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Faculty of Commerce

Department of Business Administration

A prospected Study For Development Of Berths Facility Services (Loading and Unloading) Of Gaza Seaport

Using Simulation Techniques

نظرة مستقبلية حول تطوير تسهيلات خدمات رسو السفن (الشحن والتفريغ) في ميناء غزة البحري باستخدام تقنية المحاكاة

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ABSTRACT

Research Title:

A prospected Study For Development Of Berths Facility Services (Loading and Unloading) Of Gaza Seaport Using Simulation Techniques

In Palestine and in Gaza City, Palestinians always confirms their right to build a multi-purpose seaport (container, bulk, ro-ro, muli purpose, and fishery), to entrench the concept of territorial waters, economic and sovereign in Palestinian state.

The design of the planned Gaza Seaport shows that the project will be done in three phases and each phase consists of sub phases. With all the importance of such project, most of the previous studies mentioned that there are many obstacles facing it. This research will focus only on production (technical) issues that to be ready for the planned Gaza Seaports.

Gaza Seaport will create about 1800 job opportunities in the first phase which will extend to 5000 direct and indirect jobs. Port will provide approximately 150-200 million dollars annually through customs payments and floors of merchandise coming through Israeli ports.

In this research Arena software package (A queuing model of the logistic activities related to the arrival, berthing, and departure processes of ships) used to simulate of berths facility services of the planned Gaza seaport , to reduce the service time in loading and unloading which helps in reducing the service cycle time including the waiting time in queue and hence more ships will be served.

After analysis by Arena, it was recommended to add two crane on berth A to serve two by two crane for each one at the same time which minimize the loading and unloading time and to use this model by decision makers in Palestinian port authority and local government institutions to manage the seaport at high performance.

The model is flexible and has the ability to interface with other interactive models using DSS in order to deal with the future Gaza seaport.

ملخص الرسالة

عنوان البحث:

نظرة مستقبلية حول تطوير تسهيلات خدمات رسو السفن (الشحن والتفريغ) في ميناء غزة البحري باستخدام تقنية المحاكاة

في فلسطين وداخل مدينة غزة، يؤكد الفلسطينيين دائماً على حقهم في بناء ميناء بحري متعدد الأغراض (الحاويات، البضائع السائبة، التموين، صيد الأسماك)، ليرسخ مفهوم المياه الإقليمية والاقتصادية وسيادة الدولة الفلسطينية .

تصميم ميناء غزة البحري ، يظهر أن المشروع سيتم إنجازه على ثلاثة مراحل وتتكون كل مرحلة من مراحل فرعية. مع كل الأهمية لذلك المشروع، معظم الدراسات السابقة ذكرت أن هناك العديد من العقبات التي تواجهها. سيركز هذا البحث فقط على القضايا الانتاجية (الفنية) وذلك لنكون مستعدين لميناء غزة البحري المخطط له.

ميناء غزة سوف يخلق حوالي 1800 فرصة عمل في المرحلة الأولى التي تمتد إلى 5000 فرصة عمل مباشرة وغير مباشرة . الميناء سيوفر قرابة 150-200 مليون دولار أمريكي سنوياً من خلال مدفوعات الجمارك والأرضيات للبضائع القادمة عبر الموانئ الإسرائيلية.

استخدم البحث حزمة برمجة أرينا (نموذج الطابور الأنشطة اللوجستية المتعلقة بالوصول، الرسو، وعمليات مغادرة السفن) لمحاكاة تسهيلات رسو السفن في ميناء غزة المخطط له، لتقليل وقت الخدمة في الشحن والتفريغ والذي يساعد في تقليل دورة الخدمة والتي تشمل فترة الانتظار في المخطاف الخارجي ومن ثم خدمة أكثر سفن ممكنة.

بعد التحليل ببرنامج الأرينا، وجد أنه من الأفضل أن نضيف رافعتين (أوناش) في الرصيفA ، لخدمة سفينتين برافعتين لكل سفينة بنفس الوقت لتقليل وقت الشحن والتفريغ و أن يستخدم هذا النموذج من قبل صناع القرار في سلطة الموانئ الفلسطينية، والمؤسسات محلية لإدارة الميناء بأعلى أداء.

هذا النموذج مرن ولديه القدرة على التفاعل مع النماذج الأخرى مثل نظام دعم القرارات وذلك سيساهم في تسهيل عملية تشغيل ميناء غزة البحري المستقبلي.

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All Thanks to Allah: Efforts are nothing without his Will Praise be to Allah the Almighty, for his mercy and protection from bad deeds, many thanks go to Him and His last prophet Mohammed (peace be upon him)

This Endeavour could not been completed without the cooperation and generosity of a number of individuals and organizations. It would not be possible to pay tribute to each and every one personally.

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Finally, the deepest appreciation is expressed to my wife and my sons **Mohammed & Abd AlRahman,** for their sacrifice and endless support throughout this long journey.

Dedication

امتثالاً لقول الله تعالى: ﴿وَمَن يَشْكُرْ فَإِنَّمَا يَشْكُرُ لِنَفْسِهِ﴾ [سورة النمل: 40]، وعملاً بحديث رسولنا الكريم عليه الصلاة والسلام: {إِنَّ أَشْكَرَ النَّاسِ لِلَّهِ تَعَالَى أَشْكَرُهُمْ لِلنَّاسِ} . . .

إلى روح شهداء فلسطين وعلى رأسهم القائد الشهيد / ياسر عرفات "أبو عمار" و الشهيد الشيخ المجاهد /احمد ياسين . . . إلى روح والدي الغالي . . . إلى أمي الحنون ... لأخوتي وأخواتي . . . إلى زوجتي التي شاركتني حياتي وسهرت الليالي من أجل تسهيل مهمة دراستي وغرست في قلبي أملاً وحصدت عملاً وأبنائي محمد وعبدالرحمن وإلى حماتي . . .إلى أساتذتي الأفاضل، الذين ضربوا أروع الأمثلة من البذل والعطاء، في تربية الجيل وكانوا منارات للهدى والنور تشع على الدنيا خيراً، وقدوةً صالحةً في كل وقت وحين . . .إلى كل من قدم لي النصائح والإرشادات، لهم مني كل الحب والوفاء، سائلاً الله العلي القدير أن ينفع بي وبهم أمة الإسلام . . .إلى كل طالب علم جاهد بوقته، وسهر الليالي الطوال، لرفعة هذا الدين والوطن فسطع علماً وبه انتفع كل طالب علم . . .إلى كل من بذل في سبيل القضية الإسلامية العربية الفلسطينية دمه وروحه وحريته . . .إلى كل هؤلاء جميعاً أهدي جهدي وعملي المتواضعين . . .سائلاً المولى العلي القدير التوفيق والرشاد والسداد . . .و ادعوا الله إن يبارك لي فيه و انفع فيه شعبي الباسل . . . والله ولي التوفيق

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LIST OF ABBREVIATIONS

DES	: Discrete-Event Simulation
DPO	**:** Development in Port Operation
DPT	**:** Development in Port Technology
DWT	**:** Dead Weight Tons
DSS	**:** Decision Support system
EGDG	**:** European Gaza Development Group
ETA	**:** Expected Time of Arrival.
FIFO	**:** First In -First Out
GDP	**:** Gross Domestic Product
GSPA	**:** Gaza seaport Authority
HLA	**:** High Level Architecture
LIFO	**:** Last in – First out
LO-LO	**:** Load on- Load off
OODA	**:** Object Oriented Design and Analysis
PLO	**:** Palestinian Liberation Organization
PMDST	**:** Port Management Decision Support Tool
PNA	**:** Palestinian National Authority
QC	: Quay Crane
SPT	**:** Shortest Process Time
UNCTAD	**:** United Nation for Cooperation, Trade and Development

CHAPTER ONE

INTRODUCTION

This chapter consists of the following sections:

1.1. Research background

1.2. Significance of the research

1.3. Problem statement

1.4. Research Objectives

1.5. Research assumptions

1.6. Research methodology

1.7. Previous Studies

CHAPTER ONE

INTRODUCTION

1.1 RESEARCH BACKGROUND

The Gaza Seaport project is a strategically important project on all aspects particularly the political and economic. The importance comes from the fact that the project emphasizes the concept of independence and utilization of natural regional resources in the international waters. A free seaport being a gateway for Palestine will not only connect Palestinian economy effectively to the world, but will also enhance the local industry and the export and commercial services. That will increase the GDP and create new job opportunities and increase the income (UNCTAD, 2006).

Palestinians currently fully rely on Israeli ports for all import and export operations. It is estimated that 7.12 million tons of good are exchanged to the external world through the Israeli ports.

