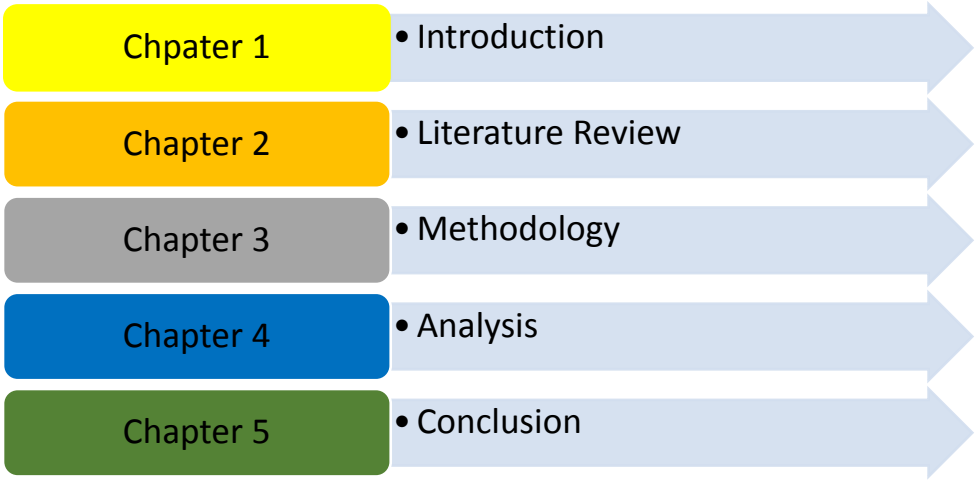

Figure 4: Research Structure
(Source: Author, 2018)

Below is the literature review that discusses the definition of the port and what importance it has for a country's national economy. The literature will also discuss how important reliable port logistics and performance are in mitigating congestion through managing resources, labor, and information. Besides, the literature also illustrates what authors and industry practitioners have said about port efficiency and performance reliability. Furthermore, the literature will also discuss how the port efficiency and container terminal operations, in particular, is significant for the overall global economy and the competition that ports create for the nation to compete through port service quality.

In addition, the researchers will critically analyze and combine the different opinions from the authors and relate it to KBSP for further understanding.

2. LITERATURE REVIEW

According to Moon (2018), ports are critical facilities where ships berth, and containers, cargoes and passengers interchange takes place. Ports may also refer to multiple harbors that consist of facilities and shelters for different types of vessels. Other definitions refer to a port as an organization where the handling and operations of waterborne traffic are being loaded, unloaded, transhipped, transferred reloaded, stored and delivered from/to port stakeholders. The port organization normally consist of a port operator, customs, warehouses, yards, berths, quay walls, quarantine, port handling equipment and gate (Moon, 2018). The main stakeholders are the shipping lines, clearing brokers, freight agents, truckers, manufacturers, and consumers. Port logistics in the context of ports is referred to as the strategic and effective management of various logistics processes such as communication, flow of information, procurement, storage, consolidation and dispatching through the assigned communications medium in a cost-effective manner to achieve organizational goals and mainly profit maximization in relation to the port functions (Knemeyer, 2006).

Logistics is defined as moving the right thing at the right time at the right place at the right price, and the R can be further extended as per the business or customer requirement (Moon, 2018). As such, ports are considered as an interface between the shippers and the consignees or in other words, it is the central processing node for the cargo interchange, logistical operations and value-added services from the shipper to the consignee. Port activities consist of different operations and functions that facilitate smooth and reliable movement of the cargo and the containers imported/exported through the port; and may also add value to a particular shipment. Port related support activities

include, transportation, packaging, warehousing, cargo/container handling, and information processing. From the literature, the importance of ports and how they play a critical role in the national and international trade is highlighted clearly. That is why Knemeyer (2006) mentioned in his book that flow of cargo and related information should be organized and managed strategically in a way that profit is maximized to the highest possible levels. Profit maximization in a port may not be achieved without operational excellence performance, efficiency and effectiveness. Time also plays a vital part from the perspective of all stakeholders, including the port operator and authority. Examples may include vessel turnaround time, container handling time per crane and container pick up time by a consignee. This should be reduced to the minimum levels possible so that all the stakeholders are able to make use of the time utilized for that particular operation; hence improving efficiency and maximizing on profits. Therefore, port congestion or delays may impact the port logistics and the effect can be cascaded to the port stakeholder who can be affected along with the end consumers (Moon, 2017).

With ports being the critical nodes, they act as a strategic hub to provide essential services that add value to the imported and exported products (Kissling, 2007). The services provided at the ports include loading, offloading, stuffing, de-stuffing, transporting, storage, sorting, consolidation and dispatching of cargoes (Moon, 2018). The efficiency in delivering these services is highly essential to all port customers, and it is imperative that port operators should be able to manage available resources well, in a manner that will enable the port to deliver world-class services to its customers. Labor and equipment need to be managed appropriately to achieve performance efficiency in vessel handling and yard operations that leads to on-time deliveries and ultimately fulfill customer's requirement as well as satisfaction (Tang & Lee, 2011; Wang, 2017). It is very clear from Tang's and Wang's literature that service quality is the main driver for retaining customer and profit maximization which is a win-win situation.

A port needs to offer reliable, efficient and effective services because only then will it be able to retain its customers, especially in the case of shipping lines where vessel

turnaround time needs to be minimized through high performance. Additionally, the excellence in port performance will lead to generating profits when port services are performed efficiently and effectively. Customer satisfaction translates to business continuity, strengthened business relationships between the port and its stakeholders, more volumes as port provides reliable services and ultimately realizing a win-win situation for all parties involved. It is critical from the port logistics perspective to minimize the time taken in providing a service (such as container delivery) for a port customer as the delay may have financial and economic implications to various parties. Subsequently, all parties across the supply chain can benefit from minimizing unnecessary waiting time which will ultimately improve the port efficiency as containers and cargoes are delivered on time to the customers at the promised time slot allocated by the port.

The importance of ports comes from the role they play and the contribution they make in developing national economies. Ports are hubs and centers of operations within a supply chain, and their reliability becomes critical for the whole supply chain. Furthermore, reliable and efficient port services can help a country's economic development through supplying the industries and citizens with the required materials when needed; and can, therefore, compete with neighboring ports to attract major shipping lines through the provision of world class services and reliability (Tang et al, 2011b). Port performance can be impacted by many factors (internal and external) that need to be addressed by the port authorities and port operating companies and taken into consideration to lessen the impact in the overall maritime business for the country in question. For example, port congestion may occur due to force majeure, weather condition, failure or shortage of equipment and lack of skilled port labors. Consequently, port operational disruption or poor performance can negatively impact the entire supply chain and therefore all other parties and port stakeholder's interests are affected accordingly (LOH & THAI, 2015).

Tang, Lee and Chew (2017) discussed the importance of the ports within the supply chain. It can be understood that ports are an important node within the supply chain and

all possible efforts should be made in order to maintain port performance levels at the highest level as possible to satisfy and retain port customers and mainly shipping lines. Additionally, the port customer will always expect service excellence and efficiency through provision of various port functions and activities such as vessel maneuvering, loading, unloading, cargo transfer, storage, and dispatching of cargo. Port capacity, therefore, needs to be adjusted accordingly in order to improve the weakest link of the port supply chain as it is known that the chain is only strong as its weakest link (Moon, 2017). Ports should refrain from providing services that exceed their capacities and should not receive or handle large container vessels unless all the supporting equipment and infrastructure are equally capable, in terms of capacity, to handle the volumes brought by incoming vessels (Moon, 2018). Tang, Lee and Chew (2017) stressed on the importance of the port service quality and its significance in economic growth through revenue maximization and through reliable and efficient handling of the vessels and cargoes brought into the terminal.

It is important to note that the amount of container traffic that was handled by the old port (MSP) has never exceeded 200K TEU annually and the port was handling feeder vessels only. Since its inauguration in 2009, KBSP has been handling almost triple the capacity of MSP with volumes ranging between 300K and 500 K TEU annually (Almahmood, 2018). The dramatic increase in the volumes handled by KBSP is due the population increase and economic growth of the country. KBSP also experienced an increase in the number of calls of mother container ships which are loaded with thousands of containers consigned for Bahrain's captive market (Almahmood, 2017). APMT management did not anticipate the large volumes carried by the mother vessels considering the limited number of port handling equipment. As a result, the increase in ship size led to an increase in the ships' waiting time as ships have to wait longer in anchorage and will have long service time as the port is unable to cope with the traffic growth.

Knemeyer (2006), suggests that information and future planning should be managed effectively in order for the port to effectively plan and be equipped with adequate infrastructure and equipment, in anticipation of the growth of traffic volumes, which is apparently KBSP had overlooked. Tang, Lee and Chew (2011) also stated that customer retention is determined by the quality of the services provided. KBSP is currently facing challenges with this because of the delays caused by the port congestion. Normally, the main reasons for having the ships wait in the anchorage area for a long time is the slow operation of the vessels that are already alongside, and the gate operations that cause shifting of port handling equipment from the berth operations to support the gate's received and delivery operations (Albastaki, 2018). These equipment are mainly RTGs, terminal trucks, reach stackers and heavy forklifts which are limited as mentioned earlier in this research. Therefore, port congestion is a complex issue that poses a major challenge to many ports globally even in the recognized terminal around the world.

It is important for governments and port operating companies to work hand in hand in order to solve the port congestions issues. Particularly, the development of the logistics and port sector is one of the main agenda items for Bahrain's Government and it is important to investigate the issue and recommend the best solutions to enhance the port and maritime sector through providing world-class port services. Bahrain port authority is currently making several initiatives and conducting projects to develop the maritime industry and contribute to enhancing port performance and efficiency such as automation, single window integration and dredging Bahrain approach channel and APMT's investments to accommodate larger vessels (MTT, 2016). Nevertheless, the port has a limited number of port handling equipment according to figure 3 that illustrate the key port information, as the terminal is equipped with four shore to ship cranes and 12 rubber-tired gantry cranes, which are not sufficient, especially during peak operating times as the port experiences an increase in throughput.

On one hand, port authorities' role in regulating port operators is to ensure that the port is always delivering best services to its clients and sufficiently market it. This is to

promote and attract the major shipping lines to utilize the facility and increase the container volumes. However, the port needs to invest and provide adequate infrastructure/superstructure and equip the port with a sufficient number of handling equipment to cope up with the expected volumes. KBSP handled around half million TEUs in 2015 and made a remarkable record which the KBSP never handled and even in Bahrain's maritime history (APMT, 2018). During the same year, KBSP's management reached an agreement with some of the shipping alliances to start calling KBSP using some of their largest mother vessels that have a length over all of 350 meters (BNA, 2018). This collaboration between the port authority and APMT resulted in a win-win situation where the main three alliances such as 2M (MAERKS, MSC, HMM), the ocean alliance (CMA-CGM, Cosco Group, OOCL, and Evergreen) and the alliance (Hapag Lloyd, NYK, Yang Ming, MOL, K-Line) deployed their vessels to KBSP and included Bahrain in their regular scheduled services to the region (MTT, 2016) making KBSP important hub in the region for the alliances.

The KBSP is capable of handling small to medium size vessels (Almahmood, 2018). Receiving larger vessels with greater container volumes may result in bottlenecks and consequently port congestion. According to Moon (2018), high berth utilization means high ships waiting time that can result in slow container handling and, therefore, port congestion. In addition, it can be concluded from the literature that utilizing terminal facilities and port handling equipment at high levels does not mean that it is the optimal level of utilization. In other words, port operators should understand that 100% port utilization does not indicate performance efficiency and effectiveness. On the contrary, continuous high levels of utilization can lead to terminal congestion. Terminals and port authorities should work closely to find the best fit for handling capacity and utilization levels to manage the terminal operation. The optimal TEU capacity for a port with four berth terminals and 4 STS cranes is 100K TEU per crane and the optimal berth utilization level for a four berth terminal should not exceed 60% (Dragović, 2009).

From a vessel operator's perspective, port congestion is described as the condition where a vessel on arrival spends more time at anchorage waiting to be berthed. The terminal operator would express congestion as the number of container/cargoes that are coming to the port as being more than the empty available storage slots in the yard. In this context, more ships will queue up in the vessel anchorage area waiting to get berthed at the terminal. The waiting time is calculated using ship service time which is one way of measuring the efficiency of the port (Onwumere, 2008). Based on classical transportation magazines, logistics, freight, and multi-modal transportation, most claim that port congestion is a common obstacle that may affect economic growth because it has negative implications on economic resources, waste of time and space as well increased operating costs and incurring costs to the community (Oyatoye, 2011).

Key performance indicators (KPIs) and Port performance indicators (PPIs) play an essential role in helping to measure and analyze the performance of the port operations in order to provide insight for the management to identify bottlenecks at the terminals. Primarily, the port KPIs/PPIs analysis can be used to compare port performance with the targeted levels and also monitor performance of the terminal in question. Furthermore, KPIs/PPIs can be a useful tool to assist the port operator and port authority to take decisions that help in controlling and mitigating any operational issues whilst assisting in developing strategic plans that can improve port performance (UNCTAD, 2017). It can be concluded, therefore, that ports play an essential role not only in economic development of a country but also in sustaining businesses and the nation's prosperity. Thus, the sustainability of ports is an important pillar in industry's growth. Port performance should be considered by governments and port operators in order to achieve an adequate level of port services to ensure that cargoes are handled without delays. Entities within the port need to collaborate with the port authority and the port operating company to achieve port performance excellence. This can be done by adhering to industry best practices such as taking delivery of cargoes from the port as soon as the

cargoes are available for delivery. It is important to note that ports are not intended to store cargo but only to facilitate the receipt and delivery.

Ports are a critical link in the supply chain, and smooth flow of cargoes is essential and important for all players across the supply chain because of the economic interest and necessity. Therefore, moving cargoes as per the 5R or 7R concept is an ultimate objective for port stakeholders. Ports compete globally through provision of world-class services at ports so as to attract and retain the shipping lines. Thus, there is a high interest for the researchers to conduct this research because KBSP is the main gateway to the country and the only port in Bahrain. The country imports most of its needs of goods through this port, and it is necessary that the port services are delivered efficiently to ensure smooth flow of goods and optimum inventories are realized in the local market.

