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IMPACT OF UMM QASR PORT ON IRAQI TRADE
Case study of container terminal in Umm Qasr Port

By

ASAAD SAEED DESHER
Iraq

A dissertation submitted to the World Maritime University in partial fulfilment of the requirement for the award of the degree of

MASTER OF SCIENCE
In
MARITIME AFFAIRS
(Port Management)

2019

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Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

Name: Asaad Saeed Desher

Signature: ……………………………

Data: September 24, 2019.

Supervised by: Assistant Professor  Satya Sahoo

Institution/Organization: World Maritime University
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Life has its trying moments; for your trust, your love, cordiality and unique support; I say a big thank you to my lovely wife Batool Taher Rabeea and to my kids Hawraa, Sarah, and Mohammed.

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To all of you “May Allah Reward You”
Abstract

Title of Dissertation: Impact of Umm Qasr Port on Iraqi Trade
Simulator Systems: Case study of container terminal in Umm Qasr Port
Tool – Data analysis model
Degree: Master of Science

Evaluation of the port performance and its impacts on trade and the national economy had paramount importance of most countries. In particular, these countries with a limited number of ports. Therefore, this thesis takes the performance appraisal of the Umm Qasr port and its impact on Iraqi trade as a case study. As well as, Umm Qasr port is the main port of Iraq, its importance comes from entire relying on it in meeting the internal demand of foreign trade.

Initially, an introduction was presented on an economic situation with the most important characteristics of Umm Qasr Port, furthermore, the challenges that facing the port capability. This was followed by identifying the possible variables affecting the port within three categories (macroeconomic variables, port productivity variables, and container terminal performance variables) where 58 variables were identified, as well as quantitative data analysis. Subsequently, Performance indicators are referred to as more effective variables for the regression procedure. Analysis of the performance of UQP for 41 months to measure the performance of the container terminals. These procedures start with measuring the reliability and efficiency of the data and analyzing them. Then through several tests to identify the variables that have a significant impact on the port's performance. Thus, the diagnosis of these independent variables contributes to the identification of the basic steps in improving the performance of the port.

Ultimately, when combining regression result and performance indicators together, and comparing them with research hypotheses. The negative and positive variables will be identified and used to address port problem and constraints. Further, an appropriate solution has been identified by making appropriate recommendations that can be adopted as part of a future strategic plan. As result, propose recommendations to address the negative influences that determine the port throughput.

KEYWORDS: Umm Qasr Port, national economy, port throughput, quantitative analysis, port performance indicators PPIs, performance efficiency, future strategy plan.
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List of Abbreviations

ADF: Augmented Dicky-Fuller ................................................................. 53
AHP: Analytic Hierarchy Process ........................................................... 17
ARIMA: Autoregressive integrated moving average ................................ 60
ARMA: Autoregressive Moving Average ................................................. 60
BTI: Bertelsmann Stifung's Transformation Index .................................. 2
CBI: Central Bank of Iraq ......................................................................... 28
DEA: Data Envelopment Analysis ............................................................ 12
DSO: The Central Statistical Organization ............................................. 5
EAM: Economic Analysis Model .............................................................. 7
FE: Foreign Exchange ............................................................................. 72
GCPI: General Company for Prots of Iraq ........................................... 2
GDP: Gross Domestic Product ................................................................. 29
ID: Iraqi Dinar ......................................................................................... 74
KASS: Kwiatkowski Phillips Schmidt Shin .............................................. 53
MAE: Mean Absolute Error .................................................................. 67
MAPA: Mean Absolute Percent Error ................................................... 67
MOC: Ministry of Commerce .................................................................. 28
MOP: Ministry of Planning ..................................................................... 5
MPHD: Ministry of Planning and Human Development ......................... 28
MSE: Mean Squared Error ..................................................................... 67
NDP: National Development Plan ............................................................ 5
OPEC: The Organization of the Petroleum Exporting Countries ............ 5
PDS: Public Distribution System ............................................................. 3
PP: Phillip-Perron ................................................................................... 53
PPIs: Port Performance Indicators .......................................................... 23
PTT: Port Throughput TEUs ................................................................. 28
SEM: Structural Equation Modelling ....................................................... 18
SFA: Stochastic Frontier Analysis .......................................................... 18
UQP: Umm Qasr Port ........................................................................... 5, 7
USD: United States Dollar ..................................................................... 72
WBG: World Bank Group ..................................................................... 28
1. INTRODUCTION

Today, no matter how different the political and economic systems adopted by the countries of the world. Instead, these countries cannot follow the policy of integrated self-sufficiency for a long time. That situation reinforces the need for multiple modes of transport in the process of trade and commodity exchange between States. Maritime transportation became an essential part of world trade. Today, a world trade that is transported by maritime traffic represents about 90% of world trade (Meersman, Voorde, Vaneislander, Voorde, & Vaneislander, 2014). This percentage of trade gives an idea about the significant importance of marine transportation. To meet the demand of trade to transport cargoes by sea, appeared the importance of ports a vital part in a supply chain in trade around the world (Dwarakish & Salim, 2015). Thus, finding efficient ports around the world is considered a significant decision (Wiegmans, Hoest, & Notteboom, 2008). According to importance of ports that were mention above, many countries seek to build active ports. Seaports of the different countries are the main link between them (Hall & Jacobs, 2012). Furthermore, as the gate or entrance through which the State's foreign trade passes freely, safely, and without obstacles. Therefore, countries are keen to develop their seaports. Hence, they play an active and influential role in developing their economic resources and activating. Further, their comprehensive development programs achieve their aspirations for economic prosperity and social welfare.

1.1. Background

Iraq has sought to take advantage of its geographical location overlooking the Gulf in the development of the maritime transport sector, which is one of the essential economic areas. Also, Iraq has only a single maritime link in its foreign trade, with a coastline of approximately 40 miles (Karo, 1956). However, this allows Iraq to benefit from the construction of ports that are used in handling cargo coming into Iraq by sea. Through the volume of investments spent on developing ports and the size of the contribution to the national economy (Bank, 2015). Iraq has sought to establish ports
along its coast, as ports are the link between maritime transport and other transport modes (Nazemzadeh, 2016). Therefore, ports should be given great importance as a useful tool in raising the national economy, particularly as, after the economic and political conditions experienced by the country during the historical periods. Hence, they are able to cope with the technological and industrial developments witnessed in the ports of developed countries. Besides, any defect, deficiency, or delay in the development of the port have negative consequences on the goods transported by maritime transport, which affects the efficiency of that port (Tongzon, Jose L., 1995). So it is necessary to support the efficacy of ports development and processing because of its great importance to the national economy, and the increase of the shipping traffic activity and foreign trade activities. Furthermore, the Arabian Gulf is a semi-closed sea with a high commercial and maritime activity business, and the Gulf States are witnessing increasing competition, especially the ports sectors (Ziadah, 2018).

Consequently, Iraqi ports, since their inception, have taken to develop their activities. Furthermore, they have decided that the best way is either to expand existing Iraqi ports or to build a new port. Based on this, the General Company for Ports of Iraqi GCPI adopted the principle of providing what is best to support the Iraqi economy and meets the increasing demand for imported goods. During recent years, exploitation along the coastline has undoubtedly become an essential issue in Iraq. While Iraq depends on its current five ports, which means many of the repercussions that extend to include sectors of the Iraqi economy. All contribute directly or indirectly to shaping future economic development.

1.2. National Economic Characteristics.

According to Bertelsmann Stiftung’s Transformation Index BTI, 2018 Iraq has the fifth-largest reserves of crude oil in the world, so it is one of the most important producers and exporters of oil. Iraq currently produces about 4% of the world's oil supplies, and is, therefore, the second-largest oil producer in OPEC (Stiftung, 2018). In contrast, of these high financial returns, the Iraqi State is mainly following the support of the food and electricity program (Celiku, Maseeh, & Sharma, 2018). The
food support mechanism is the adoption of the Public Distribution System (PDS), which is the ration card system provided by the government with subsidized prices. Whereas, the fact that the agricultural and industrial productions are not sufficient to meet the quantities required of basket foodstuffs in the public distribution system. Therefore, the Ministry of Commerce imports the difference between the amounts needed and the local production of the foods that are necessary (USDA, 2019). This indicates two critical issues. First, as the population grows and the general economic situation evolves, the volume of imports will increase in general. Second, this increase in demand will result in the need for an environment, infrastructure, and sufficient resources in ports to cover the increase in the volume of imports.

*Figure 1: Iraq Total Population, 2019.*
Most economic studies related to ports depend on two categories (direct and indirect) impact, which are most of the production, employment, value-added, income, etc. (Santos, Salvador, Dias, & Soares, 2018). The existence of specialized studies is likely to be useful in building a clear idea of the possibility of strategic planning and sustainable development, as well as identify future challenges for the following years. This is on the one hand, and on the other, that comes within meeting the increase in imports due to the rise in population, in addition to an increase in industrial activities and construction at present, which are expected to continue to grow.

*Figure 2: Total Export & Import volume of Iraq, 2019.*

Consequently, there is an urgent need to develop a strategic development plan for the ports, in order to ensure that the port can do what is required, in particular, to meet the internal needs of the country. Therefore, it became necessary to know the positive independence factors in the port on the one hand and overcome the negative factors on the other.
1.3. Features of Umm Qasr Port UQP

Referring to the annual report of the Iraqi ports for the year 2017, the total goods traded amounted 13.6 million tons for various products (GCPI, 2018). Whereas the Central Statistical Organization CSO reported, the total imports of goods through the seaports (24.5 billion dollars) registered a decrease in the amount of (4.24%) for 2016. In contrast, the total import by land transport registered an increase of (3.1%), which means that imports came through the ports of neighbouring countries, which will be discuss during the research in detail (CSO, 2018). It is worth mentioning that according to the National Development Plan NDP issued by the Ministry of Planning MOP for the years 2018-2022, it presented a transport sector which aims to increase the capacity of existing ports, a navigation canal, and land transportation to 23 million tons annually. While also completing the initial structures and direct construction of the ALFAW port (MOP, 2018).

Iraq relies heavily on its imports, particularly ration card materials, through seaports as well as those of neighbouring countries. It has five commercial ports, and in addition to, two oil platforms for the export of petroleum products. Umm Qasr Port UQP in the northern and southern parts is the main port of Iraq.

The reality of Iraqi ports is determined by the several major obstacles that require work to overcome a lot of effort and financial spending. However, this may not necessarily be the best way to achieve a distinct development in the work of ports, and can specifically take the northern and southern port of Umm Qasr (the two main ports) in Iraq. For example, since the date of establishment of these two ports was in 1965 this means that the chances of developing these two ports are minimal because there are no specific studies on the basic factors affecting the activities of the port. The table below shows the port’s details:
<table>
<thead>
<tr>
<th>Name of the port</th>
<th>Umm Qasr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near city</td>
<td>Basrah</td>
</tr>
<tr>
<td>Location</td>
<td>Latitude: 30° 03´ N / Longitude: 047° 56´ E</td>
</tr>
<tr>
<td>Ownership</td>
<td>General Company for Ports of Iraq GCPI</td>
</tr>
<tr>
<td>UN/Code</td>
<td>IQ UQR</td>
</tr>
<tr>
<td>Port Type</td>
<td>Seaport</td>
</tr>
<tr>
<td>Port Size</td>
<td>Medium</td>
</tr>
<tr>
<td>Port Specialized</td>
<td>Multi-purpose port (container, grain, RO-RO, general cargo, projects cargo, etc.)</td>
</tr>
</tbody>
</table>
| Operators        | • Iraqi Port Authority IPA  
|                  | • Private Container Operators Companies (Gulftainer, International Container Terminal Services Inc. ICTSI, AL-LOREEN, and CMA-CGM)  
|                  | • Private Stevedoring Companies |
| Port waterway    | Navigation channel with 56 NM. And 11.5 m depth |
| Number of berths | 26 berths (4 berths under-construction) |
| Handling Equipment | 8 Gantry cranes, 11 Mobile cranes, 18 Shore cranes, and Grain Conveyors |

Iraqi ports face several challenges, and the problems can be summarized as follows:

- Managerial and operation issues
- Limited depth
- Length of the navigational channel.
- Lack of a trade policy that takes into consideration the economic conditions required to maintain competitive performance in other word administrative problems.
- The weak performance of the road leading to the port and railway lines.
- The specialized berths size and the inefficient handling equipment, which are un-commensurate with the increasing volume of vessels.
- Other problems

Because of these factors, Iraqi ports may not meet or cover all Iraqi imports and exports. Here, the research seeks to recall the role of the Iraqi ports in activating the movement of economic activity. In addition, the opportunities for the development of existing ports are almost difficult to achieve, and activating them, taking into account
the plans for the establishment of the port of Al-Faw model, it shows the main economic impacts and potential financial returns in the case of operations, in addition to the possibility of developing the existing ports. As ports are an essential economic factor in the development of the national economy, public authorities have adopted a strategy to revitalize existing ports as a critical factor in stimulating foreign trade due to the limited capacity of ports and their inability to cope with the expected increase in trade.

In this context, this study will analyse the situation of current ports and try to recommend to develop them if that is necessary.