The port will reduce and possible eliminate the economic dependence on Israeli economy and enable free trade of Palestinian imports and exports. The seaport will enable the establishment of new economic and commercial ties and interrelations within the economic sectors. The port offers free access-road for Palestine to the world and opens the maritime windowpane for dealing with the world directly without any constraints on either import or export (World Bank,2006).

Due to the vital importance of a seaport, the first phase contract was signed with a Dutch- French consortium that specialize in seaports, with an estimated cost of 69 million dollars. Port Authority (2005) says that Gaza Seaport will create about 1800 job opportunities in the first phase which will extend to 5000 direct and indirect jobs. The port will secure an estimated figure of 150-200 million USD generated through customs and container storage and service facilities.

The design of Gaza Seaport shows that the project will be done in three phases and each phase consists of sub phases, as explained in chapter three (Gaza Seaport final report, 1995)

With all the importance of such project, most of the previous studies mentioned that there are many obstacles facing it . Those can be summarized by administrative, functional, technical, marketing, financial, political , geopolitical, economic, social and regulatory .

This research will focus only on production (technical) issues that to be ready for the planned Gaza Seaport.

1.2 SIGNIFICANCE OF THE RESEARCH

The significance of the research is to develop a port module simulation using a computer program, where it will benefit the planned Gaza Seaport in many ways; such as providing a greater processing speed, better accuracy and improved consistency, faster information retrieval and data integrity.

Also it will make the movement of sea going ships better and easier and to simulates, retrieves and processes data reliably in order to overcome the numerous disadvantages of the manual system. In addition, this research will develop a decision support system for the seaport management to help the seaport manager make a decision quickly, through applying the right knowledge and introduce the proper solutions to problems that may occur during the work in the planned seaport.

Also it helps to predict problems that may occur in order to avoid them. Moreover, the decision support system will help seaport operators to enhance the performance, increase the productivity and efficiency, as well as, solving the occurrence of conflict at the seaport. This leads to increase customer satisfaction, reduce the cost, minimize the ships waiting time and serve more ships.

1.3 PROBLEM STATEMENT

Port efficiency is an important requirement in order to survive in the competitive world of shipping business. Different equipment's like crane and pumps within the ports are expensive to run and purchase. Hence if we don't manage those facilities that will result in loss and higher cost in running the port. However, insufficient facilities result in delays which could cause capital and customer loss. In this research, choosing one of those systems which depend on the activity operation of the seaport.

It can be measured by the number of ships which are being serviced per day and the quality of service. The most critical activity which affects the waiting time of ships is the loading and unloading of cargos.

The planners of Gaza Seaport project did not suggest to have cranes on the berths as all the cargos will be handled using vessels cranes. Handling equipment's are very important in determining the efficiency of any seaport. Therefore, if there were cranes on the berths to reduce the time needed to serve vessels.

The main problem addressed in this research is: What will be the impact of using a computerized simulation model to improvement and effectiveness of berths facilities services on the planned Gaza Seaport in the first phase (sub phases IA and sub phases IB) ?

1.4 RESEARCH OBJECTIVES

The main objective of this research is to provide decision makers with useful tool to resolve the problem statement, so that this research is being carried out with several objectives.

Following are the objectives of: **Using a simulation model for the planned Gaza Seaport .**

1. Build a simulation model for helping decision makers to establish an improved system for the planned Gaza Seaport considering the number of berths for each type of ships and the number of cranes used in port operation.

2. Decide if the cranes of the vessels are sufficient to serve efficiently the coming vessels. In order to enhance loading and unloading operation, to be completed without tardiness and with the least cycle time.

3. Provide a decision support system based on simulation to be a useful tool in development of berths facility Services of the planned Gaza Seaport .

4. Evaluate the performance of using the simulation model by Gaza Seaport Authority decision makers.

5. Provide recommendations that will contribute to sorting out issues to the operations managers of planned Gaza Seaport in designing freight systems.

1.5 RESEARCH ASSUMPTIONS

The project of the Gaza Seaport will be based on fact-based assumption that the political constraints are excluded to establish the port .

1.6 RESEARCH METHODOLOGY

This research relies on collecting data about Gaza Seaport from the Ports Authority and Ministry of Transportation and other sources to determine the expected number of vessels will be received in the first phase, the types of vessels, types of its cranes, types of received products, information technology system will be involved, number of workers will be employed and their qualification, the organizing of the port and other information. Collecting data about the capabilities of ships cranes and its abilities to serve the loading and unloading activities efficiently with the expected time from the main future competitors of the planned Gaza Seaport like Israeli and Egyptian ports. If it is found that the planned Gaza Seaport needs to add berth cranes, a study will be made to determine the suitable types of cranes should be involved using internet, books, magazines, interviews with experts and all other available sources.

After building the final model, it was offered on a number of experts regarding their practice, academic and technical experience to check the applicability of the research model, where their notes were taken deeply into account.

A simulation model will be constructed using ARENA Software simulation package and other simulation concepts to determine if the added cranes working efficiently or not and to determine the time per ship, waiting time, delay time and other information. ARENA simulation package has been selected because of its flexibility in modeling many scheduling and planning problems. The model also will provide estimates for port performance indicators, such as ship turnaround time berth occupancy, ship outputs, crane needed, etc. The modeling process starts by statistically analyzing the different input data to provide appropriate portability distribution for arrival, service time, etc. More recommendation will be added to improve the loading and unloading activities and then increasing the efficiency of the planned Gaza Seaport using simulation techniques .

1.7 PREVIOUS STUDIES

In this section surveying previous work, research literature, and publications done by others related to the topic covered in this research. There are many researchers that have been concentrating on the field of seaport management and most of them are considering only the management or scheduling. The research can summarize the researches in the field of seaport management in the following subsections.

Following are some of the related previous studies:

1. **(Firas, 2014) Using a Simulation Model for Crisis and Emergency Management (A Case Study on Coastal Municipalities Water Utility "CMWU")**

This research develops a highly efficient and effective simulation-based decision making tool which can be applied in real-time management situations. It basically simulates the using of mobile pumps to discharge and dispose flooded storm water from incident areas through efficient and effective resources reallocation to finish the assigned tasks as quickly as possible to minimize the loss of life, asset and property. In this research Arena software package used to combine the using of discrete logic with continuous models to facilitate a solution for the flooding problem due to high storms and rain falls that struck Rafah city on 8 January 2013 and imitates the real time situation taking into account reducing the response time, service time and waiting time spent to finish the assigned tasks and hence output analyzer used to analyze and evaluate the effectiveness and efficiency of different suggested scenarios when responding to an emergency event and illustrates which is the best scenario for the decision maker to follow? The model is flexible enough to fit with dynamic situation changes and has the ability to interface with other interactive models using GIS maps, national databases and user friendly interfaces in order to deal with high complex crisis and emergency flooding problems (Firas, 2014).

2. **(Ammar, 2012) Developing a Decision Support System for Seaport Management (Case Study: Iraqi Seaports) .**

The objective of this study is to develop a decision support system for the seaport management to help the seaport manager make a decision quickly, through applying the right knowledge and introduce the proper solutions to problems that may occur during the work in the seaport. Also it helps to predict problems that may occur in order to avoid them. Moreover, the developed decision support system will help seaport operators to enhance the performance, increase the productivity and efficiency, as well as, solving the occurrence of conflict at the seaport. This leads to increase customer satisfaction, reduce the cost, and minimize the ships waiting time.

It is recommended to adding a new component called KBMS (KBMS Knowledge-Based Management), which is used in advanced DSS(Decision Support System) as a separated system that can supply the required expertise for solving some aspects of complex unstructured and semi-structured problems and provide knowledge that can enhance the operation of other DSS component. Integrating the system with other systems in the seaport like the yard management system and the vessel traffic system. Develop our system to be able to working with intranet or internet and communicate with other seaports. Add a part to the system for the urgent vessels, which loaded by perishable goods. Develop the system farther to be an expert system (Ammar, 2012).

3. **(Aykagan Ak, 2008) Berth and Quay Crane Scheduling: Problems, Models and Solution Methods.**

This study focused on planning problems related to berth and quay cranes which are the most important resources in container terminals at seaports. A mathematical model based on multi-commodity network flow is developed and solved on a series of realistic test problems. Then showed how transshipments, terminal time windows, and service levels can be incorporated in the model as well as how improvements to schedule reliability can be achieved by properly modifying the instance data. It is recommended to use other methods to handle transshipments, terminal time windows and service level requirements are provided. Follow better ideas to improve the reliability of schedules. A future study can be conducted on the problem of determining vessel routes considering berth resource limitations. The efficiency of the model and the ideas presented in this study can guide a smooth integration of the vessel routing problem and the voyage and berth scheduling problem (Aykagan, 2008).