There have been several complaints raised by port stakeholders regarding KBSP congestion and delays in clearing cargoes. The research team was incentivized to carry out the research due to the increasing global trend of port privatization and hope that the research can assist not only KBSP but also serve as a base point for reference to other ports who may or may not be privatized but are facing performance problems. In respect to Bahrain maritime industry, no such research has been initiated; thus this paper seeks to provide in depth knowledge in regard to the topical issue. The researchers are also motivated to solve the congestion at KBSP which will benefit Bahrain and help the country to achieve the optimal port performance levels. This is because there have been several complaints raised by port stakeholders regarding KBSP congestion and delays in clearing cargoes. Therefore, the researchers will use qualitative and quantitative analytical tools in order to evaluate the performance level at KBSP and develop possible solutions to mitigate the port congestion, which will be discussed further in the following chapters.

3. METHODOLOGY

3.1 Introduction

This chapter seeks to discuss the methodology, assist to formulate research designs and explain the data collection methods and analytical tools used for this study. The researchers have made a preliminary analysis through SWOT in the introduction part to analyze the Bahrain maritime industry in order to understand the context within which KBSP currently operates in. The main objective of this research is not just to describe the state of the port under this study, but also include the process of exploring facts through the data analysis in order to reach the best possible solution for the issue at hand. The research uses a mix, which is a design that combines two methods, including quantitative and qualitative approaches to obtain more comprehensive, valid, reliable and interpretive results that can help in evaluating the KBSP performance, measuring the congestion levels and suggesting ways of possible improvements. Table 2 provides an overview of the methodology used by the researchers:

Table 2: Methodology Review.

Problem	Approach	Method
1- Evaluate KBSP container terminal performance	Quantitative	KPI Analysis
2- Investigate factors that contribute to terminal congestion	Quantitative and Qualitative	Regression analysis (E-views) Questionnaires
3- Forecast future throughput	Quantitative	Regression analysis (E-views)

(Source: Author, 2018)

From the quantitative data perspective, the researchers have initiated the analysis process for the KBSP primary statistical data by using three analytical tools:

a. Firstly, measuring the performance of the KBSP by using Key Performance Indicator (KPI) instrument to give the current status of KBSP;
b. Secondly, carry out a regression analysis using E-views software to identify factors (X1 to X10) that affect the KBSP container throughput (Y);
c. Thirdly, conducting a forecast using E-views software to predict future container terminal throughput to support the researchers in providing appropriate recommendations to be implemented by KBSP.

The quantitative data analysis was then followed by the collection of questionnaires to further investigate the underlying issues facing the industry in order to support the results of the analysis and relate it to the quantitative data analysis that was conducted in the first stage. After conducting a series of quantitative analysis using the three analytical instruments mentioned above and thereafter supported by the questionnaires and SWOT analysis results, the researchers have reviewed and interpreted the the analysis and proceeded with the evaluation of the KBSP performance, the conclusion of the case study and finally developed the recommendations for possible ways to resolve the issue and improve the current state of the port.

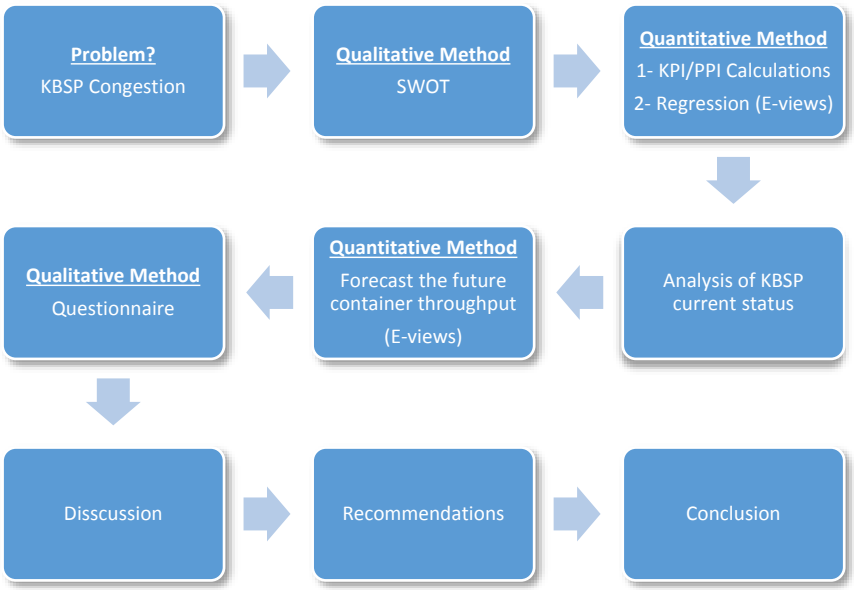

Figure 5: Research Design
(Source: Author, 2018)

3.2 Data Collection Method

Data collection is one of the most important stages in the research activities carried out after developing the research design. At this point, KBSP's primary statistical data collection was carried out through obtaining port statistics from Bahrain port authority. Surveys were also conducted using questionnaires for port stakeholders, which were circulated after obtaining the necessary approvals from WMU and the port authority for this study. The primary data was collected directly from the port operating company APMT, the port authority and the port stakeholders, while secondary data was obtained through literature and reports from academic resources and some interviews. This ensures validity and accuracy of all the data collected.

3.3 Qualitative Methods

3.3.1 SWOT Analysis Approach

The SWOT analysis approach provides for a framework that would aid the research team to identify and map out the industry within which KBSP operates in. The analysis is, therefore, a useful tool to assist the researchers in analyzing the strengths, weaknesses, opportunities of KBSP. SWOT analysis is geared towards aiding the research team gain deep and accurate understanding of KBSP about its current circumstances, which can be translated into strategies and solutions that are being faced or are likely to be faced by the KBSP (USDA, 2008). Moreover, SWOT analysis is an approach used to assess the feasibility of a business strategy, hence the potential threats and opportunities. Basically this method uses internal information and information related to the external environment of the company (Singh, 2010).

3.3.2 Questionnaires

The questionnaire is an instrument employed in indirect communication techniques. The questionnaire as a data collection tool is a number of written questions, which must be answered by the respondent. The results of the questionnaires will be

transformed into numbers, tables, statistical analysis and descriptions and conclusions of the results of the study. In the mixed methodology the questionnaire is an important element in the collection of research information. Research has proven that questionnaire design can have an impact on the quality of the data used in a study.

The purpose of the questionnaire includes:

1. Gathering a great deal of information relevant to the needs of guidance and information regarding the KBSP.
2. Obtaining data first hand ensuring the highest reliability and validity.
3. Using it to obtain data about the background issues that exist in the KBSP.

While on the other hand the key functions of the questionnaires include:

1. Gathering information as basic material in the framework of strategy preparation.
2. Guaranteeing the validity of information obtained by other methods.
3. Taking a sampling of the attitudes or opinions of respondents.
4. Using it as a tool for obtaining data that is in accordance with the research objectives and elaboration of the hypothesis (Burns et al, 2000).

3.4 Quantitative Methods

3.4.1 Measuring the Port Key Performance Indicators (KPIs)

KPIs are measurable values that describe the performance level of the port by measuring the time for a particular port activity carried out in the terminal (Moon, 2018). The KPIs can be used in measuring the effectiveness and port performance efficiency that can lead to improving service quality by minimizing port time and cargo handling time. For example, the port authority has certain KPIs set for APMT in the concession agreement which works as a base for the port operating company; and the authority periodically compares it with the actual performance. In addition, KPI assessment is a very important tool to evaluate port performance and also to provide ways for improvements in terms of operational efficiency and productivity. Performance indicators

for measuring performance are generally determined based on the time-related KPIs, tonnage or TEU handled, the number of vessel calls at the port and other port-related KPIs (World Bank, 1993).

For this case study, the research was initiated with the time-related KPIs in order to preliminary measure and evaluate the KBSP's performance and also to support the regression and forecast analysis generated from E-views. The preliminary analysis result can help the researchers in developing ways for improvements that will be addressed through recommendations at the end of this study. The important time-related KPIs that were used for analyzing KBSP performance are as follows:

Table 3: KPIs Used for KBSP CT Analysis

KPI	Abbr	Indicator (Average)
Average Time in Port	ATP	$ATP = \frac{\sum \text{Total Time in Port (in hours)}}{\text{Total number of ships}}$
Average Gross Berthing Time	AGBT	$AGBT = \frac{\sum \text{berthing time (in hours)}}{\text{Total number of ships}}$
Average Idle Time	AIT	$AIT = \frac{\sum \text{Total Time in Port (in hours)}}{\text{Total number of ships}}$
Average Service Time	AST	$AST = \frac{\sum \text{Total Time in Port (in hours)}}{\text{Total number of ships}}$
Average Manoeuvring Time	AMT	$AMT = \frac{\sum \text{Manoeuvring Time (in hours)}}{\text{Total number of ships}}$
Avenge Ship Turnaround Time	ASTT	$ASTT = \frac{\sum \text{Hours vessel stayed (buoy to buoy time)}}{\text{Total number of ships}}$
Berth Occupancy rate	BOR	$BOR = \frac{\sum \text{Total Service Time in Port X Meters used}}{\sum \text{Available Hours X Meters}}$
Gross Crane Productivity	GCP	$GCP = \frac{\sum \text{Number of Container Moves}}{\text{Total Vessel Time at berth from first to last line}}$
Net Crane Productivity	NCP	GCP – total idling time
Gross Berth Productivity	GBP	$GBP = \frac{\sum \text{Container Moves}}{\text{Total Vessel Time at berth from first to last line}}$
TEU Per Crane Hour	TPCH	$TPCH = \frac{\sum \text{TEU handled}}{\text{Total Crane-hours worked}}$
TEU Per Ship Per Day	TPSPD	$TPSPD = \frac{\sum \text{TEU handled}}{\text{Total Vessel days in port}}$
TEU Per Ship Per Port Hour	PSO	$PSO = \frac{\sum \text{TEU handled}}{\text{Total Port Hours}}$
TEU Per Ship Per Berth Hour	BSO	$BSO = \frac{\sum \text{TEU handled}}{\text{Total service Hours}}$
TEU Per Ship Working Hour	WSO	$WSO = \frac{\sum \text{TEU handled}}{\text{Total Productive Hours}}$
AVG Productive Ratio	APR	$APR = \frac{\sum \text{Productive Time (in hours) X 100}}{\text{Total Service Time (in Hours)}}$
Labour Utilization	LUR	$LUR = \frac{\sum \text{Service Time in Port (in hours) X 100}}{\text{Total available hours X Workers}}$
Crane Utilization Rate	CUR	$CUR = \frac{\sum \text{Service Time in Port (in hours) X 100}}{\text{[illegible]}}$

(Source: Moon, 2018)

3.4.2 Regression Analysis to Forecast the Future Throughput

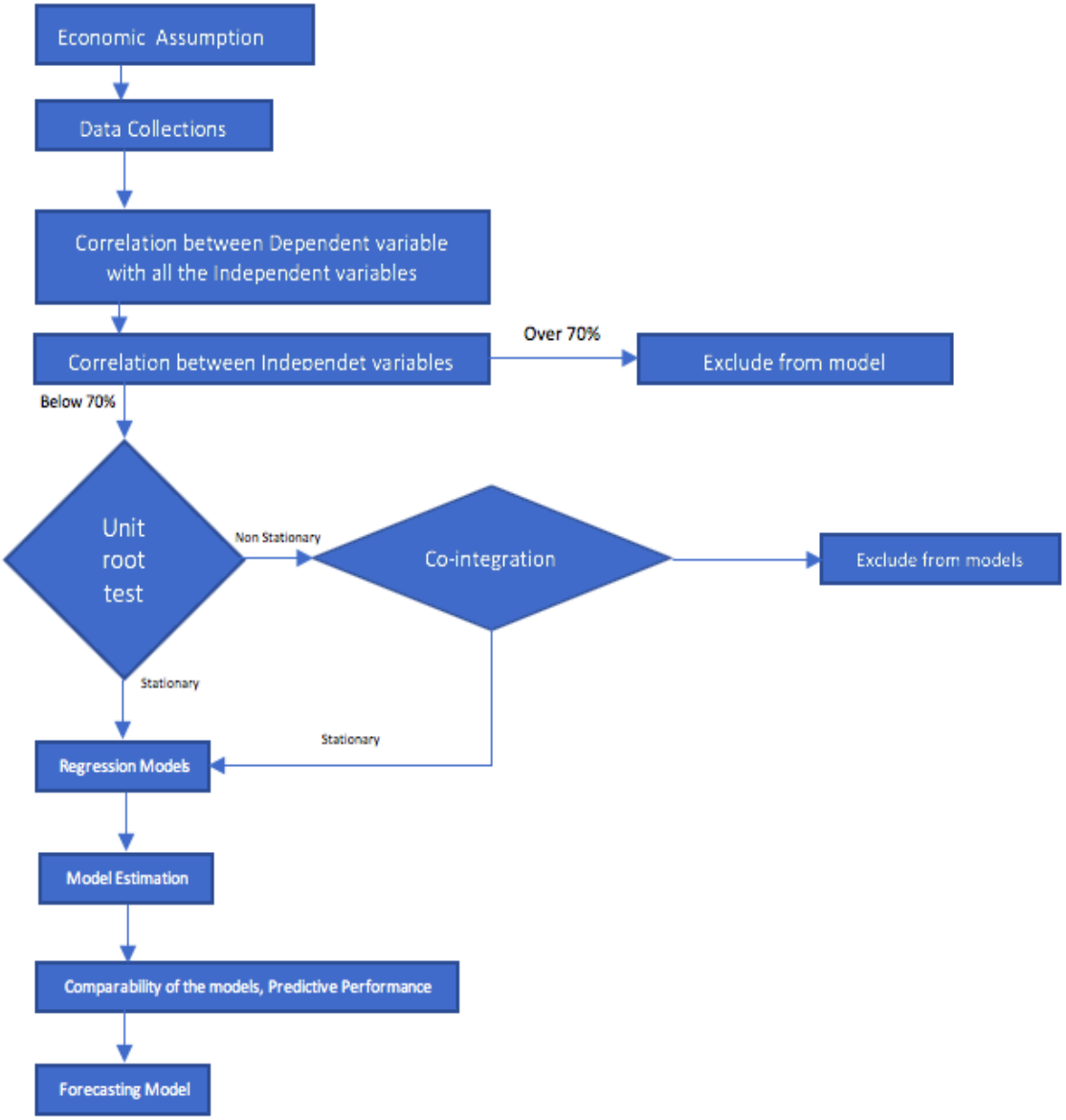

Figure 6: Eviews Regression Flowchart
(Source: Author, 2018)

The annual container terminal throughput for KBSP is measured by the aggregated number of container moves handled across the quayside and consist mainly of imports

and exports. The terminal has of late become a transhipment hub to the upper northern Gulf but handles very small volumes of transhipment containers due to various economic reasons and value proposition (Almahmood, 2018).