1.4. Aim and Objectives

The purpose of the research can be summarized by identifying obstacles and constraints imposed the current Iraqi port (UMM QASR). Meanwhile, determining the priority of its development based on measuring the performance of the port and analysing the primary factors. Thus employing the PPIs to determine the independent variables that have a significant impact on the productivity of the port using Economic Analysis Model EAM. This could benefit from providing the best ways to support strategic plans for the development of the current port, or move towards the construction of a new port. Furthermore, to mention the benefits of building a new port in Iraq if necessary for local economic growth. The research is based on the hypothesis that there are ports that can cover the increasing demand of the country. Furthermore, the pursuit of the ALFAW port is a strategic option for Iraq to enhance the competitiveness of Iraqi ports on the one hand and diversify the sources of income in Iraq on the other. This the research objectives so far will focus on some of the points below:

- To analyze the current situation of Umm Qasr Port UQP, and if it is sufficient to cover the demand for port services without the need to build a new port in Iraq.
- To explain and identify how sufficient the container terminals influences UQP in general.
To describe and identify the relationship between container throughput and the national economy.

To calculate and analyze the primary variables that may affect the work of UQP from a macro and microeconomic point of view.

To determine whether Iraq needs to build a new port to meet the demand for port services.

In addition to the objectives set, the research is expected to find the answers to the following research questions:

- a. What are services and facilities that should be provided at the port to meet the domestic needs while competing with external ports?
- b. Does the existing container operations have enough to improve the port efficiently?
- c. How does the port's performance contributes to the national economy and trade?
- d. What are the driving factors that affect port efficiency?
- e. Do the existing ports have enough capacity to handle the increase of import in the future?

1.5. Contribution

The transport sector is an essential factor in the economic development of countries in general. Ports are an important node in the transport sector, especially the link between maritime transport and multimodal transport. The study of measuring the efficiency of port performance finds an effective contribution at two level:

- Despite the literature dealing with the performance of ports and container terminals in particular this continues to focus mainly on only two port areas, the European Union and the Far East. Therefore, due to the scarcity of studies dealing with the ports performance in developing countries, this study is therefore gaining importance in its subject, which is characterized by the impact of the Umm Qasr Port on the commercial performance of Iraq. The
importance of the study lies in its focus on using the data analysis model to assist decision makers. Moreover, unlike most of the literature, it is important to focus on a port in developing countries that may be of interest to port stockholders and shipping companies to expand their business. Furthermore, the study is characterized being addressed by the subject of influences on the port from the macro and micro economic perspective.

- At the professional or applied level of study and according to the results of the study, the study showed that the port suffers from several problems. However, the port will evolve and the number, size of ships and cargo will increase as well, however, it will require a lot to focus on. One of the most important areas of focus is the adoption of a clearly defined trade and economic policy for the port. In contrast, this policy reflects the economic importance of the port. In addition, to focusing on minimizing negative coefficients affecting port performance, and at the same time developing and maximizing positive impact factors, it will be discussed in more detail in the sixth chapter of this study.

1.6. Methodology

The research will be by providing a general background view of the current situation in UQP, and will then move on to reviewing the literature that shows the impact of the effectiveness of the performance of the port, especially the container terminals on the performance of the port first and then on the national economy. In other words, this will include a general idea of the use of data on port productivity, especially container terminals, in measuring and raising the level of performance efficiency.

To reach the research objective and try to answer the questions, the quantitative research methodology is used. In addition, UQP as a case study and according to the data collected from the Port Authority and container terminal operators is also used. The quantitative research methodology aims to find the answers to the research and determine the impact of the productivity of UQP on the national economy and the level of trade in general. Furthermore, the data is analysed after being collected and tested
using regression and economic analysis as an analytical tool and a descriptive of counting of possible outcomes.

1.7. Structure of the dissertation

The research in general, including the case study, consists of six chapters, seeks to cover the discussion of various aspects and research relationships related to the productivity of the port on the one hand, and the performance of the port and its economic impact on the other. The order of the chapters is as follows:

- **Chapter one** includes an introduction of the economic situation in the country and gives a general idea of the Iraqi ports and the UQP in particular. In addition, it indicates the aims and motivation of the research, as well as the objectives to be pursued.

- **Chapter two** includes a review of the literature related to port performance and the uses of data in performance appraisal, with a view to attempting to obtain a broader perception and understanding of the research problem. The literature shows the significant impact of port performance on local economics and their contribution to determining the economic situation of countries. Furthermore, through this chapter the concept of research is conceived and a focus on a sample area of developing countries is urgently needed to study the port reality.

- **Chapter three** explains the research methodology and the method that will take in the investigation of the subject of the study, while also covering the case study as well as the dependent variables and the port performance measures. Moreover, the tools that used in data analysis are mentioned. Thus, this chapter presents the design or research steps. In addition, it provides the research hypothesizes.

- **Chapter four** reviews the sources of data collected for research and divides it into three main categories based on the need of their use. In addition, it provides the primary analysis of the data as well as the tools and analytical methods. As a result the preparation of tables for the relationship between
variables and clarify the type of relationship depending on the research hypotheses.

- **Chapter five** presents the regression steps with an analysis of these steps as well as providing the economics of the results obtained. In addition, the statement of significant and insignificant variables were excluded from regression, and the preparation of the results table. At the end of the chapter, a forecasting was made using E-Views, and made comparing between two forecastings to choose which is the best dynamic or static.

- **Chapter six** includes re-presenting a general idea about the research problem and presenting the results and the research findings, as well as checking the hypotheses and discussing its results and explaining the use of the results to find solutions. Furthermore, the limitations are viewed and some recommendations suggested.
2. LITERATURE REVIEW

The maritime industry is characterized by economics, trade, regulatory, and technological changes, as well as, the rapid development of information technology and its uses at most economic levels. It has been the product of globalization, further creating a new competitive environment in which maritime logistics and port services have had an essential role in capitalizing on the benefits available in maritime transportation (Slack, 2001). Changes of these characteristics are suspect in predicting the future of the industry, and this is accompanied by an increase in pressure resulting from the weakness and disruption of the operation of public ports of various types (containers, general cargo, bulk goods, etc.) (Slack, 2001).

According to Notteboom & Yap 2012, ports are generally open working areas in an interactive relationship with the external environment (external ports, shipping companies, customers, suppliers, and port users). Therefore, ports face many challenges as a result of their intense competition. This requires adaptation to continue and stay and contribute to the development of the economic base. Furthermore, it involves the provision of services in quantities and specifications required to meet consumer needs. As a result, Notteboom & Yap pointed out that this entails planning by using models or quantitative techniques of decision-making nature and increase work levels to raise awareness of the port’s strategic needs. Also, assisting in the continuity of ports contributions in the economic, social, and administrative development and to achieve their effectiveness by decision-makers (Notteboom, Theo & Yap, 2012).

It has become known that performance measurement is a fundamental concept for any operation activity, and this is mentioned by Hong Gao, Liang Lv & Wei Liu, 2010. They have shown that ports are a complex field where many different sources overlap, moreover, they try to advise the port owners and operators to measure the port performance so that it can be lead to make ports more efficient. Hong Gao, Liang Lv & Wei Liu suggested that using Data Envelopment Analysis DEA is the best way to evaluate the port performance. Also, when using an effective port performance measure, it helps a lot in achieving the set objectives. with the effective measure of the
port to achieve what goals sets. In other words, to improve the port for greater efficiency (Hong Gao, Liang Lv, & Wei Liu, Aug 2010).

One of the most important fundamental concepts in a port is to satisfy the performance level. VAGGELAS and PALLIS 2015, considered the port performance measurement to be of a high priority and indicated that it helps to assess performance while providing a broader perspective to address weaknesses based on port users' perceptions of operational standards (Conference Paper, 2015). However, the performance measurement criteria must, therefore, be meaningful and measurable.

Borrowing from the words of, Wang, Song, and Cullinane in their paper of 2003 noted that the importance of measuring the performance of the port is more than just a critical management tool for port operators, but its significance is highlighted to comprise of planning and implementation at the national and regional levels. Wang, Sony, and Cullinane pointed out that the importance of the ports stands out through the provision of services activities for ships, goods and internal transport. Therefore, port performance is the most critical criterion in service delivery. This indicates that performance measurement contributes to determine the correct direction of any organization when responding to performance standards, and vice versa, the system will move in the wrong direction when the performance measures are not adequately defined (Wang, Song, & Cullinane, 2003).

According to Berkoz and Tekba 1999, the distinctive status of the ports comes from its essential role for the economy. Moreover, being one of the transport sector pillars and its association with the expansion of the global economy. This is what made them say that ports are a way to integrate into the global economic system. When comparing transport modes, the maritime transport is considered the cheapest means of transportation. Therefore ports play an active role in linking foreign trade and hinterlands, taking into account that the production of hinterlands and logistics functions are vital elements of economic development. Today's ports have become multifunctional centers, not only as a docking facilities. This was the result of what Berkoz & Tekba did, when they analysed the regression to examine the role of ports in the country’s development. Where the Gross National Income is taken as the
dependent variable, while the port size, ships visits, export and import, number of workers, and domestic stock capacity are independent variables (Berkoz & Tekba, 1999).

Dwarakish and Salim also mention this in their article on the role of ports in the development of a nation 2015, and that it constitutes an economic activity for coastal areas and hinterlands alike. They agreed that the total burden of exports and import and ship visits are highly correlated to gross national incomes. Whereas, the port size, number of employees, and stock capacity does not necessarily have the same effect. They pointed out that the higher the productivity of goods, the more significant needs of more infrastructure and services. Nevertheless, the port is still a social function as a result of its impact on the lives of employees and indirect beneficiaries. As per Dwarakish and Salim, the port efficiency factors are easy to observe as explanatory variables, especially for container terminals. However, there are many challenges remaining that require more port operations such as buffering, abstraction, padding, and storage (Dwarakish & Salim, 2015).

The change in the port system from multimodal to integration in the production chain poses many challenges faced by port authorities. This is what Moglia and Sanguineri pointed out in their article 2003, adding that this development requires the use of essential strategic factors (Moglia & Sanguineri, 2003). According to them, expansion of the ports leads to two critical objectives: economic growth and job opportunities development, considering that the development of commercial activities have led to an integration in the global market, while at the same time reinforcing the position of ports as logistics centers.

In light economic complexity situation, there were uncertainties and pressing problems, as well as the difficulty of the administrative structure of commercial ports and diversification of their services. The changes pressure in the market and the global economy raises questions about the role of the port authority to deal with these changes. Notteboom and Winkelmans took the European model as an example of the changes in their article in 2001. They pointed out that changing the current patterns of port authorities may not match market changes and meet the customers' requirements
or port users. Instead, they believe in building more flexible logistics systems will add the necessary port competencies, the so-called Value-Added Logistics activities (Notteboom, Theo E. & Winkelmans, 2001). That the idea to move beyond the port borders towards the hinterland, is commensurate with the current reality of the port of Umm Qasr and that the available spaces near the port could be invested for this purpose.

A reference to Notteboom and Rodrigue in their article 2005, that the adoption of the regionalization idea in ports results in enhancing their ability to meet challenges such as congestion and limited handling capacity and increased costs, consequently strengthened their competitiveness. However, the issue of port capacity and cost efficiency remain outside of the port's ability to respond to the change required. Furthermore, the development of the internal distribution network, as well as the effectiveness of access to hinterland can play a crucial driver in the port's acquisition of features to overcome traditional patterns. Furthermore, can play a more pivotal role in enhancing its logistical position (Notteboom* & Rodrigue, 2005). Through their discussion, may have gone beyond the port expansion idea, which is necessary for the establishment of logistics centers to strengthen the modes of internal transport and the beginning of multimodal transport.

Through the experimental study of Munim and Schramm, they applied the structural equation model to 91 seaports to analyse the economic effects of the quality of the port infrastructure by classifying the countries into two groups. They argue in their article of 2018, that the investment in infrastructure had a good influence on the port logistics performance, having shown, that it is appropriate for developing countries to pay attention to improving the quality of port infrastructure as it the plays a vital role in enhancing the logistic performance of ports (Ziaul & Hans-Joachim Schramm, 2018).

Making decisions to improve port performance based on data analysis models is a successful choice, significantly reducing potential risks or minimizing missed opportunities by introducing quantitative methods in problem analysis and decision making, in particular with a container terminal.
Notteboom, Coeck, and Van Den Broeck 2000 stated the lack of general efficiency figure covering all determinants of the container terminals. So, they used the stochastic frontier model to derive a single relative efficiency measure where it obtains the relative technical efficiency based on individual results aggregated. They also raised their concerns about the criteria for measuring the effectiveness of the container terminal concerning the interest of the port operators on the one hand and the shipping lines on the other. They pointed out the need to adopt techniques to standardize the productivity of the port (Notteboom, Theo, Coeck, & Van Den Broeck, 2000).