4. **(Al-Madhoun, 2007) Managerial Obstacles Facing the Gaza Seaport project in Palestine.**

This study describes the main managerial obstacles facing the Gaza Seaport project, including obstacles of Human resources, Production (Technical), Marketing and Financial. The study recommends the establishment of a permanent port, modifying the existing Regional master plan and supports the changing of the existing proposed location of Gaza Seaport, also it recommends that there is a need for a new marketing analysis for Gaza Seaport. The Study recommends further future studies concerns deep researches for each field of obstacles separately, Human, Production (Technical), Marketing, Financial, other obstacles such as Law, social and Political and the existing proposed location of Gaza Seaport, should be changed to the north of Gaza (AL-Madhoun, 2007).

5. **(Yahia,2004) Time Schedule Preparation By Predicting Production Rate Using Simulation Case Study:- Beach Camp Shore Protection.**

This study is intended to investigate the problem of scheduling engineering projects utilizing the production rates by the simulation. The main goal of this study is to improve the scheduling of projects and productivity estimation in the construction industry in Gaza Strip. This study focuses on the application of simulation technique for modeling and simulation an ongoing project in Gaza Strip with the intention to conclude the appropriate project construction production rates and time probabilistic during the planning and implementation the projects. Also, the present investigation shows that there is a need to train the contractors and improve their abilities to use the productivity measurement methods for time scheduling. It is recommended that more attention should be paid to the use of the productivity measurement methods in construction sector in Gaza Strip, local companies should use simulation in preparing time schedules, local universities should offer and conduct training courses and seminars to local contractors on how to use new scientific tools to help improving project scheduling and productivity measurement and there is a need to link the simulation package (Arena) with MS project software to create an automatic interference between the two. This will save time, efforts, and improve performance on site (Yahia, 2004).

6. **(Ismael , 2004) Modern Trends in Managing Seaports, Case Study, Port of Lattakia .**

This research represents an investigation of the present status of Lattakia port in Syria, as a case study for implanting the modern trends in managing the Seaport of Lattakia. The research analyzes the strength, weaknesses , opportunities and threats of Lattakia port, to enhance its productivity for better services for its potential customers. The research aims to study and analyze the Lattakia port's activities from the technical, administrative, marketing approaches.

This study recommends, the necessarily for effective marketing plan for lattakia port to serve its potential customers, development of rail lines and its linkage with the Lattakia port, the private sector involvement will enhance the level of services presented to the customers, there is a need for re-structuring the administrative processes and structure in lattakia port, there is a need for more interest in the environment protection, there is a need for applying the Quality control concepts on the port's activities, also a need for more independency in decision making process, thus more decentralization (Ismael, 2004).

7. **(Chervyakov, 2003) Simulation-Based Evaluation Of Berth Allocation Polices Of Container Terminals.**

This study discussed simulation-based evaluation of berth allocation polices of container terminals where the aim of this investigation is to test and verify a hypothesis concerning policies for berth allocation to ships in a container terminal. The chosen domain is a rich research area where simulation could be used. Because of the high amount of variables involved and demand for optimal usage of available resources management of a container terminal is a great challenge. The approach used during the investigation was to a high extend experimental, meaning that experiments were done with the software developed for that purpose. The results from the experiment were used as a ground for verification of the hypothesis. It recommended two algorithm representing two berth allocation policies were developed and tested. The results show that a policy that favors the shortening of overall time spent by a ship in harbor may be a better choice than the policy used today which tries to minimize the distance between the berth assigned to the ship and the stacks where the containers are stored (Chervyakov, 2003).

8. **(Kap Hwan Kim & Kyung Chan Moon, 2003) Berth scheduling by simulated annealing.**

This study describe method for determining the availability times of berth and positions of the containers in seaport container terminals based on the problem of scheduling berth. Since the time of unloading and loading of containers requires a certain amount of space in the dock for a predetermined period for each ship. Therefore, a mixed-integer linear programming (MILP) model was formulated for this case by using the simulated annealing algorithm applied for the problem of scheduling the pavement to find sub-optimal solutions. Where the results appeared to indicate that the simulated annealing algorithm obtains a solution that is similar to the optimal solutions found by this model (MILP). Also it is recommended that managers in many container terminals should attempt to reduce costs by efficiently utilizing resources, including human resources, berths, container yards, container cranes, and various yards equipment. Among all the resources, berths are the most important resource and good schedules of berths improve customer's satisfaction and increase seaport throughput, leading to higher revenues of seaport. Seaport managers usually schedule the usage of berths by an intuitive trial-and-error method supported by a schedule board or a graphic-user-interface in a computer system. This research attempts to maximize the utilization of a berth and to satisfy various constraints for berthing container vessels by using an analytical approach" (Kap & Kyung, 2003).

9. (Smaling, 1996) The most optimal layout for Gaza Sea Port.

This study described the most optimal layout for Gaza Seaport, based on the throughput forecast and to investigate the nautical and hydraulic conditions of the layout. It is recommended to:

1. Measure the wave climate just outside the port (at the 18 m depth contour) .
2. Find out more about the relation between current and other site conditions as wind and waves.
3. Get more insight in the interaction between ships and wave climate at Gaza;
4. Make a technical/contractual design (especially of the breakwater) and a detailed cost estimate.
5. Find out more about visibility reduction near Gaza in case of heavy rain and fog; make an extensive study on the (number of) ships calling at Gaza. If detailed information on sizes and arrival patterns is established, a more thorough calculation can be made of number of quays and required quay lengths.
6. Estimate the effect of rotating the entrance channel or changing the length or alignment of the breakwater (Smaling, 1996).

10. (Grabowsky & Poort, 1994) Basic Engineering Study for the Port of Gaza.

This study described the basic engineering for establishing the most suitable location of Gaza Seaport, the study indicates that it has been selected 6 sites along the shore of the Gaza Strip. This study showed the technical and environmental advantages and disadvantages of each of the proposed sites, the study recommends that No. 4 and the site south of Gaza City in Netzarim is the best position to create a seaport for a variety of reasons which are :

1. Requirements to run the port.
2. Regional plan for the Gaza Strip.
3. Environmental aspects.
4. The time factor.
5. Security aspects.
6. The cost of the project and maintenance (Grabowsky, 1994).

The Palestinian studies which were done inside Palestine (Al-Madhoun,2007) depended on a questionnaire and mentioned the position of the port based on the opinion not on a specific studies and (Yahia,2004) used simulation in his case study on beach camp shore protection .

The Arabic studies (Abdul Hakeem,2012) and (Ismael,2004) was applied for different Arab port as Iraqi Seaports and Lattakia, the research used the problems which were facing this port facility services and testified them in Gaza Seaport.

The foreign studies (Aykagan Ak, 2008), (CHERVYAKOV, 2003) and (Kap Hwan Kim & Kyung Chan Moon, 2003) were concerned on berth facility but in this studies , it is only concerned with the first phase of the port and not full port activities.

(D. Smaling-1996) and (Grabowsky & Poort- 1994) were made based on assumptions were valid during the time of their issuing , those studies may be need to be modified and some conclusions and recommendations needed to be changed.

This research tries to apply "Simulation –Arena " on all the expected problems that may face the berths of Gaza Seaport, aims to reach to the best optimal solution to all of the Palestinian experts and decision makers. This research tries to focus on this gap, using simulation in seaports which seems to be limited in all the previous studies .

CHAPTER (2)
LITERATURE REVIEW

This chapter consists of the following sections:

CHAPTER(2)

LITERATURE REVIEW

2.1 WHAT IS A PORT?

Ports service multiple roles in the maritime industry, and are part of a complex network of players. The port works as an interface linking sea and land transport. There are a large number of definitions of ports. A few will be presented below. A simple definition of ports can be taken from (**Stopford**, 2009) book Maritime Economics where ports are defined as; *"A geographical area where ships are brought alongside land to load and discharge cargo – usually a deep-water area such as a bay or river mouth".*

This definition is quite simple, but it gives an explanation of the fundamental role of a port. At the same time it is important to see that ports role is more intricate than just a location by the sea. Today ports are a major player in the global transportations system, without ports the merchandise vessel would not have any place to load or discharge cargo and then again serve no purpose; therefore ports can be seen as enabler of seaborne trade to a region.

2.2 DEFINITIVE CLASSIFICATIONS

The main idea of port operation is the handling of cargoes. This includes containerized cargo, break-bulk cargo, bulk (palletized) cargo, dry bulk cargo, and liquid bulk cargo. Among all, containerized cargo is the newest form of cargo operation and started mainly in the sixties (Muller, 1995).

Now-a-days many ports handle only one or two types of cargo and are considered a single purpose port. This term is more popular for containerized cargo-handling ports, as it becomes the trend to use containerized cargo for the shipment of goods. On the other hand, many regional ports still operate different types of cargoes from the same berth groups by using same dockside facilities. Cargo operation for these types of multipurpose ports are more difficult than single purpose ports and for high amount of cargo handling , optimization and improvement of efficiency is difficult to obtain.