- There is a continuous fluctuation on the monthly container throughput at KBSP affected which is affected by the captive market's demand and seasonality that causes a commercial and economic impact (Almahmood, 2018).
- According to the statistical analysis of the KBSP annual TEU throughput; the regression estimation can be developed as follow (Alhameedi, 2018):

$$\textbf{TEU Throughput} = \sum(\boldsymbol{Export}) + \sum(\boldsymbol{Import}) + \sum(\boldsymbol{Transshipment}) + \sum(\boldsymbol{Restow})$$

This research is focused on KBSP container terminal and particularly the berth throughput performance evaluation as per the best industry practices to determine the optimal performance level. Therefore, in the E-Views estimation model; the KBSP TEU throughput is considered as the (Y) or the dependent variable while the (X) independent variables are KBSP KPIs/PPIs (see table 5) and some economic indicators that may have a correlation or impact (positively or negatively) on the KBSP throughput. The researchers have considered for the regression analysis a 13 years' time series data in a monthly frequency that consist of 156 observations in E-views. The KBSP container terminal annual throughput model can be estimated in the model as follows:

$$\textbf{CT Throughput} = \alpha + \beta_1 * \text{Number of Vessels} + \beta_2 * \text{Crane Productivity} + \text{Total Transhipment} + \text{Berth Productivity} + \ldots \mu$$

The KBSP annual TEU throughput can be estimated mathematically in E-views as per table 4 below:

Table 4: KBSP TEU throughput Estimation in E-Views.

Item	Description
E-views Model Estimation	$Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \ldots + \beta_kX_k + \mu$
Y	Dependent variable
Xi	Independent variable
α	Constant
β_i	Coefficient
μ	Error term

(Source: Alhameedi et al, 2018)

Table 5: Independent Variables

Independent variables	Xi	Description
Total import moves	X_1	No. of import containers handled at the terminal
Total export moves	X_2	No. of export containers handled at the terminal
Total re-stow (TUE)	X_3	No. of re-stow containers handled at the terminal
Total transhipment	X_4	No. of transhipment containers handled at the terminal
LCL un-stuffing	X_5	No. of LCL operations handled at freight stations
Berth productivity	X_6	No. of TEUs handled at berth per vessel
Gross crane productivity	X_7	No. of TEUs handled by a crane per hour
Gate turn time	X_8	Time between In-time and Out-time per truck for delivery or receive operation
Vessel turnaround time	X_9	Time from arrival to departure of a vessel
Gate transactions	X_{10}	No. of transactions performed at Gate House of the terminal
General cargo throughput	X_{11}	Volume of general cargo freight tons handled at the GC terminal
Car volume	X_{12}	No. of vehicles imported/exported via GC terminal
Container vessels	X_{13}	No. of container vessels operated at the terminal
General cargo vessels	X_{14}	No. of general cargo vessels operated at the GC terminal
Container dwell time	X_{15}	Period of time that a container stays at the terminal
Clarkson CT earning	X_{16}	Ave. earning of a Containership Earnings per day in USD as per Clarkson Index
Clarkson NB price 2600 TEU vessel	X_{17}	Ave. price of new built vessel of 2600 TEUs as per Clarkson Index

(Source: Alhameedi et al, 2018 and MTT, 2018)

4. IN-DEPTH ANALYSIS OF KBSP

4.1 General Overview

4.1.1 Vessels Calling KBSP

The average length overall (ALOA) for vessels that can call KBSP has increased from 227 meters in 2016 to 228 which is not a significant increase. As can be seen from the figure 8 there was an 11% decrease in the number of container vessels calling the port within the length of 300m 2017. In addition, the same number of vessels have called KBSP container terminal that is greater than 300 m in length in the same year. On the other hand, the average vessel gross tonnage is increasing. This is because the Ministry of Transportation has successfully convinced the main Asian ocean alliances to include KBSP in their services to Bahrain and replace their feeder vessels with fixed mother vessel services to the port (Almahmood, 2018).

The main shipping lines that are deploying mother vessels to KBSP includes ocean alliance (CMA CGM, Evergreen, OOCL and Cosco shipping) and other group liner companies such as the alliance (K-Line, NYK, Yang Ming, Happag Lloyd, and MOL); hence contributing to more tonnage to the services calling KBSP (MTT, 2016). The AVGT in 2017 increased by a mere 2% from 37,580 GT in 2016 to 38,199 GT. Figure 7 groups the gross tonnage of the vessels that are calling KBSP and indicates an average decrease in the number of vessels within the 300,001 gross tonnage and above when compared with 2016.

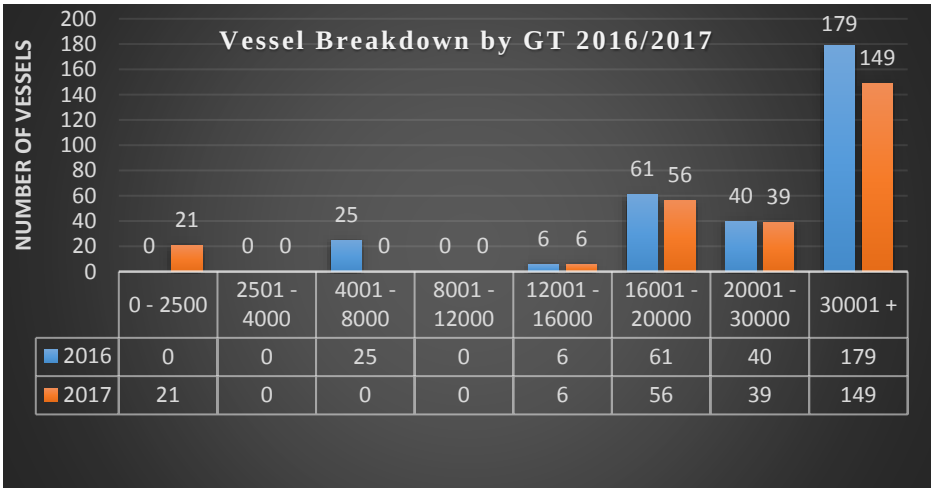

Figure 7: KBSP Vessel by GT.
(Source: MTT, 2018)

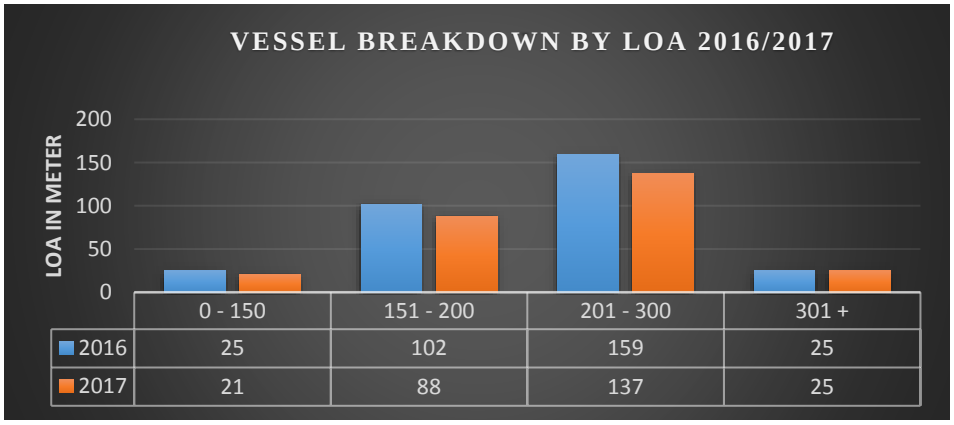

Figure 8: KBSP Vessels by Length Overall.
(Source: MTT, 2018)

4.1.2 Total Container Vessels Called KBSP 2016/2017

According to figure 9, the number of container vessels calling KBSP from 2013 to 2017 is constantly declining by an average of 12%. The decrease from 2013 to 2017 is equivalent to 41%, which is almost half the number of vessels handled in 2013. The decrease indicates that many shipping lines stopped or diverted their services to other terminals in the region as there was no value proposition for calling KBSP (Almahmood, 2018). It is evident that the decrease of number of vessels calling the port is related to the

fluctuation of service level at KBSP as reflected in the stakeholders' complaints as well as the questionnaires. Moreover, the TEU throughput is also trending with the decline of the number of container vessels because of the constant decline by an average of 6%. The decline from 2013 to 2017 is also 6% as a result of the decline of the number of container vessels as discussed above (MTT, 2018).

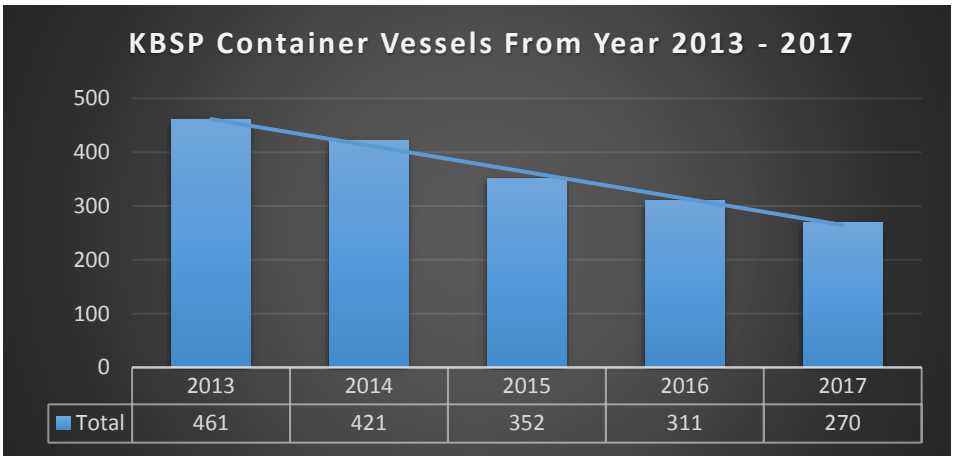

Figure 9: KBSP CT Vessels
(Source: MTT, 2018)

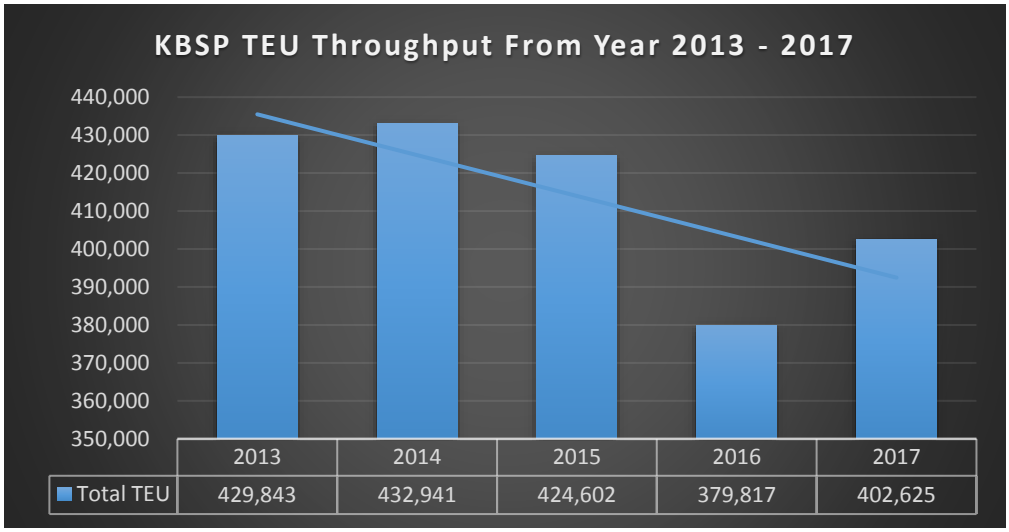

Figure 10: KBSP Throughput
(Source: MTT, 2018)

4.1.3 Understanding the Characteristics of KBSP using SWOT Analysis

The researchers have developed preliminary research using the SWOT analysis instrument that combines information from credible resources and interviews. The purpose of the SWOT is to enable the researchers to understand Bahrain's maritime industry and the characteristics of the sector as holistically possessed by KBSP in order to provide consideration and input for the next stage of the research. Here is the following result of the analysis:

Table 6: Matrix of the SWOT Analysis Results

STRENGTH	OPPORTUNITY
• Port Facilities Infrastructures: KBSP, which was officially inaugurated in 2009, stands firmly under the government of Bahrain. KBSP has modern, and new port handling equipment and port infrastructure was built in 2008. The port has all needed auxiliary services to support operational activities including customs clearance, marine control towers, passenger terminals, administration buildings, container shipping stations and medical care center (MTT, 2016). • Strategic Location: Another advantage that KBSP has in terms of hinterland connectivity especially to Saudi Arabia as strategically located at the center of the Gulf (MTT, 2018). • Draught: Since 2012, KBSP has carried out several dredging projects in stages starting from 13 meters to 17 meters, and pursued to a depth of 20 meters by 2019. This provides an opportunity for ships of large size to be able to call KBSP in their services to the region (MTT, 2018).	• Single window project: As the best country in the Middle East in terms of ICT development, the maritime sector together with KBSP collaborates with the Bahrain's e-government directorate to integrate all government and non-government entities in an electronic platform that will ease port transactions between all port stakeholders. This project was made to facilitate the flow of information and grant the approval feature of the concerned authorities for security clearance, export import declaration and cargo inspection. Besides that, single window can also facilitate inter-port transactions with service users through online self-service features (ITU, 2017). • The trade agreement and commercial ties that have been built by Bahrain government with major countries can be a great opportunity for APMT to attract international shipping companies to carry out their activities and transhipment through the KBSP (EDB, 2018).
• Congestion: As the only commercial port in the country that facilitates trade activities, KBSP become very important for the maritime industry and therefore in high demand. The port has 4 STS cranes and 12 RTGs only to handle the country's trade activities. (Almahmood, 2018). KBSP may face difficulty in handling incoming ships due to limited equipment. • Security procedures: the rise in the security level and customs formalities that requires scanning of all containers delivered to consignees contribute to the port congestion and delays (Sharif, 2018). • The congestion at King Fahad Causeway to Saudi Arabia is making KBSP unsuitable for trade by shipping lines who want to transhipment their containers and cargo through KBSP (BCCI, 2015).	• Throughput growth: The vast growth of the economy as a whole will lead to the opportunity for the container throughput to increase in the future. As a result, shipping lines and port stakeholders may divert their traffic to the other ports to avoid delays. • KPI target: If the APMT is not able to reach the annual KPI standard that has been set in the concession agreement, APMT must pay a certain number of un-negotiable penalties paid to the government (Almahmood, 2018). • Inadequate urban planning: the slow improvement of the roadway access to KBSP may not compensate the heavy traffic congestion around the port area and industrial zone. This will also interrupt the flow of the national supply chain (Almahmood, 2018).
WEAKNESS	THREATS

4.1.4 Stakeholders´ point of view

The research questionnaires that were distributed to the relevant stakeholders aim to provide qualitative information that can support the quantitative data that has been previously processed. In addition, the results of this questionnaire can provide an overview of the actual state that exists in the industry from the perspective of various relevant entities and port stakeholders. The correspondents are representatives of entities that include 27,6% government officials, 48,3% shipping lines, and shipping agencies, 19% freight forwarders, 8,6% ship chandlers, 5,2% trucking/haulage companies, 13,8% customs clearing agents and 19% others. The following conclusions can be made from the results of the questionnaire based on the answers obtained:

Table 7: Questionnaires Results overview

No.	Questions	%	Answers	Indication
1	Import Container Volume Per Month	65.5%	More than 50/month	Indicated that the KBSP port is classified as a congested port because it's the only port in Bahrain that handles the export and import.
2	In your opinion, how long it takes to pick up a container from KBSP?	43.1%	30 – 60 minutes	The industry standard for picking up or dropping off a container is 20 minutes. KBSP takes considerably longer to deliver a container.
3	KBSP terminal charges are reasonable versus the services provided?	48.9%	Fair	The port charge is reasonably compensating the service that has been provided.
4	Do you feel that KBSP is E-services compliant? If yes, do the E-Systems meet your expectations?	46.4%	Yes	This shows that KBSP is attempting to develop their E-services in terms of clients' self-service. The industry is satisfied with the service.
5	What causes excessive dwell times in your opinion?	36.4%	Customs scanning	The possibility of the delays in the scanning process carried out by the customs. APMT may have no influence on governmental operations.
6	What is the ship average waiting time at the KBSP during peak time?	42.1%	1-2 days	This confirms that there is a delay in vessel berthing which will affect vessel operations.
7	What is the average dwell times for containers and other cargoes within KBSP?	25%	2 – 4 days	For the relative size of the Bahrain maritime industry, 2-4 days are quite long and therefore, the dwell time is expected to be lower at KBSP.

8	How often do you experience congestion related to terminal operations?	22.8%	Seldom (50% - 25 % of the time)	This indicating that the port users experiencing congestions and delays at KBSP 25% - 50% of the time.
9	How often do you experience congestion related to vessel operations?	29,8%	Seldom (50% - 25 % of the time)	This indicating that the port users experiencing congestions and delays at KBSP 25% - 50% of the time.
10	How often do you experience congestion related to appointment procedure?	25.5%	Seldom (50% - 25 % of the time)	This indicates that the procedure of appointment might not be efficient and need improvement.
11	How often do you experience congestion related to CT gate operations?	25.5%	Often (50% - 75 % of the time)	This indicates that the port-users experiencing congestion in the CT gate operation 25%-50% of the time.
12	How often do you experience congestion related to scanning operations?	29.1%	Seldom (25% - 50 % of the time)	This indicates that the port users experience congestion in the scanning process 25% - 50% of the time.
13	How often do you experience congestion related to Customs documentation procedure?	23.6%	Seldom (25% - 50 % of the time)	This indicates that the port users experiencing delays in the processing of customs documentation 25%-50% of the time.
14	How are port workers assigned to a particular cargo/container handling operation?	40.7%	Per work schedule (E.g., shifts)	This indicates that KBSP applies the division of working time within the port's worker to have create an effective working environment.
15	Does the port have a terminal operating system (TOS) that incorporates container/cargo location?	84.9%	Yes	This indicates that KBSP is equipped with an adequate terminal operating system that captures cargoes/containers location.
16	KBSP delivers the containers according to appointment/time slot provided?	40%	Often	This indicates that KBSP often adheres to the appointment schedule given to the customer. On time delivery should be always adhered to.
17	What causes excessive dwell times in your opinion?	36.4%	Custome scanning	This indicates that other governmental agencies contribute to the increase in container dwell time hence port congestion.
18	I can obtain container appointment from KBSP whenever needed at short notice?	40.7%	Maybe	The port-users service indicated that there is an uncertainty to retrieve the cargoes within short notice.

No.	Questions	Rate	Indication
19	Kindly rate the following E-services (Appointment):	4	84.6% of the correspondents rated that the E-service (appointment) at KBSP as quite satisfying.
20	Online payment:	4	38.8% of the correspondents show unsatisfaction. However, 38.7% of them rated the E-service (online payment) at KBSP as satisfactory.
21	Container/cargo Tracking	5	33.3% of the correspondents are rated unsatisfied. However, 46.3% rated the E-service (container/cargo track) at KBSP as satisfying.
22	Refund process	1	50.9% of the correspondents rated the E-service regarding the refund at KBSP as not satisfying, this indicates the possibility of poor performance in the administrative processes carried out by APMT.
23	How congested is KBSP in your opinion?	5	37.5% of the correspondents rated KBSP as moderately congested. However, 33.9% assumed that the KBSP is highly congested, this indicates that some of the stakeholders are experiencing congestion at KBSP.
24	How congested is the Container terminal gate in your opinion?	4	44.6% of the correspondents rated the container terminal as moderately congested. However, 33.9% assumed that the KBSP is highly congested.
25	How do the clearance processes and Customs procedures affect the operation of KBSP?	4	35.2% of the correspondents stated that the customs procedures affect KBSP operations. Moreover, 9.3% assumed that the customs procedure is highly affecting KBSP operations. This indicates that the customs procedures do impact the container terminal operations.
26	How customer friendly is KBSP?	4	35.7% of the correspondents were moderately satisfied. However, 48.3% rated KBSP as user-friendly (satisfactory).
27	In your opinion, how adequate are KBSP facilities and port handling equipment?	4	32.7% of the correspondents expressed satisfaction. However, 34.6% rated KBSP as having adequate facilities and equipment.
28	The speed of loading and unloading operations of ships?	4	43.9% of the correspondents expressed somewhat dissatisfaction, but 45.6% rated the speed of the loading and unloading operation of ships as quite reasonable.
29	The speed of receipt and delivery operations of CT gate?	4	59.3% of the correspondents rated moderate. However, 24.1% rated the speed of the receipt and delivery operation of CT gate as fair.
30	Condition and availability of container yard	4	41.1% of the correspondents rated average. However, 39.3% rated the condition and availability of the container yard as good while 9% said it is excellent.

33.	Accessibility from berth to container yard/stacking area	5	40.7% of the correspondents rated the accessibility from berth to container yard as good. Moreover, 11.1% rated excellent.
31	Warehouse capacity for cargo/container storage	4	43.6% of the correspondents rated average. However 30.9% rated the warehouse capacity as very good, and 14.5% rated excellent.
32	How efficient is the documentation process for the pre-arrival of ships?	5	46.4% of the correspondents rated the documentation process for pre-arrival of ships as very good, and 7.1% rated it as excellent.
33	How efficient is the ship clearance process for departing ships?	5	44.6% of the correspondents rated the ship clearance process for departing ships as very good, while 10.7% said it is excellent.
34	Port workers/officer response toward customer's complaints	5	35.1% of the correspondents rated the port workers' response towards customers' complaints as very good, and 10.5% rated excellent.
35	Overall Condition of the berth/quayside	5	33.3% of the correspondents rated the overall condition of the berth as very good, and 17.5% rated excellent.
36	Availability of parking area for vehicles at the port	5	33.3% of the correspondents rated the availability of parking area for vehicles at the port as very good, and 22.8% rated excellent.
37	Accessibility from gate the berth		35.7% of the correspondents rated the accessibility from the gate to the berth as very good, and 22.8% rated it as excellent.

4.2 Results and Finding from the Quantitative Methods

4.2.1 Performance of KBSP

After processing the primary data through the calculation of important indicators related to assessing berth performance, the results in table 8 are obtained as follows:

Table 8: KBSP KPIs Years 2016 / 2017

KPI	Abbreviation	2016	2017	Unit	% Change
AVG Time in Port	ATP	18:14	22:00	Hour: Minute	+21%
AVG Gross Berthing Time	AGBT	16:53	20:15	Hour: Minute	+20%
AVG Ship Waiting Time	AWT	01:54	05:07	Hour: Minute	+270%
AVG Idle Time	AIT	03:26	02:14	Hour: Minute	-34%
AVG Service Time	AST	13:26	18:00	Hour: Minute	+36%
AVG Maneuvering Time	AMT	01:32	01:44	Hour: Minute	+14%
AVG Ship Turnaround Time	ASTT	18:00	22:00	Hour: Minute	+22%
Berth Occupancy Rate	BOR	60%	63%	%	+5%
Gross Crane Productivity	GCP	16	18.72	Moves / crane / gross / working hour	+17%
Net Crane Productivity	NCP	17	19.5	Moves / crane /net / working hour	+15%
Gross Berth Productivity	GBP	49	50	Moves / hour	+2%
TEU per Crane Hour	TPCH	30	27	TEUs / ship / crane / hour	-10%
TEU per Ship per day	TPSPD	1,208	1,491	TEUs / ship / day	+23%
TEU per Ship per Port hour	PSO	66	68	TEUs / ship / hour	+3%
TEU per Ship per Berth hour	BSO	72	74	TEUs / ship / port hour	+3%
TEU per Ship Working Hour	WSO	90	83	TEUs / ship / working hour	-8%
AVG Productive Ratio	APR	80%	89%	%	+11%
Labour Utilization	LUR	35%	40%	%	+14%
Crane Utilization Rate	CUR	36%	42%	%	+36%
Quay Productivity	QP	241	228	Moves / hour	+6%

(Source: Alhameedi et al, 2018 and MTT, 2018)

1) Average Time in Port (ATP)

ATP increased by twenty-one percent from 18.14 hrs in 2016 to 22.00 hrs in 2017. The increase of the average port time is as a result of several reasons, and mainly the operational reasons such as heat break given to port laborers due to high temperatures during summer time, pilotage delays, occupied or unavailable berths, bad weather, vessel delays at berth, shortage of pilots and pilotage equipment (Almahmood, 2018).

2) Average Ship Waiting Time (AWT)

AWT for arriving ships has dramatically increased by two hundred and seventy percent from 01:54 (2016) to 05:07 (2017) hours per ship. This indicates that the four berths are utilized whenever ships are arriving, which means that the container handling operations

are taking longer time as port time and average service time have also increased by 4 hours and 5 hours respectively (Almahmood, 2018).

3) Average Gross Berthing Time (AGBT)

AGBT increased by twenty percent from 16:53 hrs (2016) to 20:15 hrs (2017) comparing years. The increase of the average gross berthing time is caused by many reasons and mainly cargo customs and security-related inspection procedures, handling delays and port handling equipment breakdown (Almahmood, 2018).

4) Average Idle Time (AIT)

AIT has decreased by thirty-four percent from 3:26 hrs (2016) to 2:14 hrs (2017). The decrease of the average idle time shows that the port operating company is taking into consideration the required preparation before vessel arrivals to ensure that all port resources such as equipment and laborers are ready to execute operations adequately and ensure less idling times during loading/offloading operations and therefore less port stay for ships (Almahmood, 2018).

5) Average Service Time (AST)

AST shows thirty-four percent increase from 13:26 hrs (2016) to 18:00 hrs (2017). The average service time increase is justified by the increase of the container volumes brought into the terminal by the new alliances after the successful negotiation with the major alliances such as OOCL, COSCO and NYK (Almahmood, 2017).

6) Average Ship Maneuvering time (AMT)

AMT increased from 1:30 hrs (2016) to 1:40 hrs (2017). The large ocean alliances vessels have an average length overall of 330 m, and the port pilots are more careful when maneuvering these large ships as the port used to receive feeder ships which require less time for maneuvering (Almahmood, 2018).

7) Average Ship Turnaround Time (ASTT)

ASTT increased by twenty-two percent from 18 hrs (2016) to 22 hrs (2017). The limited number of gantry cranes and RTGs at KBSP and the increase in the volume and the vessel size, tonnage and length caused the increase in the average ship turnaround time as larger vessels require more time for handling at KBSP (Almahmood, 2018).

8) Berth Occupancy Rate (BOR)

BOR increased by three percent from 60 % (2016) to 63 % (2017). According to Dragović (2009), the optimal berth occupancy rate for a four berth terminal should not exceed 60%. It can be seen that the BOR is increasing above the optimal level due to the deployment of large vessels by the alliances which directly affected the BOR ratio and subsequently the ship waiting time (Moon, 2018).