In a different perspective, Tongzon and Heng, 2005, pointed out that the use of a stochastic frontier production model of panel data may reflect the perception of the privatization effect of the port in its acquisition of a competitive advantage. Further, believing that the model has been applied to many industries, and it could be used to the port industry. Their findings help in the research on improving the operational efficiency of the port by the private sector to respond quickly to customer demand, in addition to increasing the competitiveness of the port. As a result, building a strategic framework can help decision-makers or port strategy makers to adopt an effective operational policy (Tongzon, Jose & Heng, 2005).

Zeng and Yang in 2010, argued in their article the importance of focusing on dynamic programming development for the entire container ports network. Where shown in their paper a method of programming to develop the demand for container transport commensurate with the problems of investment on one hand, and using these investments with a low level of efficiency from other hand. The optimum productivity of the port must be distributed in a compatible manner with a complete network, taking into account the economies of scale of the shipping lines and container terminals as well as the pressure of external competition. In contrast, they did not address the fact the port's determinants are the internal transport networks of the hinterland, as well as the performance factors of the port, which would have a significant impact on the productivity of the port (Zeng & Yang, 2010).

Luo and Grigalunas 2003, developed the transport demand simulation model, and applied it on 14 major ports in the United States. They found that the possibility of
using simulation methods could be used to provide great insight into the container port services demand, service areas, and use multimodal transport (Luo & Grigalunas, 2003).

According to Lirn, Thanopoulou, Beynon, and Beresford 2004, the Analytic Hierarchy Process AHP is a successful and multidimensional tool or method, in which they focused on exploring the vital features of a transhipment port and building a market strategy for shipping lines. In other words, they used of AHP to determine the criteria used for the selection of a trans-shipment port from the viewpoint of shipping lines. They concluded that five essential characteristics were of the highest importance. The criterion of their study is very far from determining the efficiency of operating an existing port. In other words, when there is an existing port, some of the results of their studies do not represent the interest of the port operators, especially the geographical location of the port (Lirn, Thanopoulou, Beynon, & Beresford, 2004).

Aversa, Botter, Haralambides, and Yoshizaki, 2005, presented an integer-programming model by applying to select a hub port on the eastern coast of South America. They argued that the unjustified importance is given to reducing transport costs and demonstrated the central factors that make the port capable of dealing with a large number of containers (Aversa, Botter, Haralambides, & Yoshizaki, 2005).

Veldman, Buckman and Saitua, 2005, used the logit model to assess the economic impact of the Scheldt River depth on access to the Antwerp port, relying on the time that the vessel had to wait for the tide. Further, by determining the real effects of creating a time series data and cross-section data along with the basis of the model test using regression analysis to select the best model. From their findings, it is possible to formulate the demand for increased container productivity after including the cost of access to the port (Veldman, Bückmann, & Saitua, 2005).

According to Garcia-Alonso and Martin-Bofarull 2007, they have raised the argument that the level of investment in the port infrastructure does not necessarily represent an increase in the development of port activity in terms of attracting maritime traffic, where they used DEA to analyses of the ports of Bilbao and Valencia in Spain, to determine whether the maritime transport is attracting the fact that the port is
efficiency based on improving investment in the infrastructure (Garcia-Alonso & Martin-Bofarull, 2007).

In the same context, Trujillo and Tovar, 2007, explained the use of economic measures to measure or improve the efficiency of European ports, and disagreed that the presence of infrastructure leads to attracting a large share of the world’s trade. They preferred to use the Stochastic Frontier Analysis SFA to estimate the efficiency of European ports on the DEA. Consequently, reliance on performance measurement is useful in policy decision-making (Trujillo & Tovar, 2007).

According to Bichou and Bell, 2007, they chose Structural Equation Modelling SEM for their application in transport logistics to link the underlying variables with measurable variables. In their view, SEM can be used to assess the effects of global factors and try to integrate them into the container industry. It should be noted that the literature of the general idea of their study takes a different approach to the use of analytical tools, where measurable variables remain restricted by the availability of primary data for port activities. This is the most literature in the lack of resources available to obtain such data (Bichou & Bell, 2007).

The models or methods of forecasting are the best of these analytical techniques, being a link between the port and the external environment, which is characterized by uncertainty in the decision-maker. Forecasting helps to make decisions with a temporal and spatial dimension due to the essential role in tactical and strategic decisions. Thus the decision-maker is said to be simply a consumer of information produced by the forecasting device, whereas, the smart decision-making process is the essence of the success of the administration. This means the diagnosis of any problem must be carefully diagnosed, and the manager understands how s/he and his/her staff make decisions and solve problems using standards, which determine the quality of the decision under specific objectives and the degree of risk.

By reviewing many of the literature, it found that most of these studies focused their research on only two regional ports (the EU and the Far East). It can also be said of the economically developed countries, that there is no such abundance in the reviews that deal with issues related to the role of ports in economically developing
countries. This makes it possible to delve into the case study of the port of Umm Qasr and indicate whether the port's performance level is feasible. This may be due to the unavailability of the necessary data, which is the basis for conducting analytical studies on port work in developing countries. On the other hand, severe misgivings by stakeholders in developing countries may be about the importance of ports and their impact on the local economy. Moreover, the idea of involving the private sector in the port's operation is an important step in port development or development of the strategic plans but does not mature if it is facing many obstacles.
3. METHODOLOGY

This chapter deals with a full description of the procedures of the case study of the Umm Qasr port carried out by the researcher to achieve the study objectives. The study is based on a quantitative analysis method to prove the hypotheses of the study. The study examined the current situation of the available data collected through the discussion with the relevant authorities and sources. There were filed visits to Umm Qasr port, in order to collect information on the subject to describe the problem and diagnosis of all indicators and comparing them to each other to find solutions to the problem of the study and made appropriate recommendations. Therefore, based on the available data, a methodology diagram was prepared, which represents the methodology to be followed in the research.

*Figure 3: Methodology Diagram. Author, 2019.*
3.1. Port Throughput

One of the most critical developments in the maritime transport sector is the development of container ships by increasing their capacity; their increasing length and draft, thus enabling them to accommodate more containers (Cullinane & Khanna, 2000). This requires, of course, equivalent developments in ports as a final result, and these requirements may take several forms in the development of seaports or container terminals in particular. For example, the speed of loading, unloading, storage, and delivery may sometimes be sufficient or may exceed the need for larger and more sophisticated handling equipment. The objective of developing ports in general and container terminals, in particular, is to encourage container ships to handle the port regularly and smoothly. This will, therefore, contribute to achieving productive efficiency in port activities and reduce the cost of staying in the port by reducing the time spent by the ship in the port. Therefore, it is necessary to calculate the efficiency of port productivity to determine the level of performance.

Most of the measures of the port throughput are, in fact, a reflection of the cargo volume or number of vessels handled by the port over time (Ducruet, Lee, & Song, 2011). For example, the change in domestic and international demand for goods is one of the most significant impacts on port productivity, at the same time, one of the internal factors is the limited infrastructure of the port itself, which may directly affect the limited productivity of the port.

So based on what was mentioned above and a review of the literature in the previous chapter, the following theoretical framework can be adopted to characterize the case study of UQP. Depending on that, the ports container productivity is affected by several factors and will be sorted under two groups from a macro and microeconomic point of view, as shown in the figure below.
The focus area of the study is the performance of UQP, and its impact on the national economy, so the quantitative and qualitative approach will be followed in the research and will rely on:
3.2. Port Performance Indicators PPIs

It is determining the performance of the port based on the available data. It has become known that it is vital for any administrative system, to calculate the performance of the organization and to assess the work level.

Relying on these calculations is important to build a full perception of the current situation. Moreover, it gives enormous scope for making a future strategic policy (Talley, 2006). So the performance of the UQP will be calculated for several reasons:

- To evaluate the port performance.
- To optimum the port throughput over time.
- To identify weaknesses that can be studied extensively.
- To accredit performance efficiency outputs as independent variables for the second part of the study; the linear regression program.
- To build a database for the port that can be employed to serve the port and will be addressed in the recommendations of this study.

Most data reports collected during the research period lack performance measures, which indicates weaknesses in these reports first, in addition, the failure to use performance measures in monitoring performance and trying to improve container terminal operations is a lack of clarity or stability of strategic plans.

The objective of using most of the PPIs is to improve the port operations as well as to provide essential data for the development of port planning and strategy. Therefore, this helps to use these indicators as transactions that enable port management to use them to employ the optimal economic performance of the port. Showing the performance indicators for easy understanding and calculation is important, and this result has led to giving greater focus on calculating the performance indicators by those interested in the port industry (Esmer, 2008). Of course, the performance indicators in the port take several forms and give the specificity of the UQP, and to the objective of the study, emphasis will be placed on the following performance indicators only.
### Table 2: Port Performance Indicators that will determining of UQP.

<table>
<thead>
<tr>
<th>PPIs</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Ship turn-around Time</td>
<td>( ASTT = \frac{\text{Total hours vessel stay in port}}{\text{Total number of vessels}} )</td>
</tr>
<tr>
<td>Average TEUs per Vessel day</td>
<td>( ATVD = \frac{\text{Total TEUs handled}}{\text{Total number of vessel days}} )</td>
</tr>
<tr>
<td>Average Vessel Time at Berth</td>
<td>( AVTB = \frac{\text{Total hours alongside berths}}{\text{Total number of vessels berthed}} )</td>
</tr>
<tr>
<td>Average Vessel Time Outside</td>
<td>( AVTO = \frac{\text{Total hours in port} - \text{total hours berth alongside}}{\text{the total number of vessel calls}} )</td>
</tr>
<tr>
<td>Average Waiting Rate</td>
<td>( AWR = \frac{\text{Total hours of vessels waiting for berth}}{\text{total hours alongside berths}} )</td>
</tr>
<tr>
<td>TEUs Per Crane Hour</td>
<td>( TPCH = \frac{\text{Total number of TEUs handled}}{\text{Total crane worked hours}} )</td>
</tr>
<tr>
<td>Dwell Time</td>
<td>( DT = \frac{\text{Total number of TEUs} \times \text{Days in port}}{\text{Total number of TEUs handled}} )</td>
</tr>
<tr>
<td>Berth Occupancy Rate (%)</td>
<td>( BOR = \frac{\text{Total time of ships at berths} \times 100}{\text{Total number of berths} \times 360 \text{ days}} )</td>
</tr>
<tr>
<td>Gross Crane Productivity</td>
<td>( GCP = \frac{\text{Number of container moves}}{\text{Total vessel time at berth}} )</td>
</tr>
<tr>
<td>Gross Berth Productivity</td>
<td>( GBP = \frac{\text{Container moves}}{\text{Total vessel time at berth}} )</td>
</tr>
<tr>
<td>TEUs per ship per berth hour</td>
<td>( BSO = \frac{\text{Total TEUs handled}}{\text{Total service hours}} )</td>
</tr>
<tr>
<td>TEUs per ship working hour</td>
<td>( WSO = \frac{\text{Total TEUs handled}}{\text{Total productive hours}} )</td>
</tr>
</tbody>
</table>


### 3.3. Regression Model.

The casual relationship between port throughput its impact on national trade and national economy on the one hand, and the independent variables in port productivity on the other can be given greater importance when examined economically. Once the port’s performance is improved in terms of speeding up the loading and unloading operations, in order to reduce the time the ship stays in the port this will in some way increase productivity, which in turn leads to an increase in the volume of cargo coming into the country. In contrast, an increase in domestic demand for goods would increase productivity. However, because several overlapping elements may cause limited
throughput, there is a need to use an analytical model to test this and determine the level of impact of these variables on the port throughput level, which can be adopted as a dependent variable.

In this regard, regression will be carried out using E-Views 10 as an economic analysis tool to be applied to the theoretical framework in Figure 3. The three regressions are made separately with the independents’ variables, but they share the same dependent variable, which is the Umm Qasr Port Throughput TEUs (Y=PTT). The necessary steps that follow in each regression are similar and will be in order as in the following diagram.
Figure 5: Diagram of regression model OLS.

Source: Satya Sahoo, his lecture of MGM 109, 2019.
As a summary of the methodology used in the study and to build a complete picture of it, the assumption is based on the following three hypotheses:

- **The first hypothesis:**  
  There is a correlation between independent macro-economic variables and UQP container throughput. The type of these relationships depends whether positive or negative effects on the independent variables themselves; the relationship type is indicated in Table No. 3.

- **The second hypothesis:**  
  There is a relationship between the microeconomic variables related to port productivity and UQP container throughput. Table 5 shows the expected signs of this relationship.

- **The third hypothesis:**  
  There is a correlation between the microeconomic variables related to port performance measurements and the UQP container throughput. These relationships can be highlighted in table 7, depending on the type of the independent variable.
4. DATA and DRIVING FACTORS

To identify the data used in the study. The data collected was adapted based on several sources, namely:

- Annual reports of the General Company for Iraqi Ports GCPI.
- Monthly, quarterly, half-yearly and annual reports of Umm Qasr Port UQP.
- Reports of private companies in UQP (container terminals operators).
- Coastal Navigation Station / GCPI (for ship calls data).
- Reports of the Central Bank of Iraq CBI, Ministry of Commerce MOC, and Ministry of Planning and Human Development MPHD.
- World Bank Group WBG.