The handling of different types of traffic (cargoes) at the same berth group causes lower throughput than if they are kept separate in separate berths. On the other hand, assigning special types of cargo for different berth groups or for specific types of port causes a loss of flexibility of port operations. Specialization of cargo handling loss the berthing capacity by dividing the port and the traffic before allocation berths , thus the loss of berthing flexibility, and also loss of transit storage areas that may be achieved by mixing complementary traffic. On the contrary, a specialized port gives a gain in service capacity in the berth facility by segregation of the different classes of traffic, and also by separation of high and low average service times and large and small ships, i.e. there is a gain through greater consistency of demand (UNCTAD, 2006).

2.2.1 SINGLE PURPOSE PORT

A single purpose port is a specialized seaport terminal for handling unique cargoes. With the recent development of containerization in the last few decades, containerized ports are mainly known as single purpose ports. Ports operated with only dry bulk cargo, bulk cargo, or ro-ro cargo may also be considered as single purpose port. This type of port has unique economical appeal and uses special types of equipment for maximum throughput. Ports with specialized terminals can use the most economical port technology for each traffic type (e.g. the shallowest possible quays, the most efficient cranes and freight handling equipment , etc.). As 80 percent of all the seaborne cargo moves by containers now-a-days, the importance of single purpose ports are imperative .

With the increase of intermodalism, almost all large ports in the industrialized world handles substantially different traffic types (especially containers dry bulk) separately, and many ports are shifting their break-bulk and neo-bulk cargo handling into containerized operation (Ramani, 1996).

2.2.2 MULTIPURPOSE PORT

A multipurpose port is the port where general cargo ships calling may carry a variety of cargoes transported in modern ways: containers, flats, pre-slung cargoes, large units of iron and steel, large units of packaged timber, as well as cars and heavy machinery, together with a basic load of palletized cargo, increasingly palletized[4]. In order to efficiently handle all these cargoes together, the terminal needs to have different types of equipment than the single purpose containerized terminal, and a greater variety of mechanical equipment than the conventional break-bulk terminal.

Multipurpose terminals ensure proper berth utilization for the seasonal fluctuation of specialized types of traffic by providing service to different types of traffic. For small traffic volumes, multipurpose traffic operation capabilities can also help reduce the underutilization due to traffic randomness and the inherent variability in the ship service times, even in instances when traffic is in a steady state (Daganzo, 1990).

2.3 WHAT IS A BERTH

It is a location in a port where a vessel can be moored, often indicated by a code or name. (Kevin Stephens, 2014).

2.4 TYPES OF BERTH

Most berths are alongside a quay or a jetty (large ports) or a floating dock (small harbors and marinas). Berths are either general or specific to the types of vessel that use them. The size of the berths varies from 5-10m for a small boat in a marina to over 400m for the largest tankers .

Following is a list of berth types that can be found in ports:

Bulk berth: Used to handle bulk cargo. Vessels are loaded using either excavators and conveyor belts or pipelines. Storage facilities for the bulk cargo are often alongside the berth - e.g. silos or stockpiles.

Container berth: Used to handle 20' and 40' standard intermodal containers. Vessels are loaded and unloaded by container cranes, designed specifically for the task. Alongside the quay there is often a large flat area used to store both the imported and exported containers.

General berth: Used to handle smaller shipments of general cargo. Vessels using these would usually have their own lifting gear, but some ports will provide mobile cranes to do this.

Lay berth: (Sometimes designated as "layberth") (1) A berth used for idle (lay-up status) vessels. (2) A berth where no loading or unloading takes place. Lay berth and lay-by berth (below) may be used somewhat interchangeably for intermediate (two to seven day) periods.

Lay-by berth: A general berth for use by vessels for short term waiting until a loading or discharging berth is available.

Marina berth: Used to allow the owners of leisure craft on and off their boats. Generally alongside pontoons and accessed by hinged bridges (in tidal locations) to the shore.

Product berth: Used to handle oil and gas related products, usually in liquid form. Vessels are loaded via loading arms containing the pipe lines. Storage facilities for the products are usually some distance away from the berth and connected by several pipes to ensure fast loading.

Roll on /Roll off: - The outstanding feature of the roll on/ roll off berth are link span ramp, allowing for bow or stern entry into the vessel by vehicular traffic. There is need for wide area backup and clear approach provision into and from which the traffic can pass. Supporting mobile equipment- tractors, trailers, fork lift trucks and low loaders for heavy loads are necessary.

X berth: Suitable for nuclear-powered warships, and part of an operational Naval base or a building and refitting yard

Z berth: Suitable for nuclear-powered warships, as a location for operational visits or stand offs (Wikipedia , 2014).

2.5 WHAT IS A CRANE ?

A machine designed for moving and lifting weight by means of a movable projecting arm or a horizontal beam which is able to travel over a certain distance (Kevin Stephens, 2014).

2.6 TYPE OF CRANES

There are two main types of crane which are :

2.6.1 QUAY CRANES

A QC plays an important role in loading and unloading the vessels. Different types of cranes are used at CTs i.e. single trolley cranes and double trolley cranes . Single trolley is used to move container from ship to shore either put down on quayside or on the available vehicles. Whereas in the double trolley cranes the first crane is used to move container from vessel to platform and then the second trolley takes the container from platform to shore. The maximum performance of QC depends on the type of crane and the performance varies in the range of 50 to 60 containers per hour where as in different operations the performance remains in the range of 22 to 30 containers per hour (D. Steenken , 2004).

2.6.2 YARD CRANES

A YC is used for stacking containers in the yard. There are three types of cranes that can be utilized to store containers in the yard, i.e. Rail Mounted Gantry cranes (RMG), Rubber Tired Gantries (RTG) and Overhead Bridge Cranes (OBC) . RTG are more flexible and movable with in the yard area but it has been noticed that the movement takes too much time from one block to another due to congestion in yard area. In case of RMG the cranes are fixed on specified rail track and movable only on the rail within the block. The OBC are mounted on the concrete and steel pillars. Gantry cranes can be span up 8 to 12 rows and can put up containers on each other up to 4-10 container height . In order to remove congestion and bottle-neck within the yard storage area and to increase the productivity most of CTs have implemented two RMGs in one block of yard area (D. Steenken , 2004).

2.7 SEAPORT AUTHORITY MANAGEMENT AND ORGANIZATION:

In considering what model of management and organization would be best suited for Gaza Port, it was assumed that the port will perform the role of a landlord port as defined before, It was also taken into consideration that the Seaport Authority is a new organization and that it will function within the framework established for it by the Palestinian Authority. Conceptually, strategic decisions at ports are made at the Port Director's level. Innovative decisions may be made by Director of Research, Navigation, Sales and Operations, while routine decision may involve planning, logistics, human resources, databank and environment. Understanding of the differences inherent in the levels at which decision are made greatly facilitates the establishment of policies needed to define the nature of specific roles of individuals involved in port management (UNCTAD, 2006).

2.8 PORT MANAGEMENT

The functions of port management are to plan, organize, and control port operational by coordinating the use of various resources of the port system in the performance of port services.

2.8.1 PORT MANAGEMENT:

Port management therefore consists of a number of distinct functions:- (United Nation Report "Port Organization and Management ", June 2006).

1- Medium-to long-term planning and strategic decision making. This involves also the setting or review of objectives (including tariff objectives) and is performed by the top management of the port.

2- Operational planning and control, including management of day-to-day (or real time) operations. This is performed by operating management which is concerned with traffic, operations, and, engineering.

3- Commercial and financial control that involves marketing(real-time)accounting, short – term financial management, personnel management, and other management functions involving short- term financial performance.

2.8.2 PORT ORGANIZATION DESIGN

Port organizational structures vary widely the objective, function, and the like, of a port .Each port has a number of distinct functional departments that are independent of its overall structure, external reporting requirements and alternative or different forms of ownership, and operation of the port .

Typically, a port has a top management team, supported by department heads, and operating /administrative unit managers such as shown in figure (2-1).

In designing the organization of a port, we must first consider external factors, such as

(World Bank,2006):

1- Who sets the ports objectives, reviews performance, and authorizes its budgets?

2- What is the degree of autonomy of the port and its management?

3- What are the regulations, reporting, and the like requirements, and what are the

constraints (operation, environmental, etc.) imposed on the port?

4- What are the jurisdictional, legal, and other powers of the port and its management?

5- What are the proposed functions of the port?

Answers to these questions enable us to determine the decision-making powers and requirements for the port's top management and allow us to develop an appropriate top management port structure.