9) Gross Crane Productivity (GCP moves / crane / gross)

GCP increased by seventeen percent from 16 (2016) to 19 (2017). The gross crane productivity shows that APMT is focusing on container handling operations and ensuring that crane operators are skilled in maintaining high productivity levels and mobilizing the port handling equipment when deployed on container ships at KBSP (Almahmood, 2018).

10) Net Crane Productivity (NCP moves / crane / gross)

NCP increased by fifteen percent from 17 (2016) to 19 (2017). The increase of the other related KPIs, such as quay productivity shows a correlation with the net crane productivity through the increase occurred. The increase in the NCP is not significant and KBSP should aim for higher productivity levels to meet shipping line expectations and reduce vessel port time (Alhameedi et al, 2018).

11) Gross Berth Productivity (GBP move / hours)

GBP increased by two percent from 49 to 50 moves per hour. The gross berth productivity is one of the key KPIs that shipping lines consider and APMT should maintain the

maximum possible levels of berth productivity to meet the port customers' expectations (Alhameedi, et al., 2018).

12) TEU Per Crane Hour (TPCH)

TPCH has slightly decreased by ten percent from 30 (2016) to 27 (2017) TEU per hour. The decrease is as a result of the limited resources and equipment of the port, such as gantry cranes that are crucial to achieve the highest productivity levels possible (Almahmood, 2018).

13) TEU per Ship per Day (TPSPD)

TPSPD increased by twenty-three percent from 1208 (2016) to 1491 (2017). The KPI shows a close correlation with the other KPIs such as quay productivity and gross berth productivity which trend together and affect TPSPD positively (Alhameedi et al, 2018).

14) TEU per Ship per Berth Hour (BSO)

BSO increased by three percent from 72 TEU (2016) to 74 TEU (2017). The increase in the berth productivity and crane productivity has positively reflected on the increase for BSO as they are highly correlated. This is due to sufficient equipment utilization made by the terminal operator and proper yard planning for every incoming ship that leads to smooth loading and offloading operations (Almahmood, 2018).

15) TEU per Ship Working Hour (WSO)

TEU per ship working hours decreased by eight percent from 90 hrs (2016) to 83 hrs (2017). The TEU per ship working hours is impacted by the labor regulation in Bahrain that gives heat breaks during summer time from 12:00 to 16:00 where the vessel operations are at stand still. The increase in vessel size also requires increased labor and the other operational delays that impact productivity level (Almahmood, 2018).

16) AVG Productive Ratio (APR)

APR increased by eleven percent from 80% (2016) to 90% (2017), which is an indication of the increase of the related KPIs such as crane productivity, berth productivity, TEU per ship hours and berth occupancy ratio that negatively affected APR (Almahmood, 2018).

17) Labor Utilization Rate (LUR)

LUR increased by fourteen percent from 35% (2016) to 40 % (2017). The labor utilization rate is affected by several factors and mainly the increase of the berth occupancy ratio due to the increase in vessel size at the port due to scheduled and regular calls by the ocean alliances vessels (Almahmood, 2018).

18) Crane Utilization Rate (CUR)

CUR increased by seventeen percent from 36% (2016) to 42% (2017). As BOR and LUR increase, the crane utilization rate increases due to the close relation of these KPIs. This is caused by the growth of vessels size and container traffic resulted by the ocean alliances services to KBSP (Almahmood, 2018).

19) TEU per Ship per Port Hour (PSO)

PSO is showing an increase of three percent from 66 TEU (2016) to 68 TEU (2017). The main increase of the PSO is mainly driven by the volume increase and the increasing size of vessels caused by the ocean alliances calling KBSP (Almahmood, 2018).

20) Quay Productivity (QP)

QP increased by six percent from 214 (2016) to 228 (2017) moves. The quay productivity should be increased to the maximum level and consider the optimal equipment utilization ratio at 60% in order to efficiently handle vessels alongside (Dragović, 2009). The QP KPI is one of the most important productivity measures that shipping lines is interested in as it affects vessel port time, the more the QP the less is the port time (Moon, 2018).

4.2.2 The Future Delineation of KBSP

The main objective for using the regression analysis is to provide the researchers with an indication of the forecast of KBSP future throughput. It can be concluded from the analysis made in the E-views by looking at the independent variables (Xi) that have been listed above in Table 5, along with the dependent variable (Y) that were selected for the regression analysis, that the dependent variable, which is the annual KBSP throughput is highly correlated and affected by the six main independent variables. These include berth productivity, crane productivity, number of container vessels, gate turnaround time, total export moves and total.

The six significant variables (X_1-X_6) basically have a relationship that is directly proportional to the results shown (Alhameedi et al, 2018). The independent variable (X_7) is an error correction term made in E-views for (X_1) after co-integration and then adding the residual into the model. The relationship can be explained as follows:

Table 9: Significant Variables.

Variable	Description
Y	Throughput
X_1	Berth productivity
X_2	Crane productivity
X_3	Number of container vessels
X_4	Gate turnaround time
X_5	Total exports moves
X_6	Transhipment moves
X_7	ECT of Berth Productivity

Source: Author, 2018.

From the above model, it can be concluded that the independent variables which are (X_1, X_3, X_4, X_5, X_6 and X_7) have a high and positive correlation with the dependent

variable (Y). To illustrate, an increase occurred by one unit in the above mentioned independent variables (X_1, X_3, X_4, X_5, X_6 and X_7) will also lead to an increase by one unit in the dependent variable (Y). It can also be concluded that the independent variable (X_2) has a negative correlation with the dependent variable (Y), whereas one-unit decrease in X_2 will lead to one-unit decrease to Y because of the negative relationship. The final equation can be express as:

$$Y = -0{,}49 + 0{,}16 * X_1 - 0{,}22 * X_2 + 0{,}29 * X_3 + 0{,}14 * X_4 + 0{,}35 * X_5 + 0{,}02 * X_6 + 0{,}23 * X_7$$

The research team estimated the following formula and ran the regression analysis to calculate the relation between the independent and dependent variable for the KBSP annual TEU throughput as follows:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.491651	0.158344	-3.104950	0.0023
D(BERTHPRO)	0.163951	0.073777	2.222258	0.0278
D(CRANEPRO)	-0.222965	0.065413	-3.408579	0.0008
D(CT_VESSELS)	0.297752	0.071606	4.158204	0.0001
GATE_TURN_TIME	0.141627	0.045135	3.137872	0.0021
D(TOTAL_EXPORT_MOVES)	0.358258	0.068877	5.201407	0.0000
D(TRANSMOVE)	0.018675	0.007055	2.647139	0.0090
ECTBERTHPRO(-1)	-0.237697	0.068824	-3.453710	0.0007
AR(1)	0.510690	0.197406	2.587004	0.0107
MA(1)	-0.743259	0.160370	-4.634646	0.0000

R-squared	0.524973	Mean dependent var	0.006558
Adjusted R-squared	0.495488	S.D. dependent var	0.150510
S.E. of regression	0.106906	Akaike info criterion	-1.570424
Sum squared resid	1.657176	Schwarz criterion	-1.374074
Log likelihood	131.7078	Hannan-Quinn criter.	-1.490671
F-statistic	17.80506	Durbin-Watson stat	1.997799
Prob(F-statistic)	0.000000		

Inverted AR Roots	.51
Inverted MA Roots	.74

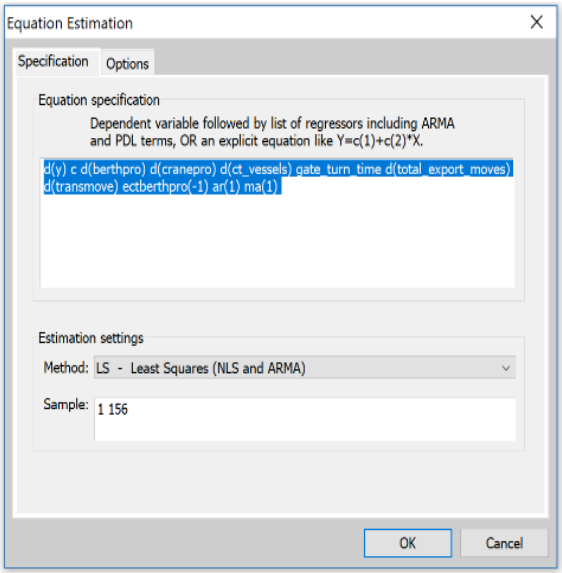

Figure 11: Regression KBSP Throughput Model and Equation
(Source: Alhameedi et al, 2018)

1) Berth Productivity (+ / positive relationship)

The increase in the number of containers will have an impact on the increase in gross berth productivity, but if KBSP is unable to improve its operational performance, it will lead to

the delay and increase in vessel waiting time, port time and will ultimately lead to port congestion (Alhameedi, et. al, 2018).

2) Crane Productivity (- / negative relationship)

There is a negative relationship between crane productivity and the KBSP TEU throughput. This can be explained by the fact that the more the number of containers being handled by cranes, the less the overall crane performance. The limited number of cranes is not well-balanced vis-à-vis the number of containers handled at KBSP. This may cause a negative impact on the crane's operating and technical condition. The deterioration in crane condition will lead to lower performance and therefore lead to port congestion result by crane breakdown or maintenance time (Alhameedi et al, 2018).

3) Number of Container Vessels (+ / positive relationship)

If the number of container vessels handled by KBSP increases, the container throughput will also increase, a rising trend that occurred in 2016-2017 due to the entry of mother vessels from the alliances, but will also have an impact on increasing berth occupancy rate, ship waiting time and crane productivity which will also contribute to the congestion issue (Alhameedi, et. al, 2018).

4) Gate Turnaround Time (+ / positive relationship)

The KBSP yard operation is highly connected to the berth operations as any congestion that happens at the yard will lead to congestion at the berth as well. When vessel operations reach their peak, and the four berths and the four gantry cranes are deployed into full use, the truck turn-around time when picking up or dropping off a container will also increase due to the fact that the concentration of the terminal operations is given to the vessel operations where most of the RTGs are deployed for vessel loading and unloading operations. Therfore, this leads to slow receipts/delivery of container (Almahmood, 2018). KBSP should also pursue low truck turn-around time as the relation between the berth productivity and the gate turn-around time is positive, which means the higher the number

of vessels at berth, the higher the gate turn-around time (Albastaki, 2018). The negative correlation between the gate turn-around time and the crane productivity is caused by deploying more gantry cranes and RTGs for the berth operations to serve vessels, which is negatively impacting the gate turn-around time for trucks (Alhameedi, et. al, 2018).

5) Total Exports Moves (+ / positive relationship)

KBSP is the only center of trade in Bahrain, the growth of the macroeconomic sector encourages increased exports. This certainly has an effect on the increasing number of vessel traffic using port services for more export, which will therefore increase the KBSP throughput (Alhameedi et al, 2018).

6) Transhipment Moves (+ / positive relationship)

Despite the fact that the transhipment volume handled at KBSP is relatively small compared with import / export volume, the increase in TEU transhipment volume will result in an increase in the KBSP annual terminal throughput due to the positive correlation as transhipment moves are included in the overall KBSP throughput.

The forecast results using the E-views program indicated that there would be a decline in the number of container throughput in the future. The decline of the future throughput can be explained by relating the results obtained from the KBSP KPI analysis. According to figure 12, the KBSP has handled 402K TEUs in 2016 which is almost four times bigger than the optimal volumes that are supposed to be handled by a terminal with 4 berths like KBSP (Moon, 2018). It can be concluded from figure 12 that the number of vessels and TEU handled at KBSP are constantly declining because optimal capacity was not taken into consideration, and therefore the service level was affected.

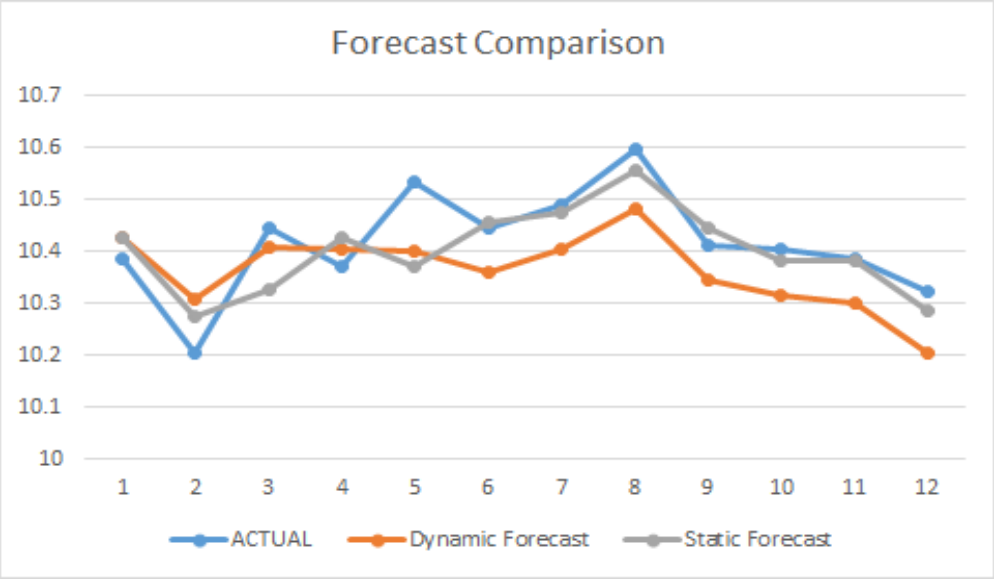

Figure 12: E-views Forecast Comparison
(Source: Author, 2018)

4.3 Discussions: Ramification of the Port Performance

A port's function has evolved from just being a gateway to playing a pivotal economic role. It is crucial to the development of a country, and the hinterland it serves, but the reverse is also true. The growth of the hinterland, and its import and export activities play a crucial role in shaping up the port and its logistical infrastructure. A port's throughput, defined accurately, is the measure of both its productivity and performance. It was, therefore, crucial to understanding the factors that influence the throughput and performance of KBSP, which has the potential of becoming a transit/transhipment hub, seeing it already serves as a connection to cargoes destined for Saudi Arabia, through the King Fahad Causeway.