These data were divided into three different categories according to periods and regression, which will be mentioned in determining the three models of the regression used. It should be noted that after the collecting the data, a preliminary analysis has been used to indicate whether there is an error or an incomplete or inconsistent between them.

4.1. The first category of data

At this stage, the regression takes place from the macroeconomy perspective, although all three regressions share the same dependent variable, which is the UQP throughput TEUs PTT. However, at this stage, the data used represents independent variables for several economic factors related to the national economy, and at the same time associated with port throughput, further, the period covered is for 2009 to 2018, respectively. The table below shows the details of the first regression variables, the time period, and the sources that were adopted in the data collection.
Table 3: First regression variables.

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Variables</th>
<th>Code</th>
<th>Frequency</th>
<th>Time Period</th>
<th>Relationship expected sign</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Port Throughput TEUs</td>
<td>Y (PTT)</td>
<td></td>
<td></td>
<td></td>
<td>GCPI</td>
</tr>
<tr>
<td>2</td>
<td>Gross Domestic Product (Trillion ID)</td>
<td>X1 (GDP)</td>
<td></td>
<td></td>
<td>+</td>
<td>CBI</td>
</tr>
<tr>
<td>3</td>
<td>Total Import Through Ports (Tons)</td>
<td>X2 (Imp_TP)</td>
<td></td>
<td></td>
<td>+</td>
<td>GCPI</td>
</tr>
<tr>
<td>4</td>
<td>Total Imports (USD)</td>
<td>X3 (Imp)</td>
<td></td>
<td></td>
<td>+</td>
<td>MPHID</td>
</tr>
<tr>
<td>5</td>
<td>Population</td>
<td>X4 (Popu)</td>
<td></td>
<td></td>
<td>-</td>
<td>WBG</td>
</tr>
<tr>
<td>6</td>
<td>Purchasing Power Parity</td>
<td>X5 (PPP)</td>
<td></td>
<td></td>
<td>+</td>
<td>CBI</td>
</tr>
<tr>
<td>7</td>
<td>Inflation Rate</td>
<td>X6 (IR)</td>
<td></td>
<td></td>
<td>-</td>
<td>WBG</td>
</tr>
<tr>
<td>8</td>
<td>Foreign Exchange</td>
<td>X7 (FE)</td>
<td></td>
<td></td>
<td>-</td>
<td>WBG</td>
</tr>
<tr>
<td>9</td>
<td>Ports Revenue</td>
<td>X8 (Rev)</td>
<td></td>
<td></td>
<td>+</td>
<td>GCPI</td>
</tr>
</tbody>
</table>

Before continuing the regression, the data to be used must be checked, tested, and analysed. Thus, the data was interrupted and sourced. In addition, the data were examined by individual charts to ascertain its validity and reliability. This procedure represents the first step before regression and is known as preliminary data analysis, which includes three phases (definition of variables, visual test or graph view, and statistical analysis).

- **X1: Gross Domestic Product GDP “Trillion ID”**

  This is considered one of the most important economic indicators for any country, and the GDP used to measure the monetary value of the total goods and services produced by states over a specified period of time; this indicator can be measured based on production, expenditure, and income. Thus it is considered as an indicator of the overall economic situation.
X2: Total Import Through Seaports (Imp_TP) “Tons”

The data for this variable were selected based on the official data established in the annual reports of Iraqi ports, and since most of Iraq's imports come from seaports, it is imperative to identify it as one of the independent variables that are likely to affect the dependent variable positively.

**Figure 6: Gross Domestic Product GDP.**

**Figure 7: Total import through ports.**

*Source: Annual reports of Iraqi Central Bank, 2019.*

*Source: GCPI annual reports, 2009-2018.*
- **X3: Total Iraq Imports (Imp) “USD”**
  This variable represents Iraq's total imports for the period 2009 to 2018, according to the Ministry of Planning, and is likely to represent an independent variable that has a positive impact on the dependent variable. It can be noted the sharp decline in imports due to an emergency security reason in the country and the suspension of imports through neighbouring countries, in addition to a government trend to import a particular type of goods.

  ![Figure 8: Total Iraqi imports.](image)


- **X4: Population (Popu)**
  The increase in population is an essential factor to consider when calculating the economic situation of a country. This is reflected in the increased provision of critical needs as well as the increased demand for imported goods. It was pointed out in the introduction to the research that the State adopts a food subsidy system and this necessarily leads to increase imports and is likely to be an independent variable negative impact on port throughput because it causes additional pressure and may not absorb the capacity of the port.
X5: Purchasing Power Parity (PPP)
This is one of the economic indicators of the country and that can be measured by the per capita gross income, which represents the number of goods and services that the individual can buy, and is likely to represent a positive independent variable impact on port throughput.

Figure 9: Total Population.

Figure 10: Purchasing Power Parity.
- **X6: Inflation Rate (IR)**
  It is noted from the figure below that this variable is witnessing rather substantial changes, especially during the period from 2014 to 2016. This is a reflection of the security emergency in the country that affected the level of government spending and the economy in general. The possibility of this variable negative impact on port throughput is because of its association as different between supply and demand in the local markets.

*Figure 11: Inflation Rate.*

- **X7: Foreign Exchange (FE)**
  This variable is directly related to the State's commercial and economic transactions. The data collected show a period of changes related to the security situation witnessed by the country for the period from 2014 to 2016, which may also negatively affect the port's dealings with its customers, thus adversely affecting the impact on the dependent variable.

X8: Total Ports Revenue (Rev)

As a result of the business, activities, and services provided by the port, total revenues represent an essential variable that could affect the productivity of the port in terms of sustaining the provision of these services and activities. Further, it can be assumed that this variable has a positive effect on the dependent variable.


Figure 12: Foreign Exchange.

Figure 13: Total revenue of ports, 2009-2018. Source: GCPI annual reports.
It is necessary to note that the four variables above (Total Imports, PPP, IR, and FE), were affected by the decline in oil price that started in 2014 and continued by decline until 2016 (Figure 13 below). This can be seen clearly especially with IR. Considering that Iraq depends heavily in its budget on the oil export, therefore, the oil prices decline had a significant impact on these variables, as shown above.

*Figure 14: Crude Oil Prices.*


The last part of the preliminary analysis of the data includes the calculation of the mean, median, maximum value, minimum value, standard deviation, probability, and the number of observations. The following table shows the data values in the first category, which the first regression will performed.
Table 4: Preliminary Analysis of Variables.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Std. Dev.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Jarque-Bera</th>
<th>Probability</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y (PTT)</td>
<td>5.24</td>
<td>5.10</td>
<td>6.03</td>
<td>4.56</td>
<td>0.51</td>
<td>0.55</td>
<td>1.93</td>
<td>0.98</td>
<td>0.61</td>
<td>10</td>
</tr>
<tr>
<td>X1 (GDP)</td>
<td>2.00</td>
<td>1.86</td>
<td>2.33</td>
<td>1.75</td>
<td>0.25</td>
<td>0.38</td>
<td>1.26</td>
<td>1.50</td>
<td>0.47</td>
<td>10</td>
</tr>
<tr>
<td>X2 (Imp_TP)</td>
<td>7.20</td>
<td>7.20</td>
<td>7.45</td>
<td>7.02</td>
<td>0.13</td>
<td>0.35</td>
<td>2.56</td>
<td>0.29</td>
<td>0.87</td>
<td>10</td>
</tr>
<tr>
<td>X3 (Imp)</td>
<td>1.83</td>
<td>1.86</td>
<td>1.97</td>
<td>1.62</td>
<td>0.13</td>
<td>-0.32</td>
<td>1.53</td>
<td>1.07</td>
<td>0.59</td>
<td>10</td>
</tr>
<tr>
<td>X4 (Popu)</td>
<td>1.55</td>
<td>1.56</td>
<td>1.58</td>
<td>1.49</td>
<td>0.03</td>
<td>-0.60</td>
<td>2.03</td>
<td>1.00</td>
<td>0.61</td>
<td>10</td>
</tr>
<tr>
<td>X5 (PPP)</td>
<td>0.69</td>
<td>0.71</td>
<td>0.78</td>
<td>0.57</td>
<td>0.08</td>
<td>-0.44</td>
<td>1.87</td>
<td>0.85</td>
<td>0.65</td>
<td>10</td>
</tr>
<tr>
<td>X6 (IR)</td>
<td>0.40</td>
<td>0.41</td>
<td>0.68</td>
<td>0.15</td>
<td>0.17</td>
<td>-0.13</td>
<td>2.29</td>
<td>0.24</td>
<td>0.89</td>
<td>10</td>
</tr>
<tr>
<td>X7 (FE)</td>
<td>3.09</td>
<td>3.09</td>
<td>3.11</td>
<td>3.07</td>
<td>0.01</td>
<td>0.24</td>
<td>1.98</td>
<td>0.53</td>
<td>0.77</td>
<td>10</td>
</tr>
<tr>
<td>X8 (Rev)</td>
<td>5.48</td>
<td>5.54</td>
<td>5.66</td>
<td>5.19</td>
<td>0.15</td>
<td>-0.83</td>
<td>2.41</td>
<td>1.30</td>
<td>0.52</td>
<td>10</td>
</tr>
</tbody>
</table>

4.2. The Second category of data

The second regression that will be made for the second category data, is related to the UQP productivity, according to the collected monthly reports of the port, for the period from January 2009 to May 2019. The same procedures were followed by the preliminary analysis to examine and analyze the data before running the regression with the same dependent variable. To define variables, the following table shows the dependent and independent variables of the second regression.
Table 5: Second regression variables.

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Variables</th>
<th>Code</th>
<th>Frequency</th>
<th>Time Period</th>
<th>Relationship expected sign</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Port Throughput TEUs</td>
<td>Y (PTT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gate Truck-In</td>
<td>X1 (GTI)</td>
<td></td>
<td></td>
<td>+</td>
<td>Iraqi Ports Authority</td>
</tr>
<tr>
<td>3</td>
<td>Gate Truck-Out</td>
<td>X2 (GTO)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>General Cargo Handling Volume</td>
<td>X3 (GCHV)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Grain Handling Volume</td>
<td>X4 (GHV)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Rice Handling Volume</td>
<td>X5 (RHV)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Sugar Handling Volume</td>
<td>X6 (SHV)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Cement Handling Volume</td>
<td>X7 (CHV)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>RO-RO* Handling</td>
<td>X8 (RO_RO)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Cars Handling tons/units</td>
<td>X9 (Car_H)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Steel Handling</td>
<td>X10 (Steel_H)</td>
<td></td>
<td></td>
<td>+</td>
<td>Iraqi Ports Authority</td>
</tr>
<tr>
<td>12</td>
<td>Ship Call</td>
<td>X11 (Ship_call)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Average of ship calls GRT*</td>
<td>X12 (Ship_GRT)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Average of ship calls LOA*</td>
<td>X13 (Ship_LOA)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Number of Private Truck</td>
<td>X14 (Private_T)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Number of Public Truck</td>
<td>X15 (Public_T)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Total Revenue</td>
<td>X16 (Rev)</td>
<td></td>
<td></td>
<td>+</td>
<td>Iraqi Ports Authority</td>
</tr>
</tbody>
</table>

* RO-RO= Roll On Roll Off, GRT=Gross Register Tonnage, LOA= Length Over All

The second part of the preliminary analysis is to verify the data collected by view graphs and to examine the data visually to make sure it is valid for use in the regression.

- X1: Gate Truck-In (GTI).
- X2: Gate Truck-Out (GTO)

These two variables represent gate operations, which are one of the three essential elements in determining the level of performance of the port in addition to the activities of the yard and quay. It can be seen from the diagrams below that the consistency of the height of these two variables is very compatible with the port productivity and therefore is essential to identify them.
as two independent variables and are supposed to positively and negatively affect the dependent variable as indicated in Table 5 above.

Figure 15: Gate operations (Gate Truck-In, Gate Truck-Out).

- **X3: General Cargo Handling Volume (GCHV)**
  Since UQP is a multi-purpose port, general cargo is an integral part of productivity. The figure below reflects the real nature of the work, and there is no disruption to the data available and may represent a positive impact on the dependent variable.
X4: Grain Handling Volume (GHV)
X5: Rice Handling Volume (RHV)
X6: Sugar Handling Volume (SHV)
X7: Cement Handling Volume (CHV)
X8: Car handling (Car_H)
X9: Steel Handling (Steel_H)

It can be noted from the graphs below, that the value of some of these variables data is zero, due to the fact that the Port Authority in 2012, adopted the policy of directing ships loaded with these types of goods to other ports to be the port of Umm Qasr, especially the northern part’s more specialized container handling. As for the effect of these variables on the dependent variable, it is indicated in table 5 above.
Figure 17: Total handling of Grain, Rice, Sugar, Cement, Car, and Steel.
- X10: Ship Calls (Ship_call)
- X11: Average of Ship Call GRT
- X12: Average of Ship Call LOA

Maritime operations are fundamental in the calculation of port productivity and have significant effects on the performance of the port, especially with the size of ships. Therefore it is expected that the impact of increasing the length of vessels will have a negative effect on the productivity of the port, mainly since most of the port berths are limited to 200 meters, and ships length of recent years have significantly increased.