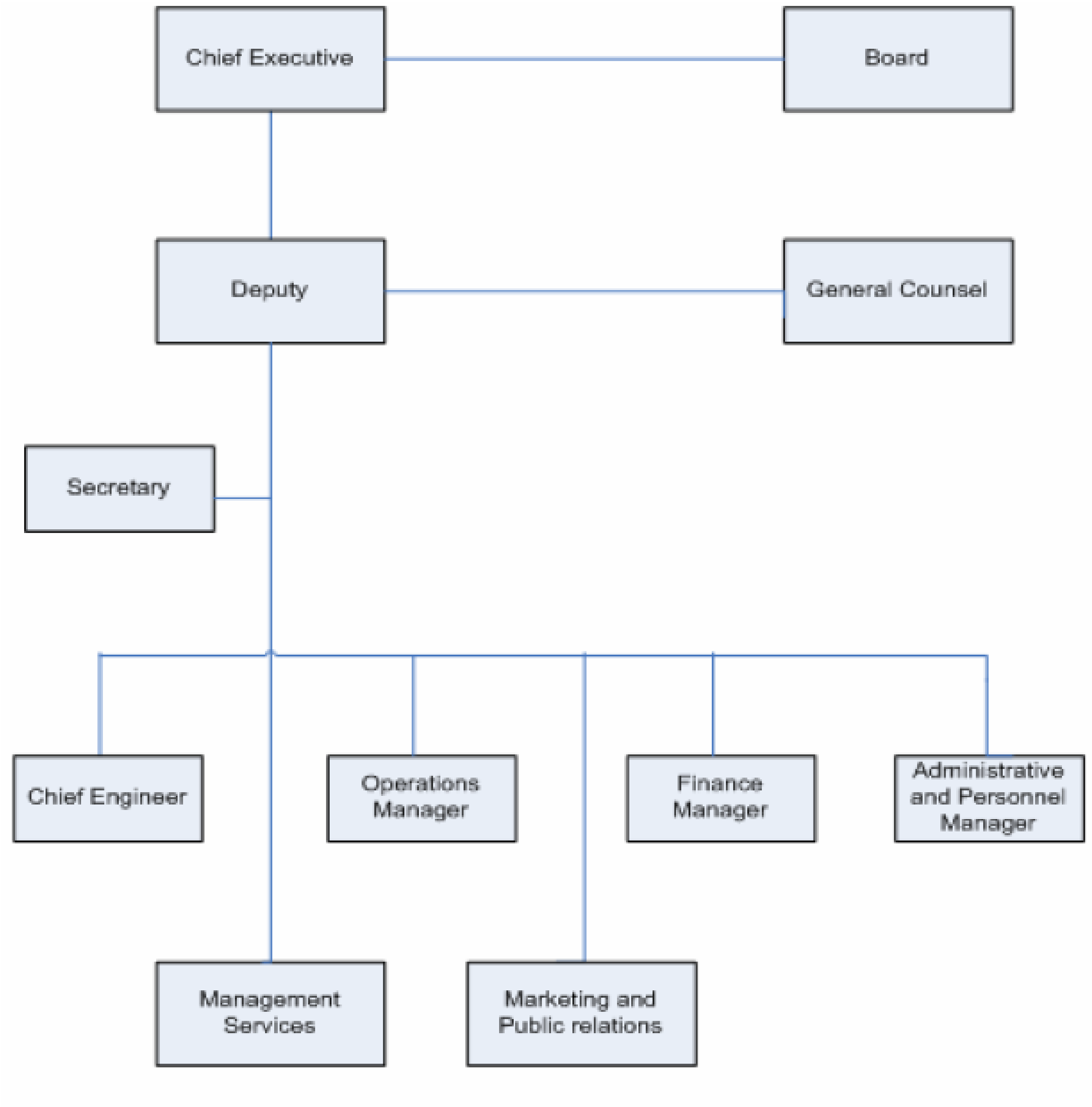


FIGURE 2.1 TYPICAL PORT ORGANIZATION

2.9 PORT PLANNING

Efficient port planning is vital for sustaining the function of the port which facilitate trade, and for ensuring that the port has the appropriate infrastructure to meet up trade demands and to move the cargo efficiently between ship and shore and other transport chain (World Bank,2006).

The potential for future port and industrial growth brings with it a need for a proper understanding of the shape which future industrial port will take because of the new unit and its effect on the region. The need for improved efficiency in smaller and more" conventional" port leads to the same requirement (Robinson,2002).

2.9.1 General Planning Principles

The port operation is a commercial activity and the port must, therefore, be designed to handle cargo at the minimum cost consistent with port efficiency. It must also be designed to allow of flexibility in use d to permit development to cope with growth, with changes in trade, industry, and transport modes. It must be concerned with amenity for its workers (UNCTAD, 2006).

2.9.2 Planning, construction, development, and operation of a port involve(Paul& Ashar,2001):

- Commercial management
- Economics and land economics
- Civil engineering and hydraulics
- Shipping control
- Port operations
- Land transport
- Finance
- Staff management Law
- Tele-communications

2.9.3 Port Productivity:

Productivity is the most general sense, can be defined as a measure of efficiency with which inputs into a process or activity are converted into outputs through some action, service, or process. The most commonly used productivity measures employ single input factors such as labor man-hours, machine hours, investment, berth length ,and the like (Alderton,1999).

2.10 PORT OPERATIONS

Port operations, particularly those of a multipurpose port, may be grouped with respect to local or content. This classification, although conveniently accepted, is being rendered o obsolete by increasing operational specialization. It ignores the unifying influences such as legislation, which are tending to make aspects of port administration more internally consistent, and congruent with the management of other large, semipublic service institutions. Under this locale/content classification port operations can be divided into water front and inland, general and special operations. These in turn can be subdivided **(United Nation Report "Port Organization and Management ", June 2010).**

A port operation involves a large variety of activity performed by many different groups and individuals, for, or on behalf of, a variety of port users and other interests. These operations can be divided into a number of major categories as follows:

1. **Waterfront Operations**: waterfront operations comprise navigation control, accommodation of ships and floating equipment, loading and unloading of vessels, servicing of ships, maintenance of ships, and marine operation administration.
2. **Navigation control**: involves all the operations required to bring a ship safely in and out of the port, including piloting and towing, lighting, and buoying.
3. **Accommodation of ships and floating equipment**: involves all the operations that must be performed to enable ships to stay safely within the harbor limits. The operations involved are essentially berthing, mooring, and providing power and communication. The equipment and facilities involved include berths of various types, tenders, ships anchors and mooring equipment, mooring buoys, mooring equipment on wharves, and electric power lines and telephone lines.
4. **Loading and unloading**: vessels involve the transfer of cargo from and to the ship holds. The equipment used depends on the type of cargo and terminal: Virtually all kinds of material-handling equipment are utilized in some ports for different types of cargo.

5. **Servicing ships**: the operation of the ship for her next voyage, using liquid handling equipment and light-loading equipment, and includes options such as bunkering, watering, victualing, cleaning of holds, and disposal service.

6. **Ship maintenance**: may be performed alongside in the port, for small repairs or disabled vessels, or in separate shipyard. The operations involved are towing, dry docking, mechanical repairs, and hull reconditioning and repairs.

7. **Marine operations administration**: relates to marine regulation, enforcement, and control of waterways within the port and vicinity. it involves wireless communication with vessels and maritime traffic control and scheduling. The necessary offices, communication equipment, boats, and helicopters are normally located in the port precincts.

8. **Inland operations**: Inland operations include cargo storage and cargo processing, interfacing transportation modes, traffic control, and short-term accommodation and administration of passengers.

9. **Traffic control**: including scheduling and routing, is to meet the requirements Imposed by all the previously mentioned functions with their associated movements of equipment and vehicles that in turn require coordination and control.

10.Passenger accommodation and administration: involve the operations required for comfortable and quick reception, feeding, documenting, and release of passengers arriving or leaving with ships.

11.**General operations**: general operations is the category including portside function such as safety and environment control, port operation control, maintenance of port facilities and equipment, and security (United Nation Report , 2010).

2.11 PORT MARKETING

Marketing is the process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, and services to create exchanges that satisfy individual and organizational goals (Kotler & Keller, 2012).

2.11.1 Port Product:

The product, or port services, is the cornerstone around which all other activities will be designed. Therefore it is very important that a marketer knows every aspect of his port in the nautical, technical as well as in commercial fields, and to be aware of the strength and weaknesses of the port in a continuous way. A customer normally makes his choice on the basis of the following elements (UNCTAD, 2006):

- Geographical position, volume and type of cargo.

- Nautical approach, ship capacity.

- Hinterland connections, value added logistics.

- Disposition of quay and land, concession contracts.

- Range of services which can be offered, such as pilotage, towage, Warehousing, survey.

- Labor force and social climate in general.

- Management and technical know-how.