There are three main entry points into Bahrain, with the major one for goods being KBSP. The other two are the airport, and King Fahd Causeway, which connects Bahrain to the eastern part of Saudi Arabia. To improve on its efficiency and service delivery, the government of Bahrain privatized the port, and KBSP is now under a concession, being run by APM, which brings on board a wealth of knowledge and expertise. The changes in

port operation, organizational structure and to some extent infrastructure has indeed had a positive impact on the efficiency of KBSP, but the industry, through the questionnaire responses received, still believe that there is still much to be done so as to improve its effectiveness.

Much focus by KBSP so far has been to service local trade, i.e., within Bahrain, but with recent economic and regional developments, Bahrain has a long-term aim to be a hub port that services the Upper Gulf region of the Middle East. This necessitates for action to be taken from both sides, i.e. APMT, to improve efficiency and effectiveness of the port, and the Government of Bahrain, in ensuring that indeed Bahrain puts measures in place to stimulate import and export activities, and also facilitate cross-border trade, which will see an increase in not only imports and exports, but also transit and transhipment cargoes. Port performance will be crucial in attracting major shipping lines to the port, bearing in mind the biggest competitors geographically are Jebel Ali Port in the UAE and Salalah port in Oman, which have a major advantage due to their strategic locations along major trade routes, giving them a preferred choice over KBSP; hence the need for KBSP to improve on its service delivery.

The approach taken by the researchers is systematic, which is, to first use quantitative analysis, to analyze the performance, so as to know what is currently happening at KBSP. Next was to forecast the future throughput by E-views, which indicate the expected throughput, and hence performance. The forecast is an important indicator, which will help gauge the necessary actions to be taken by KBSP, as provided for by the results of the forecast. The researchers also incorporated qualitative analysis by using preliminary SWOT analysis and Questionnaires, so as to understand, first hand, from the stakeholders, what problems and challenges they may be facing, first hand. This instills a local perspective on the research, by taking into consideration the input provided by the local industry.

The KPIs, APT and AGBT show an increase from 2016 to 2017. This indicates an increase in the time that a vessel takes in the port, and also in the berth. This can logically

be explained by the increase in vessel sizes; thus it will need more time for loading and offloading. This can be confirmed by data provided in figure 8, which indicates an increase in the average vessel GRT from 37,580 in 2016 to 38,199 in 2017. Even though this is a logical explanation operationally, KBSP needs to implement long-term measures to reduce vessel turnaround time, to ensure competitiveness with other major container ports and terminals, hence be able to attract bigger ships and enjoy economies of scale.

Operationally, KPIs indicate that KBSP is almost reaching its optimum, by observing its BOR, which increased from 60% to 63% currently, against a suggested optimum occupancy rate of 65% for a four berth terminal (Moon, 2018). Even though there is improvement operationally, by looking at QP, GCP, NCP, and GBP, the improvement is very minute, and all points to a stagnation in the increase in throughput by the port; hence the port cannot be able to handle more, efficiently and effectively, until and unless more resources are allocated, to facilitate more handling. The alarming KPIs that suggest that KBSP needs to take immediate and swift action is the increase in AST and ASTT. Even though there has been an increase in vessel sizes, which will, in turn, explain the increase in ship service time and ship turnaround time, as explained above, the major worry is for commercial and financial purposes on the part of liner companies, and other ship operators, who want to minimize a vessels' time in port, and keep port-related costs to a minimum (Notteboom, 2006).

Major shipping lines will only deploy mother vessels to the ports that are well equipped in terms of draught, length, handling equipment and labor. Hence, the need for KBSP to plan strategically for the aforementioned factors if they are to retain the vessels that are calling at their port and attract other bigger vessels and alliances to the port. Moreover, figure 12 indicates that KBSP throughput is constantly decreasing from 2013 to 2017. The decrease from 429K in 2013 to 402K TEU in 2017 is equivalent to six percent compared to 2013 with 2017 (MTT, 2018). The figures suggest that KBSP is losing volumes and subsequently customers due to the low performance delivered. Besides, inferring that it is way above its optimum handling capacity; thus there is need for

corrective action to be taken to avoid congestion of its capacity and exceeding optimum utilization levels of its available resources. The current throughput indicates that the current resources, such as yard space, handling equipment, and labor, are actually being overused.

Even though the forecast by E-views suggest a reduction in throughput, as figure 12 shows, this may be provided for by the current conditions at the port, where operations are exceeding optimum levels, and may thus lead to diseconomies of scale. On the contrary, the trend shows a steady number over the last five years (see per figure 13) through the simple forecast generated from the same annual data which provides for an increase in throughput. In the upper confidence level, an increase of almost 90% is forecasted by the 2022; hence the need for the port to plan accordingly for the expected increase in volumes, which will affect the throughput of the port, and thereby the need to increase its capacity. This move will not only help in preparing KBSP to handle more cargo in the future but also address the bottlenecks in operations that are already being manifested in its current scenario. The general outcry from the industry is that the port is congested, and much needs to be done to address the situation, in terms of streamlining processes and procedures, implementation of appropriate systems that would simplify importation processes, and on time delivery of containers from the port.

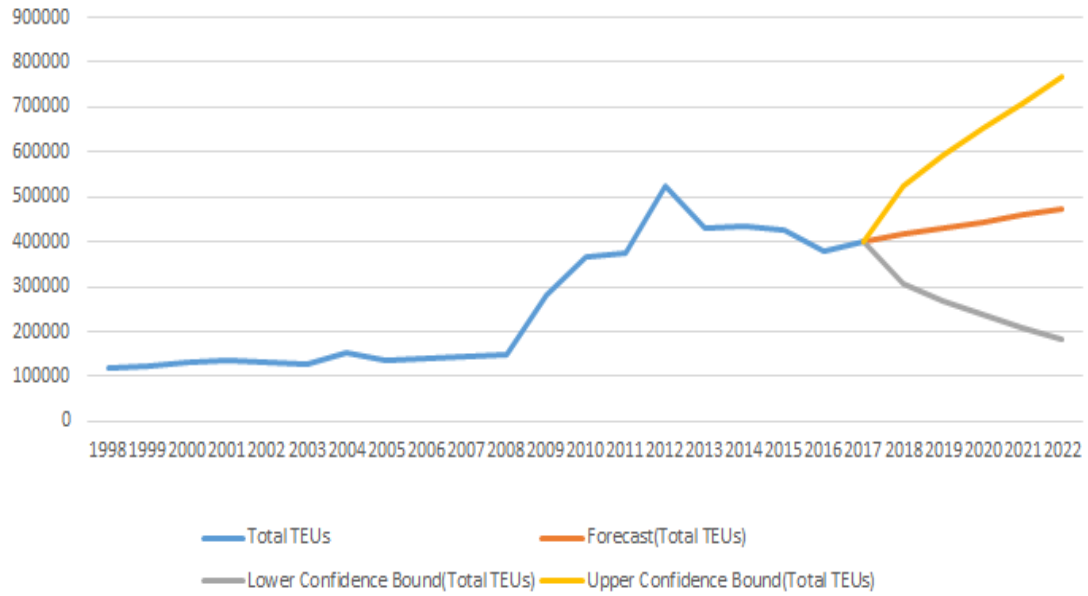

Figure 13: KBSP TEUs per annum from 1998 - 2017
(Source: Author, 2018 and MTT, 2018)

4.4 Implications: Improving KBSP

The aim of this research is not only to evaluate performance but also to provide for much-needed solutions to the problems at hand that face KBSP and Bahrain Port logistics sector at large. The three researchers have ample experience in not only port operations and administration, but also in providing a wealth of experience in shipping, logistics, and freight forwarding; hence providing a holistic approach to tackling and suggesting remedial action, for the challenges facing KBSP. The recommendations are divided into two, i.e. short-term goals, which can be implemented operationally and almost immediately, and long-term goals, which will need a more strategic approach, and maybe capital intensive. These goals are to be prioritized due to the urgency of the recommendations. The Short-term Goals suggested may be implemented within six months of this research, and may not necessarily have a huge financial impact on KBSP. On the other hand, the long term recommendations require a more strategic approach and are capital intensive, and so more time in planning and implementation is needed. It may

take 2 to 4 years, or more, since the inception to implementation or execution, and even longer for completion of such projects.

1) Increase number of Handling Equipment

According to the feedback provided by the respondents, there is a shortage of yard handling equipment at KBSP. Whatever equipment presently available is utilized for both yard and gate operations, which is not sufficient during peak times, and results in congestions and long queues. This leads to incurring of extra costs, delays and ultimately unsatisfied customers, which is not good for business. Even though KBSP has adequate yard capacity, it lacks port handling equipment. There are only four gantry cranes and 12 RTGs available to serve the port for incoming volumes that exceed 400k TEUs annually. APMT should, therefore, consider investing in port handling equipment to keep a balance between berth and yard operations and also meet the increasing demand of the captive market (Almahmood, 2018).

KBSP can take advantage of APMT's good networks and connections with providers of handling equipment, such as reach stackers, front loaders, mobile cranes and other necessary equipment, so as to acquire the machines. This could be by buying, or long-term lease, whichever is more cost effective. Addition of such equipment will result in a smooth cargo flow from vessel operations, yard operations, and gate operations; hence no congestion. It is also important to make sure that availability of equipment alone would not be sufficient, but to ensure that the equipment are maintained and serviced appropriately, to minimize downtime, and maximize on the availability of the equipment. This will most definitely improve the turnaround time of the vessels calling KBSP, and also reduce the dwell time of the containers in the port, leading to improved capacity, and ultimately increase throughput.

2) Increase number of Qualified Staff

The increase in the number of equipment would necessitate an increase in the personnel handling the equipment. It is important that KBSP ensures they have adequate staff all

round; to oversee proper administration and operations. It is also important to ensure that the staff are responsible and adequately trained to handle equipment; to ensure the equipment are always in a good working condition; hence facilitating smooth operations. It is also important for ports, KBSP included, to ensure such personnel are trained about customer service, and that even though their work may have no direct contact with the customers, it does actually play a significant role in ensuring customer satisfaction. Further, staff need to understand the mission and vision of the organization, and buy into its corporate goals. Skilled personnel will not only enhance service delivery but also contribute to sustainable growth and development of the organization.

3) Enhance ICT

Even though Bahrain is ranked as the best country in the Middle East in terms of ICT development (ITU, 2017), there is still a lot of room for improvement in the port ICT infrastructure. Presently, there exists only EDI between the port and the shipping line (Almahmood, 2018). No other platforms exist to improve the clearance process. Hence most documentation is done manually, which is time-consuming and leads to delays in the documentation, vessel and container handling and thus congestion. IMO, through its FAL committee has recommended that for countries to facilitate maritime transport, they need to use IT to improve its data exchange, and also suggested that provisions and guidelines should be provided in implementing the single window system by 2019 (IMO, 1967). The single window system is a system that incorporates all stakeholders in the documentation and clearance process, making it a fast, seamless and efficient process. Even though APMT has recently introduced an online platform known as (LIFT), it focuses primarily on basic functions such as invoicing and payments, appointments for cargo delivery and tracking of cargo.

What KBSP needs is an ideal single window system which would not only incorporate the port/terminal and the shipping lines but also other relevant stakeholders, such as importers, exporters, customs authority, customs agents and OGAs.

Implementation of SWS would improve the clearance process that would otherwise take a few days to complete, to only a few hours. Optimal use of IT would improve inward and outward vessel clearance, and cargo clearance; hence less turnaround time for the vessel and also reduced container dwell time. This will also address the issue of cargo overstaying at the port, incurring huge storage costs by the traders, which are then passed on to the consumers.

4) Expansion of the Container Terminal (KBSP Phase 2)

As shipping lines are cutting down on costs, they are utilizing bigger and bigger vessels so as to reap the benefits realized by economies of scale. It is not an exception with the scenario at KBSP. As discussed earlier, the average size of the vessels has increased, but statistics show that the number of vessels is going down.

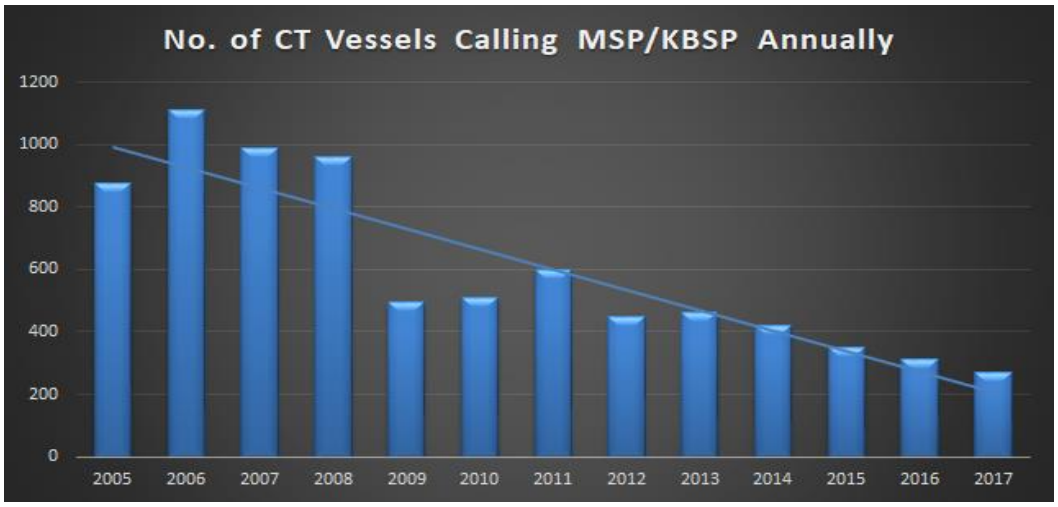

Figure 14: MSP/KBSP Number of Vessels 2005 - 2017.
(Source: MTT, 2018)

Figure 14 shows the number of container vessels annually calling at MSP/KBSP from 2005-2017. With the deployment of bigger ships, KBSP needs to undertake an expansion project, to expand both the quay and yard, to allow the berth to accommodate bigger ships, and also ensure that the yard has increased capacity to handle even more cargo. Bigger vessels do not necessarily translate to increased annual throughput, but just that shipping

lines are consolidating all containers destined for Bahrain, which would have taken smaller but more feeder ships to deliver, are now delivered by fewer and bigger ships. This has exerted more pressure on KBSP, which has to work longer on bigger ships, with the same amount of limited resources; hence the increase in the time a ship stays at KBSP, resulting in more vessels waiting for the limited berthing space. It will, therefore, be prudent, for KBSP to undertake an expansion project, so that the port can evolve in tandem with the global shipping trends, and capitalize on the opportunities that shipping lines provide, ahead of other ports in the region. Being able to accommodate larger ships will be a major factor in attracting major shipping lines to designate KBSP as their hub port; thus giving KBSP a major boost in throughput.