*Figure 18: Marine operation (Ship Call, Ship GRT, and Ship LOA).*
X13: Total Number of Private Truck (Private_T)
X14: Total Number of Public Truck (Public_T)

Naturally, the values of these two variables are unstable, due to several reasons, including the owner of the goods, the type of products, the destination of the goods, local transport prices and others. However, it is necessary to know that the impact of private trucks may be positive, while the effects of public trucks will be adverse.

*Figure 19: Public & Private Trucks.*
Table 6 shows the preliminary statistical analysis of the variables to be used in the second regression procedure, which is the portion of port productivity. These same variables will be adopted to be part of the third regression in addition to the port performance measures, which we will address in the next section.

Table 6: Preliminary analysis of second regression variables.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Std. Dev.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Jarque-Bera</th>
<th>Probability</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y (PTT)</td>
<td>4.19</td>
<td>4.02</td>
<td>5.02</td>
<td>3.14</td>
<td>0.51</td>
<td>0.32</td>
<td>1.93</td>
<td>7.98</td>
<td>0.02</td>
<td>125</td>
</tr>
<tr>
<td>X1 (GTI)</td>
<td>3.68</td>
<td>3.66</td>
<td>4.18</td>
<td>2.99</td>
<td>0.26</td>
<td>-0.04</td>
<td>2.45</td>
<td>1.59</td>
<td>0.45</td>
<td>125</td>
</tr>
<tr>
<td>X2 (GTO)</td>
<td>3.68</td>
<td>3.66</td>
<td>4.19</td>
<td>3.02</td>
<td>0.26</td>
<td>-0.03</td>
<td>2.39</td>
<td>1.95</td>
<td>0.38</td>
<td>125</td>
</tr>
<tr>
<td>X3 (GCHV)</td>
<td>4.81</td>
<td>4.81</td>
<td>5.23</td>
<td>4.30</td>
<td>0.18</td>
<td>-0.06</td>
<td>2.75</td>
<td>0.40</td>
<td>0.82</td>
<td>125</td>
</tr>
<tr>
<td>X4 (GHV)</td>
<td>1.32</td>
<td>0.00</td>
<td>5.02</td>
<td>0.00</td>
<td>2.09</td>
<td>0.97</td>
<td>1.98</td>
<td>25.05</td>
<td>0.00</td>
<td>125</td>
</tr>
<tr>
<td>X5 (RHV)</td>
<td>3.58</td>
<td>4.71</td>
<td>5.30</td>
<td>0.00</td>
<td>2.12</td>
<td>-1.08</td>
<td>2.22</td>
<td>27.47</td>
<td>0.00</td>
<td>125</td>
</tr>
<tr>
<td>X6 (SHV)</td>
<td>2.56</td>
<td>4.23</td>
<td>5.08</td>
<td>0.00</td>
<td>2.32</td>
<td>-0.19</td>
<td>1.06</td>
<td>20.23</td>
<td>0.00</td>
<td>125</td>
</tr>
<tr>
<td>X7 (CHV)</td>
<td>1.32</td>
<td>0.00</td>
<td>5.02</td>
<td>0.00</td>
<td>2.09</td>
<td>0.97</td>
<td>1.98</td>
<td>25.05</td>
<td>0.00</td>
<td>125</td>
</tr>
<tr>
<td>X8 (RO_RO)</td>
<td>0.74</td>
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<td>0.00</td>
<td>1.58</td>
<td>1.64</td>
<td>3.71</td>
<td>58.71</td>
<td>0.00</td>
<td>125</td>
</tr>
<tr>
<td>X9 (Car_H)</td>
<td>2.66</td>
<td>3.26</td>
<td>4.17</td>
<td>0.00</td>
<td>1.44</td>
<td>-1.11</td>
<td>2.62</td>
<td>26.32</td>
<td>0.00</td>
<td>125</td>
</tr>
<tr>
<td>X10 (Steel_H)</td>
<td>4.46</td>
<td>4.59</td>
<td>5.16</td>
<td>0.00</td>
<td>0.61</td>
<td>-4.04</td>
<td>26.88</td>
<td>3313.31</td>
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<td>125</td>
</tr>
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<td>X11 (Ship_call)</td>
<td>1.84</td>
<td>1.85</td>
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<td>1.46</td>
<td>0.12</td>
<td>-0.65</td>
<td>3.09</td>
<td>8.87</td>
<td>0.01</td>
<td>125</td>
</tr>
<tr>
<td>X12 (Ship_GRT)</td>
<td>4.29</td>
<td>4.30</td>
<td>4.47</td>
<td>4.07</td>
<td>0.05</td>
<td>-0.23</td>
<td>4.88</td>
<td>19.63</td>
<td>0.00</td>
<td>125</td>
</tr>
<tr>
<td>X13 (Ship_LOA)</td>
<td>2.21</td>
<td>2.22</td>
<td>2.31</td>
<td>2.10</td>
<td>0.04</td>
<td>-0.62</td>
<td>3.10</td>
<td>7.98</td>
<td>0.02</td>
<td>125</td>
</tr>
<tr>
<td>X14 (Private_T)</td>
<td>3.51</td>
<td>3.47</td>
<td>4.15</td>
<td>2.74</td>
<td>0.32</td>
<td>0.24</td>
<td>2.23</td>
<td>4.29</td>
<td>0.12</td>
<td>125</td>
</tr>
<tr>
<td>X15 (Public_T)</td>
<td>2.62</td>
<td>2.60</td>
<td>3.21</td>
<td>1.60</td>
<td>0.32</td>
<td>-0.57</td>
<td>3.29</td>
<td>7.09</td>
<td>0.03</td>
<td>125</td>
</tr>
<tr>
<td>X16 (Rev)</td>
<td>4.41</td>
<td>4.45</td>
<td>4.67</td>
<td>3.84</td>
<td>0.16</td>
<td>-0.91</td>
<td>3.26</td>
<td>17.51</td>
<td>0.00</td>
<td>125</td>
</tr>
</tbody>
</table>
4.3. The third category of data

The third regression process is based mainly on the variables obtained from measuring the efficiency of port performance (as independent variables) and integrating it with the variables related to port productivity. The purpose of this is to focus on the variables that will affect the performance of the port and at the same time, affect the port throughput. Due to the limited data required to measure performance efficiency, the period from January 2016 to May 2019 has been determined as a period of time series for measuring performance and regression. The total data collected was from private companies operating container terminals in addition to the coastal navigation station and the port authority.
Table 7: Third regression variables.

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Variables</th>
<th>Code</th>
<th>Frequency</th>
<th>Time Period</th>
<th>Relationship expected sign</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Port Throughput TEUs</td>
<td>Y (PTT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Full Container Truck Delivery</td>
<td>X1 (Full_CoD)</td>
<td></td>
<td></td>
<td>+</td>
<td>Iraqi Ports Authority and container terminal operators</td>
</tr>
<tr>
<td>3</td>
<td>Full Container Truck Receiving</td>
<td>X2 (Full_RoD)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Empty Container Truck Delivery</td>
<td>X3 (Emp_CoD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Empty Container Truck Receiving</td>
<td>X4 (Emp_RoD)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Container Traffic / Boxes (moves)</td>
<td>X5 (Co_Tbox)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Ship Turn-around Time</td>
<td>X6 (Ship_TT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Average Waiting Time</td>
<td>X7 (Waiting_t)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Average Waiting Time Rate</td>
<td>X8 (Waiting_r)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Average Berth Productivity</td>
<td>X9 (Berth_P)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Total Time at Berth</td>
<td>X10 (Time_B)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Berth Occupancy Rate</td>
<td>X11 (Berth_OR)</td>
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</tr>
<tr>
<td>13</td>
<td>Total Working Time</td>
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<td>-</td>
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<tr>
<td>14</td>
<td>TEUs/Ship/Hours</td>
<td>X13 (WSO)</td>
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<td>+</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>TEUs/Ship/Berth</td>
<td>X14 (BSO)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Average Crane Gross Productivity</td>
<td>X15 (Crane_P)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Average Ship Gross Productivity</td>
<td>X16 (Ship_P)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Quay Productivity</td>
<td>X17 (Quay_P)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Full Container Dwell Time</td>
<td>X18 (Full_Dwell)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Empty Container Dwell Time</td>
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<td></td>
<td></td>
<td>-</td>
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</tr>
<tr>
<td>21</td>
<td>Gate Truck-In</td>
<td>X20 (Truck_I)</td>
<td></td>
<td></td>
<td>-</td>
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</tr>
<tr>
<td>22</td>
<td>Gate Truck-Out</td>
<td>X21 (Truck_O)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>23</td>
<td>General cargo Handling Volume</td>
<td>X22 (GCHV)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>24</td>
<td>Grain Handling Volume</td>
<td>X23 (GHV)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Rice Handling Volume</td>
<td>X24 (RHV)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Sugar Handling Volume</td>
<td>X25 (SHV)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Cement Handling Volume</td>
<td>X26 (CHV)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Cars Handling Volume</td>
<td>X27 (Car_H)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Steel Handling Volume</td>
<td>X28 (Steel_H)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Ship Calls</td>
<td>X29 (Ship_call)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Average of Ship Calls GRT</td>
<td>X30 (Ship_GRT)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Average of Ship Calls LOA</td>
<td>X31 (Ship_LOA)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Total Private Trucks</td>
<td>X32 (Private_T)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Total Public Trucks</td>
<td>X33 (Public_T)</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Total Port Revenue</td>
<td>X34 (Rev)</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

Monthly: 2016M01-2019M05
- X1: Full Container Truck Delivery (Full_CoD)
- X2: Full Container Truck Receiving (Full_CoR)
- X3: Empty Container Truck Delivery (Emp_CoD)
- X4: Empty Container Truck Receiving (Emp_CoR)

These variables express the gate operation and have direct impact of the port throughput and container terminal in particular, as the traffic jams of trucks will have a significant effect, due to the lack of adequate parking spaces first, and secondly, that the internal roads of the port are not enough to rotate or change the lanes of trucks. The difference between the data can be seen from the diagram below, and this gives two explanations. First, the port is highly dependent on the import of goods. Second, the effect of these variables on the dependent variable will be different, as indicated in Table 7.

*Figure 20: Gate operation variables of third regression, 2016M01-2019M05.*
- X5: Total Container Traffic/Box (Co_Tbox)
- X6: Average Ship Turn-around Time (Ship_TT)
- X7: Average Waiting Time (Waiting_t)
- X8: Average Waiting Time Rate (Waiting_r)
- X9: Average Berth Productivity (Berth_P)
- X10: Total Time at Berth (Time_B)
- X11: Berth Occupancy Rate (Berth_OR)
- X12: Total Working Time (Working_T)
- X13: WSO TEUs/Ship/Hours (WSO)
- X14: BSO TEUs/Ship/Berth (BSO)
- X15: Average Crane Gross Productivity (Crane_P)
- X16: Average Ship Gross Productivity (Ship_P)
- X17: Quay Productivity (Quay_P)
- X18: Full Container Dwell Time (Full_Dwell)
- X19: Empty Container Dwell Time (Emp_Dwell)

This set of independent variables is based on the port performance calculation, and its importance is indicated in chapter three, the methodology. In order to shed light on these variables, some points concerning the efficiency of the port or container terminals in particular, and attempting to analyze the weaknesses in performance, will be addressed in order to improve performance.

Most of the above variables are related to the three leading indicators shown in the following graphs. Moreover, to the basic operations of the container terminal (berth, yard, and gate), hence several points can be extrapolated:

a) The trend of ship turn-around time is going up slightly. With the increase in the number of the ship calls and container traffic, the container terminal operators are required to take more effective measures to avoid such an increase, which may adversely affect the port's productivity. The other elements of port operations can be analyzed in a variety of ways to reduce ship turn-around time.
b) The waiting time reflects a significant decrease, which indicates that the port operations are efficient, but with increased container handling; this variable may be reversed in the future.

c) That the decrease in dwell time is a positive indicator of the efficiency of the container yard performance, and it is therefore imperative to maintain this level because it maintains a balance between the berth and the gate operations. As a result, increasing port productivity, and reducing this indicator requires additional space or more efficient handling equipment.

Figure 21: Average Ship Turn-around Time.
What can be seen from the graphs above, namely April 2016. The reason for this is stopped operation at terminal No. 3 and transfer all its operations to terminal No. 4. As a result, the scheduling of ships was interfered and a number of vessels were disrupted as well. This is reflected in the data in the figure above.