- Fiscal environment, Attraction pool

- The potential buyer can be ship owner (liner business) or can be the company that controls the commodity flow (tramping business).In both cases it is very important to have information on client. Trying to attract a client can be done by first selling the port's knowhow in transport business and by selling the port itself.

2.11.2 Port Pricing:

Port revenues are primarily derived from the imposition of port tariffs, which are usually linked or related to services or facilities and equipment supplied by the port for the use of cargo and ships, road vehicles, rail cars, barges, or other equipment's . Pricing is a major factor in the implementation of a port's strategic plan. The port management concept may be viewed from three aspects:

(a) the port's planning and development philosophy, with its goal or objectives.

(b) the port's investment criteria and policies.

(c) the port's pricing policies and techniques.

Supporting (Asaf, 2001), that the professional literature on port pricing is concerned with two set of topics. First, it is related to the pre-privatization era, whereby pricing is addressed from the point of view of an operating, public port authority. The second set of topics are primarily concerned with the technical aspects of port tariffs themselves, including the structure of tariffs, charging units, charging mechanisms (min/mix), bundling of charges, and actual comparisons of charges at various ports (Asaf, 2001).

2.11.3 Port Promotion

Port Promotion can be defined as communication between the port and various target groups, in order to inform them and influence their attitudes and behavior towards the port (UNICTAD, 2006).

Of the company's marketing functions, promotion is the most visible as well as the most culture-related one. Through the promotional function however, the company is standing up and speaking out, willing to be seen and heard. The promotional task will not be exactly the same in every market, and the different types of promotion are as follows (World Bank, 2006):

- Advertising
- Direct mailing
- International shipping exhibitions
- Organizing port days
- Personal selling/direct business trips
- Representatives
- Domestic fairs
- School visits
- Organizing conference
- International press day
- Domestic networking

2.12 PORT FINANCING

The central function of the port financial management is to control the budget of the port against the budget set by management in line with the objective of the port, policies of port management, and the government, and various rule-making bodies .For this purpose, accounting techniques are used to facilitate the planning and control of revenues and costs. Budgetary control provides an approach for estimating revenues and costs based on projected port traffic and resulting operations, and an effective control of revenues and costs in line with estimates, establishes financial policy, and cash flow requirement (Alderton,1999).

Based on information received from the PNA, the current status, costs of construction and funding available are as follows:

- Dutch grant Euro 22,843,296
- French grant Euro 19,744,902
- Euro Investment Bank loan US $20,946,100
- Palestinian Authority funds US $4,594,908

The construction contract includes the following items:

> Dredging of 933,000 cu m of soil to 10 m depth of water; Landfill; Paving of dandified areas; Breakwater; Causeway; two Ro-Ro berths and one 200 m long genera! cargo berth and underground utility conduit (trench).

It is understood that the current construction contract does not provide for a small craft harbor which was recommended in previous studies(Sofermer,1996).

No other facilities or equipment needed for Subphase IA operations (such as onshore buildings and other installations, utilities, equipment, navigational aids, tugs, and pilot boats) are included in the contract. To date no funds for onshore facilities and procurement of equipment have been committed and only order of magnitude cost estimates for these items.

CHAPTER (3)

DEVELOPMENT OF GAZA SEAPORT

This chapter consists of the following sections:

3.1 History of Gaza Seaport

3.2 Oslo Peace Agreement

3.3 Port Requirements

3.4 layout and phasing (future Development phases)

3.5 Container and General Cargo Handling Phases IA

3.6 Environment Impact Assessment

3.7 Gaza Port Institutional Plan

3.8 The Port Free Zone of Gaza Seaport

3.9 Port authority functions and tasks

3.10 Organizational Chart

CHAPTER(3)

DEVELOPMENT OF GAZA SEAPORT

3.1 HISTORY OF GAZA SEAPORT

Gaza port historical estate, before 1948 and to 1967, was one of the important seaports in Palestine .Haifa seaport was the mother seaport in Palestine, associated with three seaports "Gaza, Akaa, and Isdood ".

Gaza commercial Seaport was considered as one of the major commercial seaport, in Palestine before the Isreali occupation. It was to be used in transporting and shipping cargoes from south Palestine, and Jordan, Iraq; shipments from and to these territories. After the Israeli occupation in (1967), Gaza Seaport closed, and it considered as a fishery port .Today, Gaza Seaport is serving the fishery field only in Gaza Strip. Figure (3.1) shows the location of Gaza Seaport City in Gaza Strip.

3.2 OSLO PEACE AGREEMENT

The agreement signed in April 1994, between the (PLO) and the Government of Israel has founded the basis for developing the economy of the occupied territories. This agreement reached between the government of Israel and Palestinian national authority (PNA) in Egypt in1995, has outlined the path to economy, and the development of a free state of Palestine (Ministry of planning, 1996).

The agreement formed the basis for the economic development of Gaza and the West Bank. Until now, the economy domestic, as the local employment is low due to the lack of industries, isolation and closures. Also, while security problems have reduced the possibilities to find work in Israel. Hence, one of the first steps to improve the economic development is to establish a commercial seaport in Gaza. This port will directly link the local economy with international. In this way, transporting through goods Israel; borders will be avoided and costs and time of the transportation will be reduced. To establish the port, the Dutch and French Governments have offered grants of 25 and 20 million US dollars, respectively. The remaining funds needed, 25 million US dollars, will be covered by a loan from the European Investment Bank.

The feasibility and physical development of the port have been studied in four main reports:-

- The Basic Engineering Study (1994)
- The Technical and Economic Study (1996)
- The Environmental Impact (1996)
- The Institutional Study (1996)

On basis of the Basic Engineering Study, a contract has been signed between the Palestinian National Authority and the European Gaza Development Group (EGDG) consortium of Dutch and French Contractors and a Dutch Engineering Firm) to design and construct the port. The contract consisted of two stages:

- Stage 1 Surveys and Contract Design
- Stage 2 Construction

3.3 PORT REQUIREMENTS:-

3.3.1 GENERAL STRATEGY OF PORT DEVELOPMENT

The Agreements between the (PNA) and the state of Israel have provided the basis for the development of Gaza port. The required capacity of the port will mainly depend on the political and economic developments, which still have to take place on basis of the process. Therefore, the port development has been based on the following assumptions (Gaza Seaport Master Plan, 1997).

a. An initial port should be provided with a capacity to receive sea-going vessels, with cargo to and from Gaza only (Sub phase IA).

b. The initial port should be easily expandable without major investments in marine protection structure to accommodate future needs of Gaza (the completed phase I).

c. The port layout must be suitable to be expanded to a large port to accommodate cargo for the west Bank, Jordan or even South Israel and Iraq (phases II and III). Large investments in marine structure will be necessary.

d. The port will be able to compete, in logistic operational efficiency as well as in port costs charged to its users.

3.3.2 FORECAST

In the Basic Engineering Study (1994) , an estimate was prepared of the forecast of cargoes expected in Gaza provided that port facilities should be available on international service level. This forecast has been further improved in the Technical and Economic study by (Sofremer, 1996), with a split in cargoes for Gaza only, and for Gaza and west bank together. The forecast for Gaza only, based on the medium growth scenario, has been used as a basis for the determination of the port requirements of phase I of Gaze Seaport (Gazaseaport, 1995), (Sofremer, 1996).

3.3.3 SHIPPING

The fleet for Gaza port will depend on many factors such as the quality of the facilities in both port of origin and port of destination, the quantities of cargo, the transportation costs and availability of berths.

3.3.4 GAZA PORT - LOCATION AND PORT PERIMETER:

The port will be constructed on the location as represented in the Basic Engineering study. It includes the coastal stretch from (323m) south of Netzarim Road up to (1020m) north of Netzarim Road, south of the village of Sheikh Eijleen, as shown in figure (3.1).

3.3.5 BERTH REQUIREMENTS

On basis of cargo forecast as represented in the technical and economic study of Sofremer, the required number of berths has been calculated. The port will start operations with two shifts a day, seven days a week. The number of workable days is assumed to be 300 days per year. Since not all commodities can be handled together at one berth, for safety or quality reasons, the table below represents the required number of berths per group of commodities.

FIGURE 3.1 PROPOSED LOCATION OF GAZA SEAPORT

3.4 LAYOUT AND PHASING (FUTURE DEVELOPMENT PHASES)

The layout studies have resulted in the concept outlined below. It consists of a highly flexible layout. Figure (3.2) shows the general layout for the port.