5) Handling Equipment

KBSP needs to improve the status of its handling equipment to match the changes happening in the shipping and ports industry. As mentioned earlier, shipping lines are building bigger vessels, and KBSP has already started feeling the impact. Bigger vessels have started calling KBSP, and for operational excellence, there is a need for the handling equipment, especially gantry cranes, to be of proper standards, both in quality and size. A close look at Hamburg Port, which is one of the leading hub ports in Europe, shows that they only had 2 ultra-modern container gantry cranes at its terminal in Tollerort in 2016, but due to more shipping companies ordering bigger container ships, Hamburg Port made an additional order of 3 more such cranes which were delivered in 2017. As a result of this investment, Hamburg port received five times more the number of 18000 TEUs vessels in 2017, than it did in 2015 (Hafen, 2017). Even though this project is capital intensive, it would certainly help to improve efficiency at KBSP. It will also market KBSP as a leading port in the region, with the right equipment and superstructure that is capable of servicing ships of all sizes.

6) Automation of KBSP

In a bid to improve efficiency, many terminal operators in the world are partially or fully automating their terminals. Automation involves the use of technologically advanced equipment, incorporated into the latest and integrated terminal loading and operating systems, so as to improve efficiency, and in the long run, increase the terminal capacity. KBSP should implement a complete automation of its container terminal, to keep up with the increasing throughput (Liu, Jula & Ioannou, 2002). Automation is also introduced so as to reduce human interface during operations, both at berth and yard, so as to minimize human error, and therefore cutting down costs related to human labor, and the inefficiencies that may be caused by the dependence on the human element

5. CONCLUSION

In a bid to increase efficiency and also achieve optimal use of available resources and equipment, ports around the world are pushing for increased volumes and throughput. With the current scenario where terminals are being ranked by majorly throughput, and secondary, factors like liner connectivity index and port performance, port authorities are keen to drive up throughput, and the approach used by most ports is to engage terminal operators who are experienced in aspects of technical and commercial operations of ports. Increase in port throughput, although beneficial commercially due to the realization of economies of scale, actually needs proper planning, operationally, tactically and strategically, to ensure that the port has measures in place to address the challenges that may be realized due to increase in throughput. The scenario at hand, at KBSP, clearly shows that there is indeed an increase in throughput, but this has actually led to exceeding the KBSP optimal throughput capacity with the limited resources, and consequently led to congestion at the port.

Even though ports are privatized to push for improved efficiency, proper targets and limits need to be set, with relevant KPIs being monitored, to ensure that the port operates within optimal and acceptable limits, thereby avoiding issues of congestions or over utilization and exploitation of available resources, which will, in turn, lead to exerting of pressure on the ports infrastructure and equipment, in the long run. It is also important for KBSP to ensure that they stick to industry best practices in terms of operations, and setting of its objectives and long-term goals and strategies of improving the port, to ensure that they do not only adapt to the ever-changing trends of the maritime industry, but actually surpass the minimum thresholds being set. Only then will KBSP be able to compete

regionally and put itself on the map in terms of being a leading container terminal regionally and world-class port.

The major challenge in the development of the forecasting model developed by the researchers was the lack of availability of data. Only port statistics are available; hence the model is more focused on port performance. A wider scope of data needs to be obtained and incorporated, to include more macroeconomic factors that could influence port throughput, and hence have an impact on the research topic. Macroeconomic factors are relatively hard to obtain, and with the same frequency as port data, which is collected hourly, daily, weekly monthly, and annually; hence a large sample size. Therefore, all other desired variables need to have a matching frequency to build an even more robust and accurate model. A more robust model may achieve higher accuracy in terms of forecast; hence it can be used to accurately forecast for longer periods ahead.

For the KPIs calculations, small idle times, like pilotage for berthing and unberthing of vessels, other small breaks due to various circumstances, such as equipment change, change in spreaders, calibrations and such, which may not seem long enough to be logged in, but happen to a considerable extent, may go unaccounted and undocumented. Therefore, they are not included in the data provided by KBSP for consideration. Such omissions may seem inconsequential, but when aggregated, in the long run, may cause bias, and create a variance from the actual scenario, however minimal it may be. There is also limited information available, vessel wise, regarding the different KPIs that were being researched on, per vessel or port call detailed time stamp information. Such data may be obtained but would need interdepartmental collaboration and coordination, which calls for extra cooperation between relevant authorities who obtain and record the data in the desired frequency.

The lack of prior research into the specific port also proved a challenge. Even though the topic of research is widely being looked into, the region has not attracted many researchers thus far; hence the lack of availability of literature and research material. This provided an opportunity for the research team to try and improve the literature available

on KBSP since it is a relatively new port. The port planning department should, therefore, partner with the relevant internal and external departments and authorities, so as to ensure relevant and significant data is recorded and obtained, which may in the be future used to further this research.

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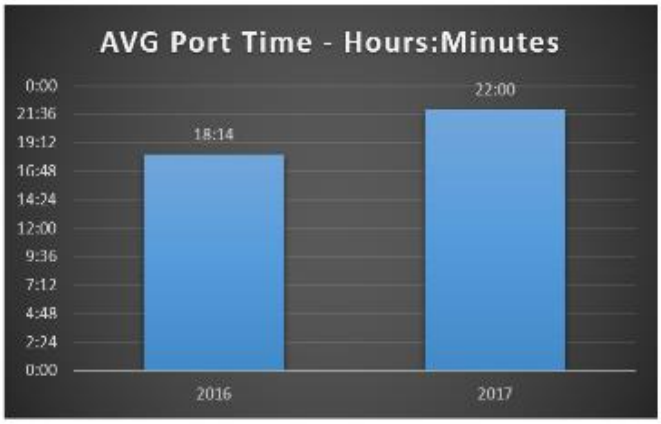
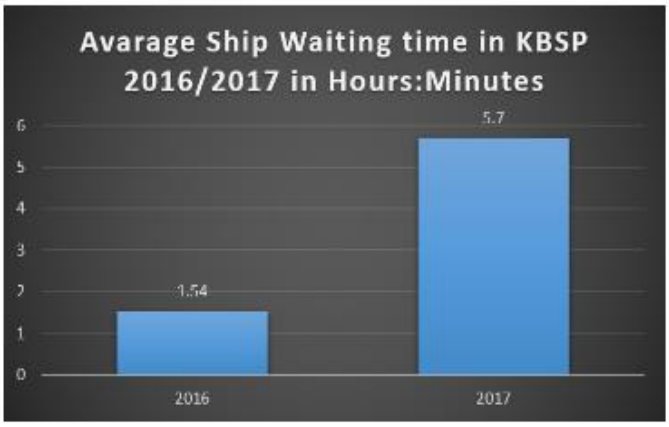
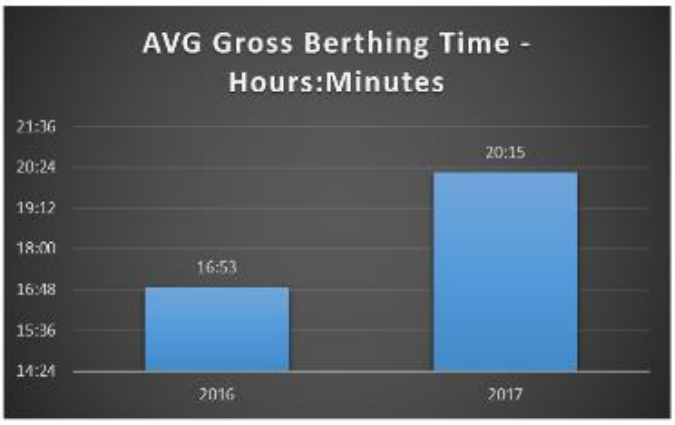
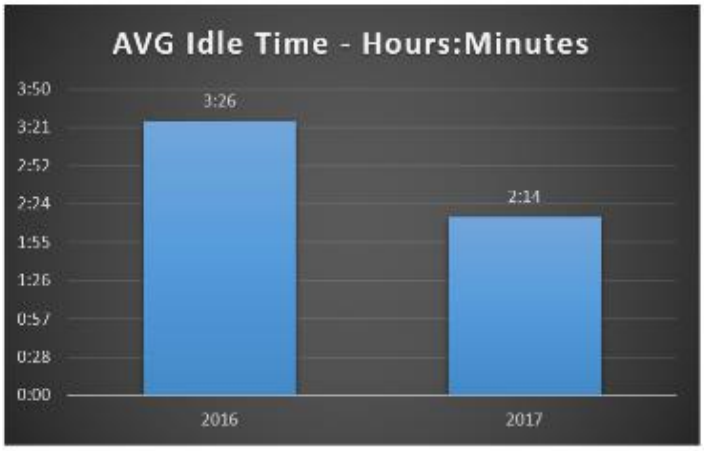
APPENDICES

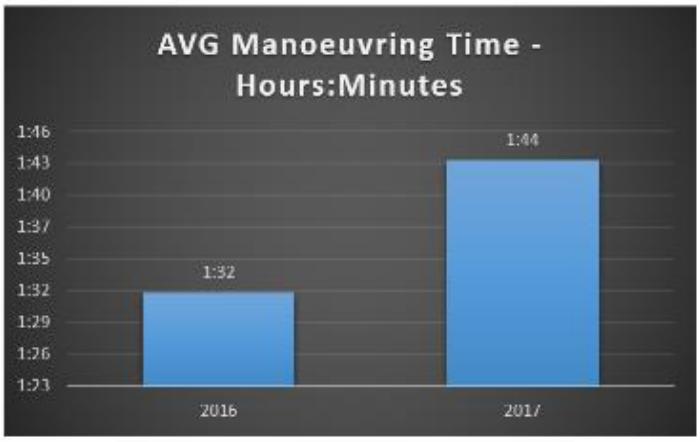

AVG Port Time - Hours:Minutes
0:00
21:36
19:12
16:48
14:24
12:00
9:36
7:12
4:48
2:24
0:00
18:14
22:00
2016
2017

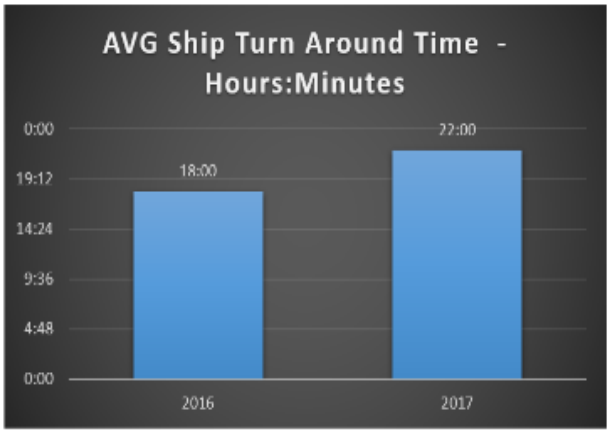

Avarage Ship Waiting time in KBSP 2016/2017 in Hours:Minutes
6
5
4
3
2
1
0
1.54
5.7
2016
2017

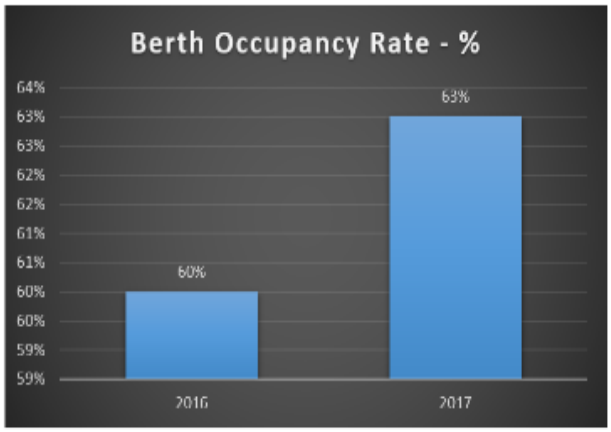

AVG Gross Berthing Time - Hours:Minutes
21:36
20:24
19:12
18:00
16:48
15:36
14:24
16:53
20:15
2016
2017

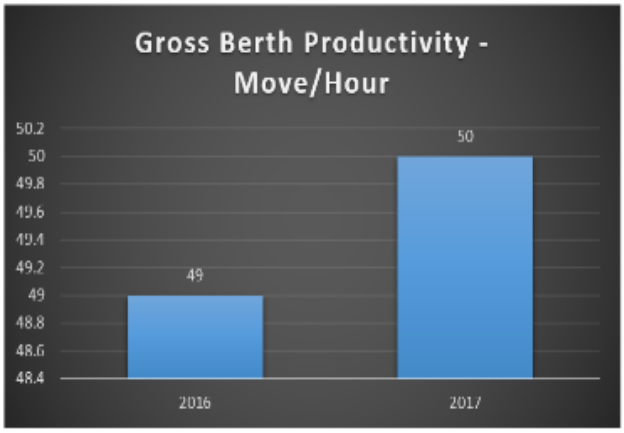

AVG Idle Time - Hours:Minutes
3:50
3:21
2:52
2:24
1:55
1:26
0:57
0:28
0:00
3:26
2:14
2016
2017