For the rest of the independent variables, they are the same as those used by the second regression, shortened for the period from January 2016 to May 2019. The table below represents the descriptive statistics analysis of regression variables.
Table 8: Preliminary analysis of third regression variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Std. Dev.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Jarque-Bera Probability</th>
<th>Obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y (PTT)</td>
<td>4.86</td>
<td>4.89</td>
<td>5.02</td>
<td>4.59</td>
<td>0.12</td>
<td>-0.77</td>
<td>2.63</td>
<td>4.29</td>
<td>41</td>
</tr>
<tr>
<td>X1 (FULL_COD)</td>
<td>3.64</td>
<td>3.65</td>
<td>3.81</td>
<td>3.48</td>
<td>0.09</td>
<td>-0.03</td>
<td>2.06</td>
<td>1.50</td>
<td>47</td>
</tr>
<tr>
<td>X2 (FULL_COR)</td>
<td>0.85</td>
<td>0.70</td>
<td>2.01</td>
<td>0.00</td>
<td>0.85</td>
<td>0.17</td>
<td>1.24</td>
<td>5.49</td>
<td>41</td>
</tr>
<tr>
<td>X3 (EMP_COD)</td>
<td>0.05</td>
<td>0.00</td>
<td>1.34</td>
<td>0.00</td>
<td>0.22</td>
<td>5.02</td>
<td>28.52</td>
<td>15</td>
<td>41</td>
</tr>
<tr>
<td>X4 (EMP_COR)</td>
<td>3.60</td>
<td>3.64</td>
<td>3.80</td>
<td>3.20</td>
<td>0.12</td>
<td>-1.04</td>
<td>4.08</td>
<td>9.42</td>
<td>41</td>
</tr>
<tr>
<td>X5 (CO_TBOX)</td>
<td>4.62</td>
<td>4.65</td>
<td>4.79</td>
<td>4.36</td>
<td>0.12</td>
<td>-0.71</td>
<td>2.47</td>
<td>3.95</td>
<td>41</td>
</tr>
<tr>
<td>X6 (SHIP_TT)</td>
<td>1.49</td>
<td>1.49</td>
<td>1.72</td>
<td>1.34</td>
<td>0.07</td>
<td>0.53</td>
<td>3.79</td>
<td>2.97</td>
<td>23</td>
</tr>
<tr>
<td>X7 (WAITING_T)</td>
<td>0.38</td>
<td>0.31</td>
<td>1.16</td>
<td>0.12</td>
<td>0.22</td>
<td>2.05</td>
<td>6.75</td>
<td>52.6</td>
<td>41</td>
</tr>
<tr>
<td>X8 (WAITING_R)</td>
<td>-0.99</td>
<td>-1.07</td>
<td>-0.01</td>
<td>-1.37</td>
<td>0.29</td>
<td>1.77</td>
<td>5.85</td>
<td>35.2</td>
<td>41</td>
</tr>
<tr>
<td>X9 (BERTH_P)</td>
<td>1.64</td>
<td>1.63</td>
<td>1.99</td>
<td>1.47</td>
<td>0.11</td>
<td>0.93</td>
<td>4.47</td>
<td>9.64</td>
<td>41</td>
</tr>
<tr>
<td>X10 (TIME_B)</td>
<td>3.01</td>
<td>3.06</td>
<td>3.24</td>
<td>2.66</td>
<td>0.16</td>
<td>-0.73</td>
<td>2.47</td>
<td>4.08</td>
<td>41</td>
</tr>
<tr>
<td>X11 (BERTH_OR)</td>
<td>-0.32</td>
<td>-0.27</td>
<td>-0.10</td>
<td>-0.67</td>
<td>0.16</td>
<td>-0.72</td>
<td>2.47</td>
<td>4.02</td>
<td>13</td>
</tr>
<tr>
<td>X12 (WORKING_T)</td>
<td>2.98</td>
<td>3.03</td>
<td>3.23</td>
<td>2.63</td>
<td>0.17</td>
<td>-0.66</td>
<td>2.39</td>
<td>3.57</td>
<td>41</td>
</tr>
<tr>
<td>X13 (WSO)</td>
<td>1.87</td>
<td>1.89</td>
<td>2.00</td>
<td>1.68</td>
<td>0.07</td>
<td>-0.67</td>
<td>3.32</td>
<td>3.28</td>
<td>19</td>
</tr>
<tr>
<td>X14 (BSO)</td>
<td>1.84</td>
<td>1.85</td>
<td>1.94</td>
<td>1.67</td>
<td>0.06</td>
<td>-0.77</td>
<td>3.03</td>
<td>4.08</td>
<td>13</td>
</tr>
<tr>
<td>X15 (CRANE_P)</td>
<td>1.45</td>
<td>1.44</td>
<td>1.76</td>
<td>1.27</td>
<td>0.12</td>
<td>0.57</td>
<td>2.76</td>
<td>2.29</td>
<td>41</td>
</tr>
<tr>
<td>X16 (SHIP_P)</td>
<td>1.65</td>
<td>1.66</td>
<td>1.80</td>
<td>1.48</td>
<td>0.08</td>
<td>-0.13</td>
<td>2.21</td>
<td>1.19</td>
<td>55</td>
</tr>
<tr>
<td>X17 (QUAY_P)</td>
<td>2.32</td>
<td>2.35</td>
<td>2.49</td>
<td>2.06</td>
<td>0.12</td>
<td>-0.71</td>
<td>2.47</td>
<td>3.94</td>
<td>14</td>
</tr>
<tr>
<td>X18 (FULL_DWELL)</td>
<td>0.62</td>
<td>0.60</td>
<td>0.88</td>
<td>0.30</td>
<td>0.09</td>
<td>-0.57</td>
<td>6.48</td>
<td>22.9</td>
<td>41</td>
</tr>
<tr>
<td>X19 (EMP_DWELL)</td>
<td>0.70</td>
<td>0.70</td>
<td>0.90</td>
<td>0.48</td>
<td>0.12</td>
<td>-0.02</td>
<td>2.74</td>
<td>0.12</td>
<td>94</td>
</tr>
<tr>
<td>X20 (TRUCK_I)</td>
<td>3.92</td>
<td>3.96</td>
<td>4.18</td>
<td>3.48</td>
<td>0.19</td>
<td>-0.77</td>
<td>2.59</td>
<td>4.30</td>
<td>12</td>
</tr>
<tr>
<td>X21 (TRUCK_O)</td>
<td>3.92</td>
<td>3.95</td>
<td>4.19</td>
<td>3.35</td>
<td>0.20</td>
<td>-1.01</td>
<td>3.30</td>
<td>7.09</td>
<td>43</td>
</tr>
<tr>
<td>X22 (GCHV)</td>
<td>4.92</td>
<td>4.91</td>
<td>5.23</td>
<td>4.54</td>
<td>0.16</td>
<td>-0.21</td>
<td>2.69</td>
<td>0.47</td>
<td>79</td>
</tr>
<tr>
<td>X23 (GHV)</td>
<td>0.68</td>
<td>0.00</td>
<td>4.91</td>
<td>0.00</td>
<td>1.66</td>
<td>2.01</td>
<td>5.04</td>
<td>34.6</td>
<td>41</td>
</tr>
<tr>
<td>X24 (RHV)</td>
<td>1.93</td>
<td>0.00</td>
<td>5.01</td>
<td>0.00</td>
<td>2.32</td>
<td>0.36</td>
<td>1.14</td>
<td>6.76</td>
<td>41</td>
</tr>
<tr>
<td>X25 (SHV)</td>
<td>0.11</td>
<td>0.00</td>
<td>4.44</td>
<td>0.00</td>
<td>0.69</td>
<td>6.17</td>
<td>39.03</td>
<td>26.9</td>
<td>41</td>
</tr>
<tr>
<td>X26 (CHV)</td>
<td>0.16</td>
<td>0.00</td>
<td>3.45</td>
<td>0.00</td>
<td>0.71</td>
<td>4.23</td>
<td>18.96</td>
<td>57.1</td>
<td>41</td>
</tr>
<tr>
<td>X27 (CAR_H)</td>
<td>2.11</td>
<td>2.81</td>
<td>3.73</td>
<td>0.00</td>
<td>1.41</td>
<td>-0.74</td>
<td>1.76</td>
<td>6.38</td>
<td>41</td>
</tr>
<tr>
<td>X28 (STELL_H)</td>
<td>4.58</td>
<td>4.63</td>
<td>5.06</td>
<td>1.91</td>
<td>0.46</td>
<td>-4.90</td>
<td>29.39</td>
<td>13.7</td>
<td>41</td>
</tr>
<tr>
<td>X29 (SHIP_CALL)</td>
<td>1.91</td>
<td>1.91</td>
<td>2.04</td>
<td>1.81</td>
<td>0.06</td>
<td>0.19</td>
<td>2.13</td>
<td>1.56</td>
<td>46</td>
</tr>
<tr>
<td>X30 (SHIP_GRT)</td>
<td>4.31</td>
<td>4.31</td>
<td>4.36</td>
<td>4.25</td>
<td>0.03</td>
<td>-0.24</td>
<td>2.38</td>
<td>1.05</td>
<td>59</td>
</tr>
<tr>
<td>X31 (SHIP_LOA)</td>
<td>2.24</td>
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<td>2.31</td>
<td>2.21</td>
<td>0.02</td>
<td>2.07</td>
<td>7.37</td>
<td>61.8</td>
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</tr>
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<td>3.88</td>
<td>4.15</td>
<td>3.37</td>
<td>0.24</td>
<td>-0.64</td>
<td>2.04</td>
<td>4.35</td>
<td>12</td>
</tr>
<tr>
<td>X33 (PUBLIC_T)</td>
<td>2.81</td>
<td>2.92</td>
<td>3.21</td>
<td>1.68</td>
<td>0.33</td>
<td>-1.56</td>
<td>5.22</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>X34 (REV)</td>
<td>4.54</td>
<td>4.55</td>
<td>4.67</td>
<td>4.41</td>
<td>0.06</td>
<td>-0.40</td>
<td>2.76</td>
<td>1.17</td>
<td>0.6</td>
</tr>
</tbody>
</table>
5. RESULTS and FINDINGS

Regression can be understood as a causal relationship between one or a set of variables called the independent and dependent variable, and this relationship may be linear or non-linear. Therefore, the purpose of regression analysis is to find out the nature of the variables taking place by studying a set of data that may help to estimate the parameters of the model and thus predict or estimate the values of the variables adopted when the estimated values of the independent variables are available. To illustrate regression analysis is concerned with understanding the mathematical model and the graphical method that represents the relationship between variables (Mills & Markellos, 2008), (Freund, Wilson, & Sa, 2006).

From this standpoint, it is clear the importance of the previous step, which is concerned with a descriptive statistical analysis of data. This chapter will give an economic justification for the results of the regression steps in figure 5, which was done using E-Views.

5.1. Unit Root Test

The unit root test aims at determining whether the dependent and independent variables are stationary or non-stationary (Brooks, 2019). This can be determined through tests:

- Augmented Dickey-Fuller ADF
- Phillip-Perron PP
- Kwiatkowski-Phillips-Schmidt-Shin KASS

This test was performed as an initial step in the regression, and therefore it is necessary to know whether the variables are stationary at level (I_0) or become stationary with first difference (I_1) or second difference (I_2) according to the test. The results are shown in Appendices 1,2, and 3.
5.2. Correlation Test

If there is a correlation between the independent variables and they have an approach to influence the dependent variable, thus this requires that by using Excel, to identifying those variables with more than 8% correlation and excluding one from the regression equation. This is done after all independent variables are calculated by the stationary level. The following diagrams show the results of the examination.

As shown in the above figure, there is a correlation between GDP and Imp_TP, and the Imp_TP which will be excluded from the equation, because the purpose of the regression is to measure the macroeconomic effect, and at the same time the Imp_TP has a correlation with the second variable of PPP. Revenue (Rev) will be excluded from the equation because it correlates with GDP, PPP, and Imp_TP, so it makes sense to eliminate one variable better than three, thus benefiting from keeping the number of independent variables.

When conducting the correlation for the second data category related to monthly regression for 2009 to 2019, as in the figure below, it was found there is no correlation between independent variables.
The correlation check was conducted for the third category of data as shown in Appendix 4, and there is a correlation between Total Container Traffic/Boxes (Co_Tbox) and Quay Productivity (Quay_P). The Co_Tbox will exclude because there is an alternative variable given the same value, which is WSO and BSO; these variables can be inferred for container movements. In addition, the Quay_P is one of the measures of PPI and therefore, its presence in the gradient is vital according to the hypothesis.

There is a correlation between Time_B and both Working_T and Berth_OR, so, therefore, the Time_B will be excluded better than the exclusion of two variables, in addition, the Time_B is to measure the total time at berth and can be replaced by the inference of Berth_OR.

Also, there is a correlation between Working_T and Berth_OR, and Working_T will be excluded because an alternative is Berth_OR and Quay_P.

5.3. T-Test

The principle of T-Test is to prove or reject the hypothesis based on the fact that the relationship between variables (dependent and independents), which represent two sets of values or data. The purpose of this test to explain Y using X, or how Y is affected by changing the X values. A simple regression equation can represent the relationship between Y and X:

\[
Y = \beta_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \cdots + \epsilon
\]

Equation 1: Simple regression equation.