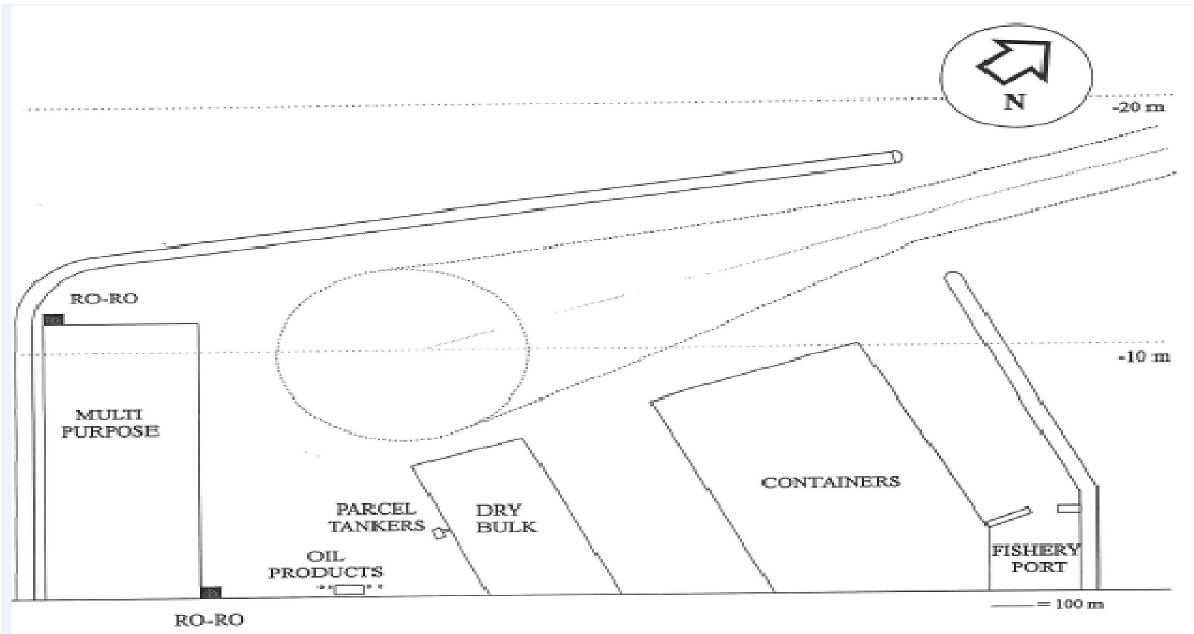


FIGURE 3.2 PROPOSED LAYOUT OF GAZA SEAPORT

Source : Sampling, 1996

Where Gaza seaport will be lay out by three phases as shown in Table (3.1).

Table (3.1) Lay-Out by phases

	No. of Berths for (general cargo, containers, solid) are	Length of Berth for (general cargo, containers, solid) are (m)	No. of Berths for Petrol is	No of Cranes	Warehouses Area (m²)	Quays (m²)	Silo (tons)	Area of Building (m²)
Phase I	10.000	20.000	90.000	20.000	4	1	600	4
Phase II	10.000	30.000	187.500	40.000	11	1 or 2	1250	8
Phase III	15.000	50.000	210.000 to 232.500	50.000	20	2 or 3	1400-1550	9-10

3.4.1 SUB PHASE IA: INITIAL PORT

Phases IA has the facility of two Ro-Ro berths and a general cargo berth with a length of 200m. The water depth is limited to 11 m (maximum vessel 30.000 DWT). A breakwater of 730 m is provided to limit downtime due to wave penetration. The wave penetration study is indicating a downtime level below 5 percent.

3.4.2 SUB PHASE IB: ADDITIONAL 400M BERTHS

An additional 400m of berth with a design water depth of MSL 15.25m will be provided. An additional berth for containers/ general cargo, and one berth close to the small craft harbour for cement and other dry bulk. Will also be provided.

3.4.3 SUB PHASE IC (DRAFT TO 12M)

The water depth will be increased to 12m to allow the use of large and more economical sizes of bulk vessels. It will not increase transport but will become more economical, enhancing the port competitive position.

3.4.4 SUB PHASE ID (BULK TERMINAL)

A new berth for bulk cargo will be provided, which will be the beginning of the next phase of the port development. This berth is suitable for the most economical grain vessels and has a design water depth of 12m.

3.4.5 SUB PHASE IE EXPANSION OF TERMINAL AREA

The future operations will require an extension of the terminal area because of the fact that cliffs will not be excavated and thus this area is not available for storage.

3.4.6 SUB PHASE IF LIQUID BERTH:

About 20% of the traffic relates to liquid oil products. A dedicated terminal including berth and bank farm will be required; suitable for vessels up to 40.000 DWT. Figure (3.2), shows lay-out by phase (I) of development in Gaza Seaport.

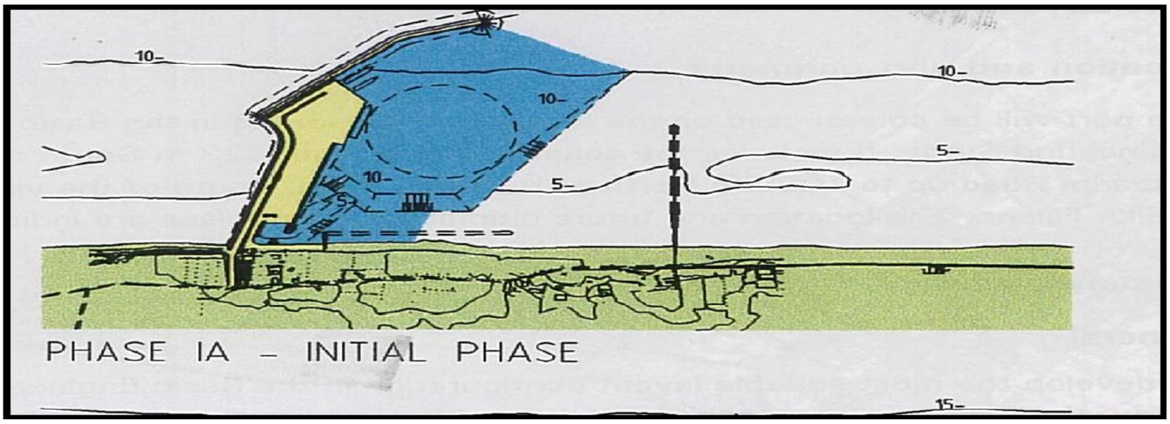


FIGURE 3.3 PHASE (I) OF DEVELOPMENT IN GAZA SEAPORT

3.4.7 PHASE II CONTAINER TERMINAL AND BREAKWATER:

In phase II a full container terminal is planned, having a maximum capacity of 500.000 TEU. Total berth length is 600m, suitable to accommodate vessels with a draft up to 14m. Protection of the terminal will be provided by extension of the existing breakwater. Figure (3.3), shows lay-out by phase (II) of development in Gaza Seaport.

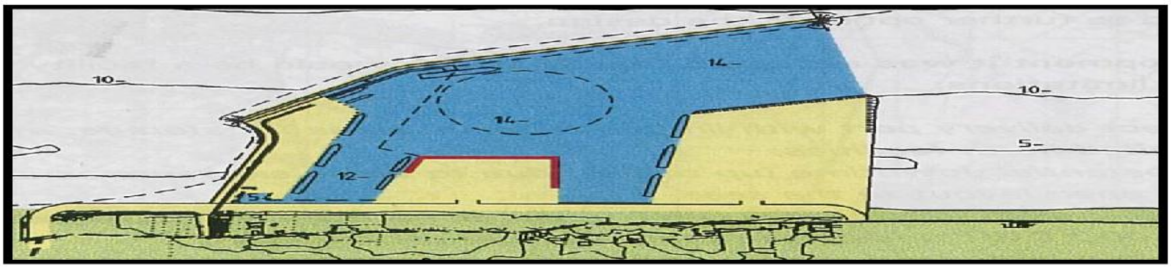


FIGURE 3.4 PHASE (II) OF DEVELOPMENT IN GAZA SEAPORT

3.4.8 PHASE III (FULLY DEVELOPMENT PORT)

In phase III, a central terminal is planned. Its capacity will depend on the actual traffic requirements at that time? The terminal is planned mainly to be used for bulk, suitable to accommodate ships with a draft up to 14m. Figure (3.4), shows lay-out by phase (III) of development in Gaza Seaport.