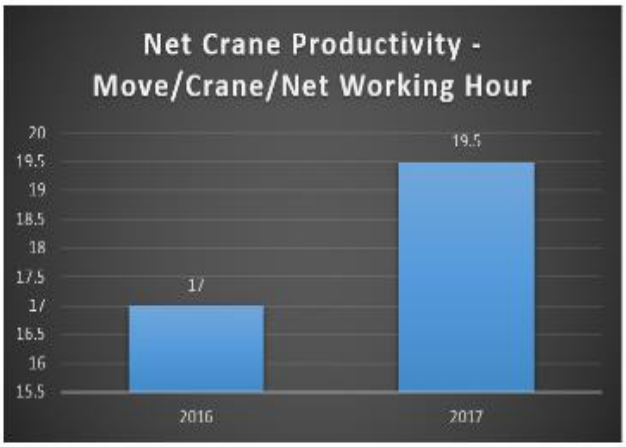

AVG Service Time - Hours:Minutes
19:12
16:48
14:24
12:00
9:36
7:12
4:48
2:24
0:00
13:26
18:00
Plot Area
2016
2017

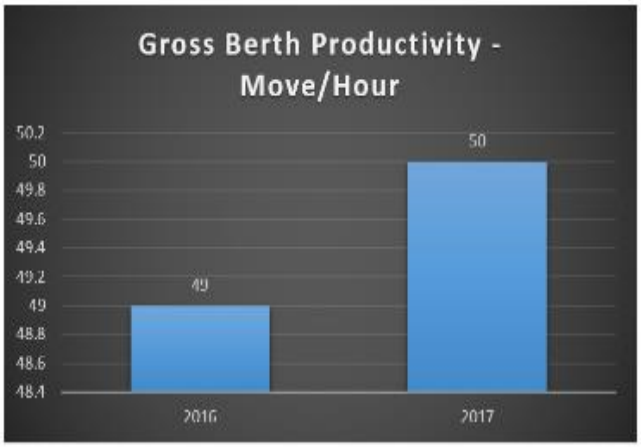

AVG Manoeuvring Time - Hours:Minutes
1:46
1:43
1:40
1:37
1:35
1:32
1:29
1:26
1:23
1:32
1:44
2016
2017

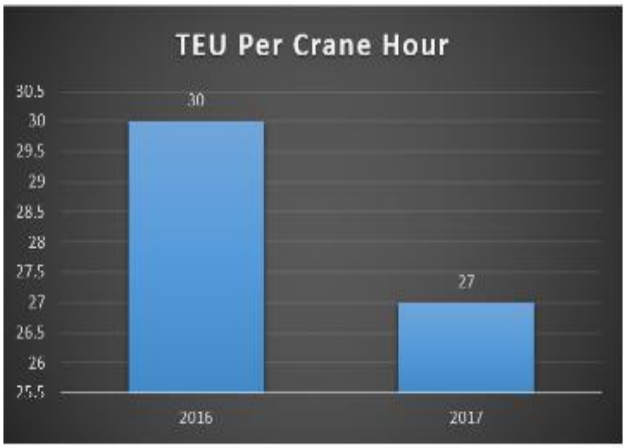

AVG Ship Turn Around Time - Hours:Minutes
0:00
19:12
14:24
9:36
4:48
0:00
18:00
22:00
2016
2017

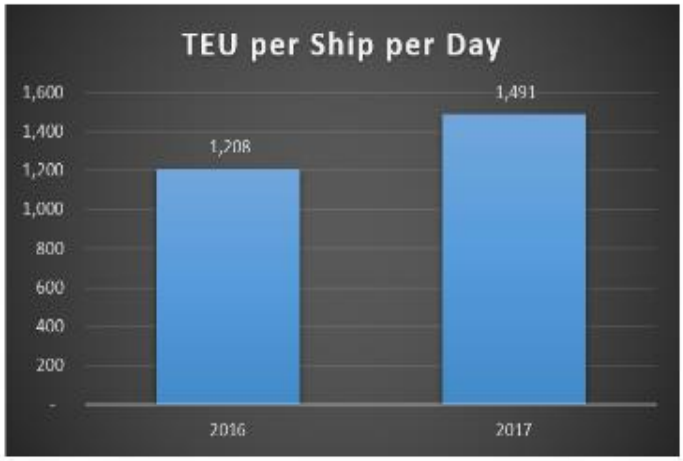

Berth Occupancy Rate - %
64%
63%
63%
62%
62%
61%
61%
60%
60%
59%
59%
60%
63%
2016
2017

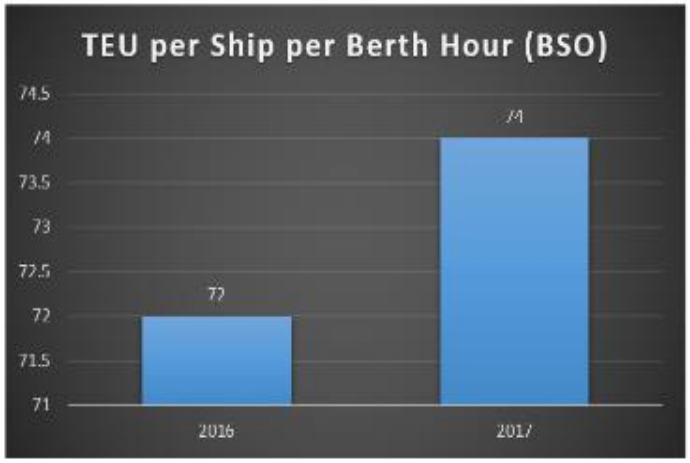

Gross Berth Productivity - Move/Hour
50.2
50
49.8
49.6
49.4
49.2
49
48.8
48.6
48.4
49
50
2016
2017

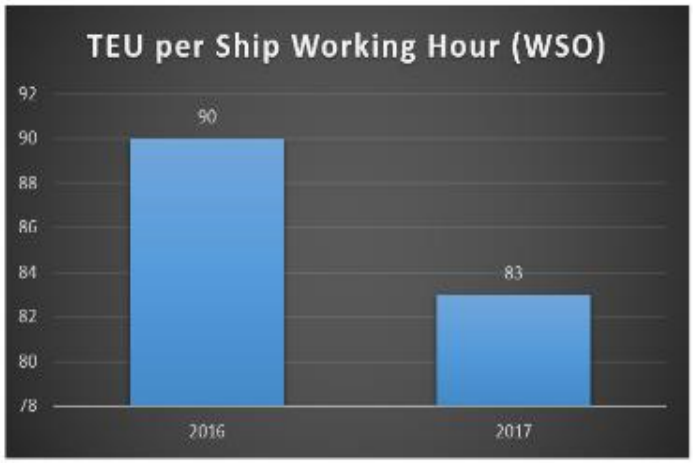

Net Crane Productivity -
Move/Crane/Net Working Hour
20
19.5
19
18.5
18
17.5
17
16.5
16
15.5
17
19.5
2016
2017

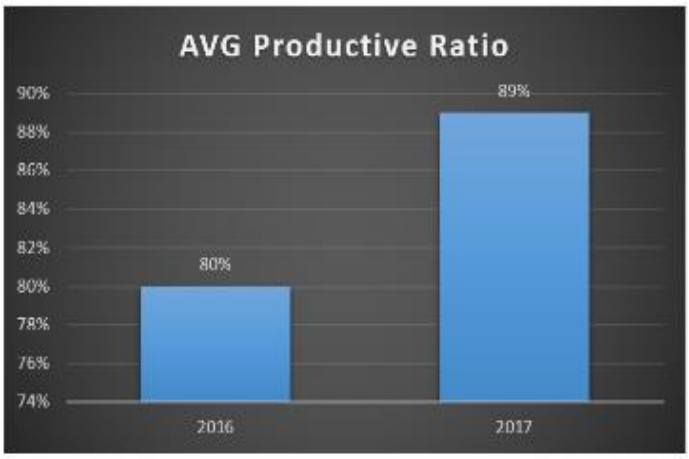

Gross Berth Productivity -
Move/Hour
50.2
50
49.8
49.6
49.4
49.2
49
48.8
48.6
48.4
49
50
2016
2017

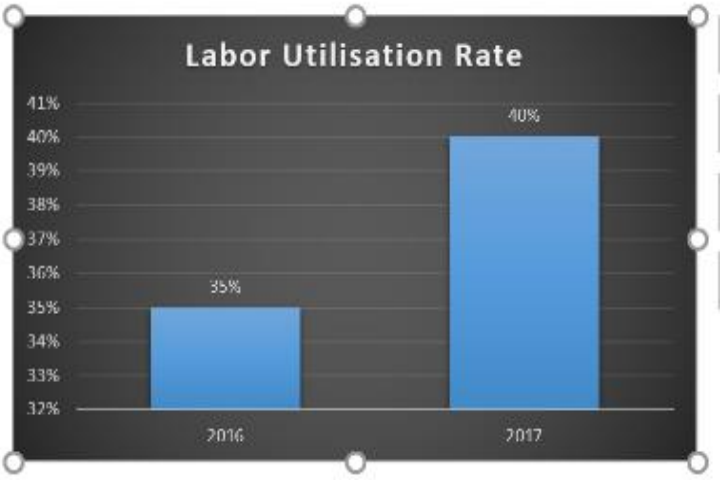

TEU Per Crane Hour
30.5
30
29.5
29
28.5
28
27.5
27
26.5
26
25.5
30
27
2016
2017

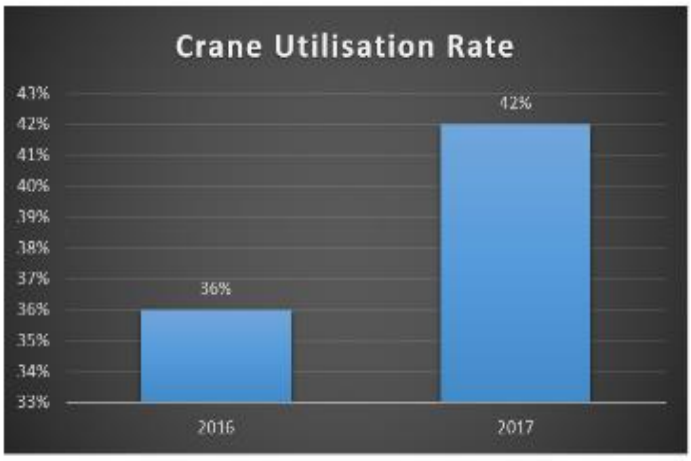

TEU per Ship per Day
1,600
1,400
1,200
1,000
800
600
400
200
-
1,208
1,491
2016
2017

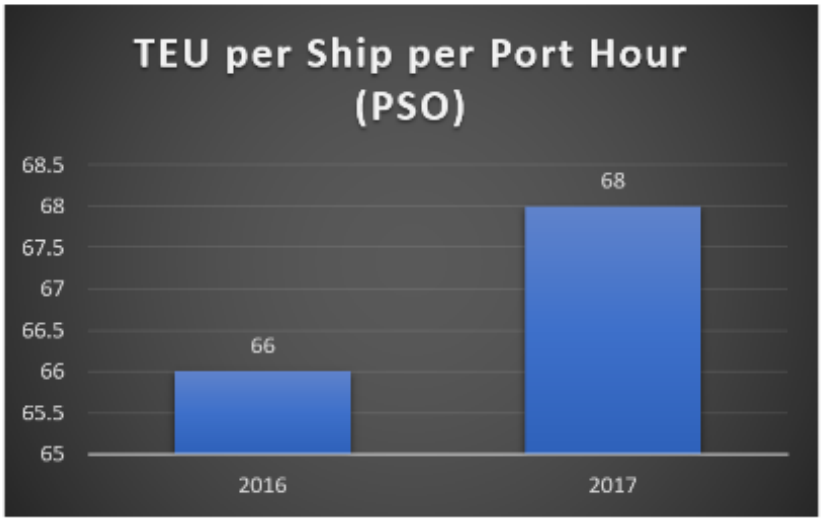

TEU per Ship per Berth Hour (BSO)
74.5
74
73.5
73
72.5
72
71.5
71
72
74
2016
2017

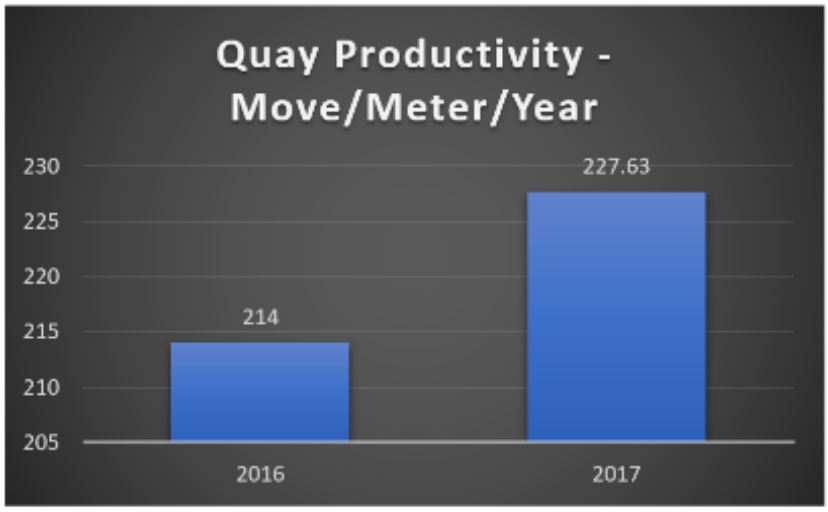

TEU per Ship Working Hour (WSO)
92
90
88
86
84
82
80
78
90
83
2016
2017


AVG Productive Ratio
90%
88%
86%
84%
82%
80%
78%
76%
74%
80%
89%
2016
2017


Labor Utilisation Rate
41%
40%
39%
38%
37%
36%
35%
34%
33%
32%
35%
40%
2016
2017


Crane Utilisation Rate
43%
42%
41%
40%
39%
38%
37%
36%
35%
34%
33%
36%
42%
2016
2017


TEU per Ship per Port Hour (PSO)
68.5
68
67.5
67
66.5
66
65.5
65
66
68
2016
2017


Quay Productivity - Move/Meter/Year
230
225
220
215
210
205
214
227.63
2016
2017