When the T-Test was performed for the three category and for the variables resulting from correlation step only, the following equations were found:
Equation 2: First regression equation.

\[ d(PTT) = c(1) + c(2)*d(GDP) + c(3)*Imp + c(4)*d(Popu) + c(5)*d(PPP) + c(6)*d(IR) + c(7)*d(FE) \] ................................................................. (1-1)

Equation 3: Second regression equation.

\[ d(PTT) = c(1) + c(2)*d(GTI) + c(3)*GTO + c(4)*d(GCHV) + c(5)*GHV + c(6)*RHV + c(7)*d(SHV) + c(8)*d(CHV) + c(9)*d(Car_h) + c(10)*Steel_h + c(11)*d(Ship_call) + c(12)*Ship_GRT + c(13)*Ship_LOA + c(14)*d(Private_T) + c(15)*Public_T + c(16)*d(Rev) \] ................................................................. (1-2)

Equation 4: Third regression equation.

\[ d(PTT) = c(1) + c(2)*Full_DoC + c(3)*d(Full_CoR) + c(4)*Emp_DoC + c(5)*Emp_CoR + c(6)*Ship_tt + c(7)*Berth_P + c(8)*d(Berth_OR) + c(9)*d(Working_T) + c(10)*d(WSO) + c(11)*BSO + c(12)*Crane_P + c(13)*Ship_P + c(14)*d(Quay_P) + c(15)*Full_Dwell + c(16)*Emp_Dwell + c(17)*d(Truck_I) + c(18)*Truck_O + c(19)*GCHV + c(20)*d(GHV) + c(21)*RHV + c(22)*SHV + c(23)*CHV + c(24)*Car_h + c(25)*Steel_h + c(26)*Ship_call + c(27)*Ship_GRT + c(28)*d(Ship_LOA) + c(29)*d(Private_T) + c(30)*Public_T + c(31)*d(Rev) \] ................................................................. (1-3)

At this stage, all independent variables are present in the equation, but it must be determined, which of them has a significant influence on the dependent variable, so the following test is required.
5.4. F-Test

Here, there is a possibility that some variables are insignificant according to the T-Test. Therefore, we can do the F-Test with the hypothesis that all coefficients in the equation with probability value greater than 5% equal to zero, and when accepting the hypothesis means all coefficients are zero and therefore exclude the variables from the equation, or reject the hypothesis which means at least one of the coefficients, is not equal zero. Thus, the result of the three regressions was as follows:

- First regression: the probability value is 0.0350 < 5% and will reject the hypothesis
- Second regression: the probability value is 0.4427 > 5% and will accept the hypothesis.
- Third regression: the probability value is 0.0000 < 5% and will reject hypothesis.

Table 9: F-Test results of three regression.

<table>
<thead>
<tr>
<th>Wald Test</th>
<th>Equation EQ02, EQ03, and EQ04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Statistic</td>
<td>Value</td>
</tr>
<tr>
<td><strong>First Regression</strong></td>
<td></td>
</tr>
<tr>
<td>F-Statistic</td>
<td>470,583</td>
</tr>
<tr>
<td>Chi-Square</td>
<td>2351,915</td>
</tr>
<tr>
<td><strong>Second Regression</strong></td>
<td></td>
</tr>
<tr>
<td>F-Statistic</td>
<td>1,015</td>
</tr>
<tr>
<td>Chi-Square</td>
<td>13,192</td>
</tr>
<tr>
<td><strong>Third Regression</strong></td>
<td></td>
</tr>
<tr>
<td>F-Statistic</td>
<td>138,549</td>
</tr>
<tr>
<td>Chi-Square</td>
<td>3463,738</td>
</tr>
</tbody>
</table>

At these results and after the F-Test, it will exclude any variable with a probability value higher than 5% to complete the regression of significant variables only. The results came as in the table below for all regression.
Table 10: Significant Variables of the three regression.

<table>
<thead>
<tr>
<th>Y</th>
<th>Regression</th>
<th>X</th>
<th>Coefficient</th>
<th>P. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Throughput</td>
<td>Annual 2009-2018</td>
<td>Imp</td>
<td>-3,499</td>
<td>0,001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IR</td>
<td>2,038</td>
<td>0,004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FE</td>
<td>-24,152</td>
<td>0,028</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rev</td>
<td>4,478</td>
<td>0,001</td>
</tr>
<tr>
<td></td>
<td>Monthly 2009-2019</td>
<td>GCHV</td>
<td>-0,098</td>
<td>0,057</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Car_H</td>
<td>0,017</td>
<td>0,003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ship_call</td>
<td>0,917</td>
<td>0,000</td>
</tr>
<tr>
<td></td>
<td>Monthly 2016-2019</td>
<td>Waiting_T</td>
<td>0,053</td>
<td>0,017</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waiting_R</td>
<td>-0,064</td>
<td>0,008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Berth_OR</td>
<td>0,651</td>
<td>0,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WSO</td>
<td>0,470</td>
<td>0,006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BSO</td>
<td>0,559</td>
<td>0,003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ship_P</td>
<td>-0,347</td>
<td>0,002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quay_P</td>
<td>0,252</td>
<td>0,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steel_H</td>
<td>0,009</td>
<td>0,052</td>
</tr>
</tbody>
</table>

5.5. Cointegration Test

At this stage, to test the cointegration requires creating pairs between dependent and independent variables that they have first difference I_1, to check if there is cointegration between them or not. Furthermore, after that tests, the residuals from that cointegration are stationary or nor, and in which level becomes stationary.

From the results of the unit root test:

- Y of first regression is at I_0 level, and
- Y of second and third regression is I_1 level. So, the cointegration test will perform only for dependent and (independent, significant, and I_1 level) variables. The results of cointegration are:
Table 11: Cointegration test results.

<table>
<thead>
<tr>
<th>Category</th>
<th>Residual</th>
<th>Stationary</th>
<th>Cointegration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Second Regression</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resid_PTT_GCHV</td>
<td>I₁ level</td>
<td>Not</td>
<td></td>
</tr>
<tr>
<td>Resid_PTT_Car_h</td>
<td>I₁ level</td>
<td>Not</td>
<td></td>
</tr>
<tr>
<td>Resid_PTT_Ship_call</td>
<td>I₁ level</td>
<td>Not</td>
<td></td>
</tr>
<tr>
<td><strong>Third Regression</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resid_PTT_Waiting_R</td>
<td>I₀ level</td>
<td>Integrated</td>
<td></td>
</tr>
<tr>
<td>Resid_PTT_Berth_OR</td>
<td>I₀ level</td>
<td>Integrated</td>
<td></td>
</tr>
<tr>
<td>Resid_PTT_WSO</td>
<td>I₀ level</td>
<td>Integrated</td>
<td></td>
</tr>
<tr>
<td>Resid_PTT_Public_T</td>
<td>I₀ level</td>
<td>integrated</td>
<td></td>
</tr>
</tbody>
</table>

Based on the above results, the stationary residual can be added to the equation as independent variables and measured whether they are significant or not, and exclude who is insignificant. The next step is to check whether the model is ARMA or not, by adding AR and MA from 1 to 5, and examine them until all the variables are significant. The results of the three regressions were:

- The first model is not integrated as well as not ARMA.
- The second model is not integrated as well as ARMA.
- The third model is integrated as well as ARMA, so the model is called Auto-Regressive Integrated Moving Average ARIMA. This means the model will perform better, and the forecasting ability will be better.
Table 12: ARIMA Model of third regression.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-1.83</td>
<td>0.046</td>
<td>-39.632</td>
<td>0.000</td>
</tr>
<tr>
<td>WAITING_T</td>
<td>-0.034</td>
<td>0.009</td>
<td>-3.703</td>
<td>0.001</td>
</tr>
<tr>
<td>D(WAITING_R)</td>
<td>0.019</td>
<td>0.009</td>
<td>2.159</td>
<td>0.041</td>
</tr>
<tr>
<td>D(BERHT_OR)</td>
<td>0.828</td>
<td>0.029</td>
<td>28.236</td>
<td>0.000</td>
</tr>
<tr>
<td>D(WSO)</td>
<td>0.074</td>
<td>0.018</td>
<td>4.005</td>
<td>0.001</td>
</tr>
<tr>
<td>BSO</td>
<td>0.796</td>
<td>0.023</td>
<td>34.541</td>
<td>0.000</td>
</tr>
<tr>
<td>SHIP_P</td>
<td>-0.035</td>
<td>0.012</td>
<td>-2.911</td>
<td>0.007</td>
</tr>
<tr>
<td>QUAY_P</td>
<td>0.191</td>
<td>0.024</td>
<td>8.012</td>
<td>0.000</td>
</tr>
<tr>
<td>STELL_H</td>
<td>-0.003</td>
<td>0.001</td>
<td>8.012</td>
<td>0.000</td>
</tr>
<tr>
<td>RESID_PTT_BERTH_OR(-1)</td>
<td>-1.222</td>
<td>0.060</td>
<td>-20.221</td>
<td>0.000</td>
</tr>
<tr>
<td>RESID_PTT_WAITING_R(-1)</td>
<td>0.089</td>
<td>0.026</td>
<td>3.378</td>
<td>0.002</td>
</tr>
<tr>
<td>RESID_PTT_WSO(-1)</td>
<td>0.109</td>
<td>0.029</td>
<td>3.627</td>
<td>0.001</td>
</tr>
<tr>
<td>AR(1)</td>
<td>-0.636</td>
<td>0.175</td>
<td>-3.644</td>
<td>0.001</td>
</tr>
<tr>
<td>MA(1)</td>
<td>0.567</td>
<td>0.269</td>
<td>2.105</td>
<td>0.045</td>
</tr>
</tbody>
</table>

5.6. Jarque-Berra Test

The aim of this test is to check whether the residual has a normality distribution or not, and if it can be adding some dummy variables to make the residue normally distribution, if it is not. At this stage, with regard to case study models, after testing the following were found:
First regression: the probability value is higher than 5%, which means accept the hypothesis, and the residual has a normality distribution.

Second regression: the probability value was less than 5%, which means reject the hypothesis, and the residual is not normally distributed. Therefore, this requires adding dummy variables, hence, adding dummy variable at 2016M01. The residual became a normal distribution with a probability value greater than 5%, at the same time excluding the GCHV variable.
Third regression: the probability value is higher than 5%, which means accepting the hypothesis, and the residual has a normality distribution.
One of the essential steps is (Heteroskedasticity Test and Serial Correlation LM Test). As a result of this test, it can be said that the models were:

- **Frist Regression**: the model is **Homoskedasticity** and **No Serial Correlation**.
  It requires nothing to do.

- **Second Regression**: the model is **Heteroskedasticity** and **Serial Correlation**.
  It requires the Newey-West Test.

### Table 13: Newey-West Test of second regression.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.005</td>
<td>0.005</td>
<td>0.859</td>
<td>0.391</td>
</tr>
<tr>
<td>D(LOG_CAR_H)</td>
<td>0.016</td>
<td>0.007</td>
<td>2.319</td>
<td>0.022</td>
</tr>
<tr>
<td>D(LOG_SHIP_CALL)</td>
<td>0.808</td>
<td>0.197</td>
<td>4.108</td>
<td>0.000</td>
</tr>
<tr>
<td>DUMMY_2016M01</td>
<td>0.544</td>
<td>0.007</td>
<td>79.780</td>
<td>0.000</td>
</tr>
</tbody>
</table>

---

**Figure 30: Jarque-Berra Test of third regression.**

![Jarque-Berra Test](chart.png)

- Series: Residuals
- Sample: 2016M03 2019M05
- Observations: 39

- Mean: 2.16e-05
- Median: -0.000315
- Maximum: 0.006670
- Minimum: -0.004432
- Std. Dev.: 0.002362
- Skewness: 0.789423
- Kurtosis: 3.800576
- Jarque-Bera: 5.092224
- Probability: 0.078386
Third Regression: the model is **Homoskedasticity** and **No Serial Correlation**. It requires nothing to do.

5.7. **Ramsey Test**

It is essential to verify that the model is linear or not, and for this purpose, it can be checked using the Ramsey Test, which is a general test for the misspecification of the functional form. This test was conducted by E-Views and for all three models, and the test results were:

- First Regression: the probability value was (0.27), which is higher than 5%, so it will accept the null hypothesis, and the model is Linear.

- Second Regression: the probability value was (0.17), which is higher than 5% so it will accept the null hypothesis and the model in Linear.

- Third Regression: the probability value was (0.88), which is higher than 5% so it will accept the null hypothesis, and the model is Linear.
Table 14: Ramsey RESET Test.

**Equation: EQ02**

<table>
<thead>
<tr>
<th>Omitted Variables:</th>
<th>Powers of fitted values from 2 to 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification:</td>
<td>PTT C IMP D(IR) FE REV</td>
</tr>
<tr>
<td>Sample:</td>
<td>2010 - 2018</td>
</tr>
<tr>
<td>Included observations:</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>2,644</td>
<td>(2, 2)</td>
<td>0,274</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>11,638</td>
<td>2</td>
<td>0,003</td>
</tr>
</tbody>
</table>

**Equation: EQ03**

<table>
<thead>
<tr>
<th>Omitted Variables:</th>
<th>Squares of fitted values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample:</td>
<td>2009M03 - 2019M05</td>
</tr>
<tr>
<td>Included observations:</td>
<td>123</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-statistic</td>
<td>1,392</td>
<td>115</td>
<td>0,166</td>
</tr>
<tr>
<td>F-statistic</td>
<td>1,938</td>
<td>(1, 115)</td>
<td>0,166</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>2,056</td>
<td>1</td>
<td>0,151</td>
</tr>
</tbody>
</table>

**Equation: EQ04**

<table>
<thead>
<tr>
<th>Omitted Variables:</th>
<th>Powers of fitted values from 2 to 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification:</td>
<td>D(PTT) C WAITING_T D(WAITING_R) D(BERHT_OR) D(WSO) BSO SHIP_P QUAY_P STELL_H RESID_PTT_BERTH_OR(-1) RESID_PTT_WAITING_R(-1) RESID_PTT_WSO(-1)</td>
</tr>
<tr>
<td>Sample:</td>
<td>2016M02 - 2019M05</td>
</tr>
<tr>
<td>Included observations:</td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>0,123</td>
<td>(2, 26)</td>
<td>0,884</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>0,379</td>
<td>2</td>
<td>0,827</td>
</tr>
</tbody>
</table>
5.8. Forecast

An important and useful step in regression is the forecasting or prediction, and there are several models that can be followed according to the model or data it addresses and the quality of data, etc. One of these prediction models is the ARIMA model, and has already indicated that the predictability is high if the model is ARIMA. The forecasting is more important when it is accurate, and this necessarily depends on measuring the Mean Square Error MSE, Mean Absolute Error MAE, and Mean Abs. Percent Error MAPA.

By using E-Views, the dynamic and static will be compared, and the final result will be those who have the least potential error, which means that their performance is better. The process of preference between dynamic and static depends on the purpose of forecasting; in other words, the dynamic forecast is a multi-step ahead forecast, while the static forecast is a single step ahead forecast. Therefore, choosing the best between these two types of the forecast depends on two things:

- The best forecasting is the one with the lowest MSE, MAE, and MAPA. and/or
- The pattern of strategy that this prediction will entail. In other words, for a long-term strategy, the multi-step forecasting is better, and vice versa for a short-term plan, the forecasting of a single step is better.

At this step, using E-Views, only the third model was forecast for being the ARIMA model, and the other two were not ARIMA. Furthermore, by checking the information criteria of these models, the third model shows the lowest value, which means it has performed better than others. The in-sample was selected with 90% of the model and 10% out of sample, which is:

- From 2016M01 until 2018M11 in-sample.
- From 2018M12 until 2019M05 out of sample.

The following diagrams show the difference between dynamic and static:
Figure 32: Dynamic Forecasting.

Figure 31: Static Forecasting.
To illustrate the difference between the dynamic and static forecast, table 11 below shows that the MSE in the static forecast is less than the dynamic, as well as concerning MAE and MAPA. As a result, the static forecast performance is much better than the dynamic forecast.

**Table 15: Compare between Static and Dynamic Forecast.**

<table>
<thead>
<tr>
<th></th>
<th>Dynamic Forecasting</th>
<th>Static Forecasting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecast: PTT_F_DYNAMIC</td>
<td>Actual: PTT</td>
<td>Forecast: PTT_F_STATIC</td>
</tr>
<tr>
<td>Included observations: 6</td>
<td></td>
<td>Included observations: 6</td>
</tr>
<tr>
<td>Root Mean Squared Error</td>
<td>0.018254</td>
<td>Root Mean Squared Error</td>
</tr>
<tr>
<td>Mean Absolute Error</td>
<td>0.016970</td>
<td>Mean Absolute Error</td>
</tr>
<tr>
<td>Mean Abs. Percent Error</td>
<td>0.346798</td>
<td>Mean Abs. Percent Error</td>
</tr>
<tr>
<td>Theil Inequality Coef.</td>
<td>0.001868</td>
<td>Theil Inequality Coef.</td>
</tr>
<tr>
<td>Bias Proportion</td>
<td>0.864293</td>
<td>Bias Proportion</td>
</tr>
<tr>
<td>Variance Proportion</td>
<td>0.000336</td>
<td>Variance Proportion</td>
</tr>
<tr>
<td>Covariance Proportion</td>
<td>0.135371</td>
<td>Covariance Proportion</td>
</tr>
<tr>
<td>Theil U2 Coefficient</td>
<td>0.159819</td>
<td>Theil U2 Coefficient</td>
</tr>
<tr>
<td>Symmetric MAPE</td>
<td>0.347495</td>
<td>Symmetric MAPE</td>
</tr>
</tbody>
</table>

Figure 33: Compare the Static and Dynamic forecasting.
Summary

Using data for 55 independent variables to indicate who are they, has a significant impact on the UQP productivity, as well as using the three regression models. Steps have been followed in this regard:

- Clearfield why these independent variables are selected and identify their relevance to the dependent variable.
- The available data has been checked for usability.
- Preliminary analysis and a visual check of data were also carried out, through the graph and descriptive statistical analysis.
- The data was checked to make sure that the variables were stationary or not, in addition to making sure that the information was correct or not.
- Following the regression steps to ensure that the model is linear, including all necessary tests, such as T-Test, F-Test, etc.

In conclusion, the port's data was used to identify what happened in the past and how it was used to predict what it might be in the future. In other words, the most appropriate use of data to determine the best in the prediction, whether static or dynamic. The results were an exclusion of 40 independent variables, and only 15 remain, as indicated in table 9.
6. DISCUSSION and CONCLUSION

6.1. General Overview

The multiplicity of activities in multi-purpose ports makes the assessment of performance difficult because of the overlap of these activities. In addition, the scarcity of data that can be adopted in measuring performance or evaluating efficiency, is limited only by cargo handling capacity data (Park, Yoon, & Park, 2014). By collecting data on UQP, it was found that the process of evaluating the performance of the port requires separating the cargo handled by type. During previous periods, there was a significant change in the cargo types that were handling in UQP, as can be seen from the data presented in chapter four "Figure 15". However, the outstanding problems and challenges mentioned in the introduction remain difficult tasks in the development of the port. It is possible through the study to indicate how the port can work on the overall situation of the port and seek to develop its performance. This is because of the urgent need for the port to play its role in supporting and promoting the national economy.

6.2. Results and finding

When testing the validity of the hypotheses using the results obtained from the regression, shown in table 9, the independent variables have a significant impact on the dependent variable, and the results are as follows:

a. The first hypothesis:

- The existence of a direct relationship between the total imports and UQP container throughput. In other words, a 1% increase in total imports would negatively affect the performance by 3.5%. This result was contrary to the expected increase in imports positively affected.
- There is a positive relationship between the Inflation Rate IR and the container throughput, where the value of the coefficient was 2.04, and this explains the existence of a powerful positive relationship where the higher of IR increases the throughput in proportion to a positive value of
the coefficient. It is noteworthy that the positive correlation was unexpected according to the hypothesis.

- The first regression results showed that the relationship between the Foreign Exchange FE and throughput is negative as expected in the hypothesis. The value of the coefficient was -24.1 since most transactions with port stakeholders are calculated in USD and then converted to the local currency. Even though CBI follows a relatively stable monetary policy, that does not prevent any change of FE having a significant impact on the financial returns of the port, as well as on throughput rates.

- The results of the first regression were consistent with the hypothesis; the relationship between port revenues and throughput is a positive impact since the value of the coefficient is 4.48.

b. The second hypothesis:

- There is a negative influence relationship between the total volume of general cargo handling and container throughput. The value of the coefficient, according to the regression results, was -0.098. The reason for this is that general cargo handling operations overlap significantly with container handling at the port, which may cause a negative impact.

- From the second regression results, there is a positive relationship between both the car handling and ship calls, which positively affects UQP throughput. It should be noted that the expectation of the ship call impact was correct. While the result of car handling was inverse, it may be because the car handling requires large storage areas, and this affects the container yard operations.

c. The third hypothesis:

- There is a positive relationship between each of waiting time, berth occupancy rate, WSO, BSO, quay productivity, and steel handling and the container throughput.

- The relationship between the waiting rate and ship productivity has a negative impact relationship on container throughput.
The above results show great importance for the port managers to focus on and exploit it properly, which may help increase the container throughput. The coefficient of these variables reflects the extent of this importance, which is generally related to performance measures. In other words, these variables would have been easy to be controlled if the performance method had developed.

6.3. Implications

The study reached a set of results:

- UQP witnessed several development stages during the period from its establishment in 1964 to the present day. Many changes in infrastructure and superstructure have come to meet the development of the country’s foreign trade, which is a reflection of the steady increase in population. So the study took these factors in addition to the factors of the national economy. As a final result, performance factors can be built on, utilized or used more effectively for more efficient productivity.

- As a multi-purpose port, it is qualified to server all types of vessels. However, based on the analysis of past data and regression results, it was found that container handling rates were increasing compared to other cargos, particularly for the period 2016 and beyond. It is therefore necessary to focus on making the port dedicated to containers to take advantage of the port’s potential better than existing interference. It should be noted that most of the cargo coming to the port are containers, general cargo, projects equipment’s, and bulk cargo.

- Imports of the Ministry of Commerce; in addition to the private imports, had a significant impact on the movement of goods at the port. The role of the port in providing the needs of the country for various cargo has emerged. At this point, the importance of the variables that have emerged as regression results can be justified, what is needed is to focus on the negative variables that affect more than positive ones, as indicators in table 9.
- The port’s financial revenues have increased after it reached in 2009 (153,150) billion ID, and in 2018 (453,306) billion ID which shows the great development of the port’s work. The financial increase must be taken into account when adopting any strategic plan for the future.

- From regression results, in terms of terminal operations, some can be summarized:
  
  a. The ship turnaround time recorded a relative increase.
  b. A slight reduction of the waiting time rate.
  c. The general trend of the dwell time of containers in the yard is slightly declining.

- The following independent variables have a positive effect on the dependent variable (Umm Qasr Port container throughput):
  
  a. IR: Inflation Rate.
  c. Car_H: Car Handling tons/units.
  e. Waiting_T: Average Waiting Time.
  f. Berth_OR: Berth Occupancy Rate.
  g. WSO: TEUs/Ship/Hours.
  h. BSO: TEUs/Ship/Berth.
  i. Quay_P: Quay Productivity.
  j. Steel_H: Steel Handling Volume.

While the negative effect variables are:

a. Imp: Total Imports (USD).
b. FE: Foreign Exchange.
c. GCHV: General Cargo Handling Volume.
d. Waiting_R: Average Waiting Time Rate.
e. Ship_P: Average Ship Gross Productivity.
How to deal with these variables was discussed when developing future strategic plans for the port. However, it is necessary to indicate the problems and challenges identified during the research, which will be addressed in the next paragraph.

6.4. Limitations and recommendations

Through the study of the reality of the port, a number of obstacles have been identified. These problems are an obstacle to the development of the port, and also prevent the port in turn to promote the maritime transport and to stimulate trade, for example, lack of depth as well as modern handling equipment, in addition to the lack of qualified warehouses. Among the most prominent of these problems is the lack of an integrated electronic program to manage all the port’s activities, which helps to obtain the necessary data to evaluate port performance and the possibility of use in the study and research.

At this stage, it is necessary to make some recommendations that are likely to take their way into the application, which are about activating a more effective port performance.

- The adoption of modern electronic technology in the management of port operation and be integrated, which helps to reduce the ship turnaround time. In addition, it represents the modernization of monitoring and documentation systems.
- The using modern handling equipment in the operations of loading and unloading. As well as, work to train and qualify the staff working on this equipment.
- The Pre-announcement of port operations, specifically the scheduling of ship berthing times and moreover, the loading, unloading, and delivery of goods. Thus as to reduce the time and bottlenecks and congestion at the port gate.
- Diversity in the commodity structure, whether for exports or imports, is not only to import consumer goods, but should go beyond the production commodities. Furthermore, the development of strategic plans to change the import policy and dependence on an equal trade.
▪ Work on maintain and increase the water depths of navigation channels leading to the port, as well as the depths in berths and docks.
▪ Paying attention to warehouses, and building cold stores and providing them with storage requirements and increasing the number of open and covered storage yards. In other words, increased interest in establishing logistics areas outside the port and taking advantage of the abundance of space.
▪ Taking advantage of the experiences of neighbouring countries, especially the United Arab Emirates, which followed in the management of its ports for the purpose of advancing the reality of Iraqi ports; including the UQP.
▪ Maintaining existing gains, initiating the construction of the new Al-Faw port project, and incorporating the existing failures in the ports into future plans to operate the port. In addition, this port provides domestic needs and increasing demands in the long term.
References


MOP. (2018). *National development plan*. ().Ministry of Planning. Retrieved from https://mop.gov.iq/static/uploads/8/pdf/153043655382b53671459f036956a85ed.db1a38412--%D9%88%D8%AB%D9%8A%D9%82%D8%A9%20%D8%AE%D8%B7%D8%A9%20%D8%A7%D9%84%D8%AA%D9%86%D9%85%D9%8A%D8%A9%20%D8%A7%D9%84%D8%88%D8%B7%D9%86%D9%8A%D8%A9.pdf


## Appendices

### Appendix 1

Unit Root Test of First Regression Annual from 2009 to 2018

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### Appendix 3

Unit Root Test of Third Regression monthly from 2016M01 to 2019M05

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