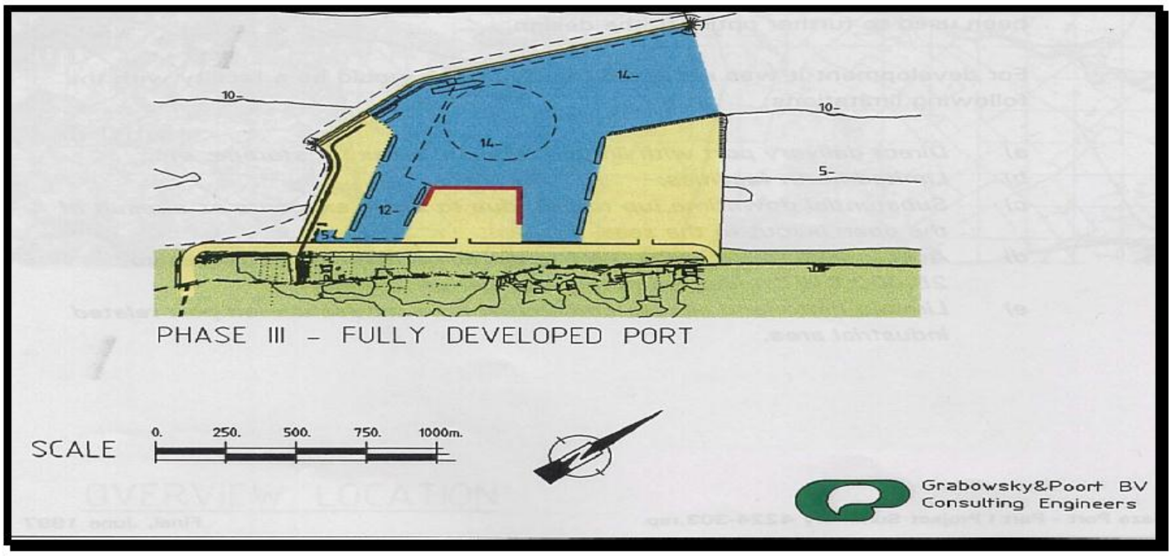


FIGURE 3.5 PHASE (III) OF DEVELOPMENT IN GAZA SEAPORT

3.5 CONTAINER AND GENERAL CARGO HANDLING PHASES IA

For [phase IA], it is assumed that the loading/ unloading operation will mainly be carried out by the ship's own gear. In the following years, it is recommended to install two tire based ship shore cranes of respectively 10 and 30 tons. The standard method of transfer for virtually all classes of cargo is by tractor/trailer combinations, using trailers of size generally associated with container operations, but more simplified. Picking up of cargo is by forklift trucks. In addition, some smaller cranes may be necessary for yard work. Depending on the development of the port, a dedicated container facility will be necessary, which will require specific handling equipment(Gaza Seaport Master Plan,1997).

3.5.1 Ancillary facilities

The following facilities should be included in the port:

a. Small craft harbor.

b. Port Authority building.

c. Gates, fencing, and gate houses.

d. Utility facilities.

e. Power substation.

f. Technical service building.

g. Firefighting station.

h. Surface water treatment.

i. Water supply station.

3.5.2 Detailing [Phase IA]

Based on a direct delivery policy it is estimated that the phase is able to serve the needs for storage area for a period of two years. In phases IA some commodities, which are forecasted, cannot be handled in an acceptable way at the facilities of phase IA. Commodities, which are excluded, are excluded to be handled in bulk are:

1.Petroleum products

For safety reasons these cannot be handled until a dedicated facility and storage is constructed.

2. **Cereals**

Only a limited volume of cereals can be handled due to lack of storage. Direct delivery requires significant storage at the consignees.

3. **Cement**

Bulk cement needs a dedicated facility with storage. Only bagged cement in pallets will be handled in smaller quantities. The detailed layout of phase IA, including the indication for building and infrastructure is described below.

A) Ro-Ro terminal

The two Ro-Ro berths have a small direct access area. From there a rod with a length of 400 m directly leads to the customs gate.

B) Lo-Lo terminal

An area is provided for the storage of containers. It is assumed that general cargo (pallets, house cargo, etc.) will be directly placed on trailers and stored at the back of this area.

C) Other customs bounded storage area

This area will be used to store dry bulk and bagged general cargo, which stay longer in port.

D) Customs gate

A fence and gatehouse will be located in the middle of the causeway. A movable weighbridge is also situated close to the gate to weigh cargoes and trucks waiting to pass the gate.

E) Parking area

Customs bounded Area

El At the Ro-Ro terminal, a parking area over a length of 150m, for approximately 30 trailers, is provided for cargo waiting to be loaded onto the ship.

E2 At the customs gate a parking area of over a length of 150m is provided for cargo waiting for customs clearance and security checks, outside customs bounded Area

E3 At the customs gate a parking area will be provided for both outgoing and incoming cargo waiting for customs clearance and security checks.

E4 A parking area for personnel will be provided at the port building.

3.6 ENVIRONMENT IMPACT ASSESSMENT

An Environmental Impact Assessment Study has been performed to study the effects of Gaza Port. This has resulted in the following principal findings:

a. Coastal erosion caused by the interruption of the littoral drift to the north.

b. Dangers of development of scattered housing in the port area.

c. Possible environmental dangers due to spillage particularly oil and cargo mishandling.

d. Exhaustion of scarce ground water resources.

e. Loss of housing in the area.

f. Possible archaeological remains in the site.

3.7 Gaza Port Institutional Plan

3.7.1 Institutional framework

The 'Landlord Model' is recommended. Gaza Seaport Authority (GSPA) as a public organization shall take care of the ownership and management of the infrastructure. One or probably more private terminal operators will carry out the investment in equipment and actual cargo handling operations.

The GSPA is responsible for:

- Provision of nautical services (traffic management, pilotage, towage).
- Maintenance and development of infrastructure.
- Commercial exploration of the port's premises by leasing.
- Monitoring of port performance and promotion of the Port.
- Environmental protection.

3.7.2 The Terminal Operators are responsible

- Investments in equipment, storages, etc.
- Handling cargo including ship-shore, handling, storage, etc.
- Attraction of cargo.
- Excellent port performance.

The Port Authority will grant a concession to the private Terminal Operators.

Depending on the interest, such a concession could be tendered. The contract should be such that the Port Authority will keep control over performance as well as tariffs to ensure a good competitive position of the port and to avoid monopolistic practices.

3.7.3 Gaza Seaport Authority (GSPA)

As Public Authority, the GSPA should function in a Commercial environment. The revenue of the GSPA is the land leases, as well as port dues and maritime services (pilotage, towage). This income should be sufficient to pay back the loans for the construction, the depreciation of the infrastructure and the salaries of the GSPA staff.

3.7.4 Terminal Operators

Although the port may start with one operator, it is preferred to have ultimately several operators in the port and handling specific cargo (general cargo, containers, oil products, grain, etc.). The private operators will set-up his own organization. The operator's costs are the investments in equipment and super-structure (storages, buildings, etc.).

3.7.5 Assistance for Starting-up

To start up the GSPA, the following parallel actions should be taken:

a. Recruitment of staff.

b. Training of staff (referred to in the next section).

c. Installation and setting up of the organization.

d. Preparation of port bye-laws and port regulations.

e. Preparation of a Business Plan and setting of tariffs;

f. Preparation of concession contracts.

3.7.6 Training

On basis of discussions with the (PNA), it was concluded that a major part of the staff of the GSPA will have insufficient experience and will need training. A human resource development plan has been developed, consisting of:

a. Courses in special issued training institutes.

b. Practical training for port authorities and terminal operators abroad.

c. Training of pilots in a special institute for ship maneuvering & study tours.

3.8 THE PORT FREE ZONE OF GAZA SEAPORT

The area of Gaza is a pre-requisite. Gaza City is to the North-East, the Wade Gaza Nature Area, is to the south-west and the highway Salah Eddine, is to the south-east enclosing an area behind the port which is covered by the port transport servicing network, and in which a major Free Zone and Logistics Center can be gradually developed. It would be useful to develop by way of the 1st phase an area of 200 hectares, including 100 completely equipped. Land reservation, vital from the beginning, should stretch to a south-eastern limit at a distance of between 3 to 400 kms from the Salah Eddine highway and, to the north-east, up to 500 kms from the Port limits in phase III.

The Gaza Free Zone can be a commercial and enterprise zone, as long as these businesses are non-polluting and of an average size. The possibility of the creation of a 'banking zone' cannot be properly examined in this present study. This question is very specific and no doubt premature.

3.9 PORT AUTHORITY FUNCTIONS AND TASKS :

3.9.1 Nautical function

1. Maintenance of channels and access.

2. Navigational aids.

3. Ship movements.

4. Use of port service boats .

5. Control of pilot and towage vessels.

6. Control of crews.

7. Registration of boats.

8. Vessel inspections.

9. Control of beacons.

10. Preparation of port statistics (Gazaseaport, 1998), (Sofremer, 1996).

3.9.2 Traffic functions

1. Safeguarding of goods.

2. Quay rental.

3. Operation of terminals and sheds.

4. Submission of reports.

5. Supervising work on vessels.

6. Operational control of mobile equipment.

7. Operation of vessels and barges.

8. Control of barriers and deliveries of goods.

9. Preparation of operational statistics.

3.9.3 Engineering functions

1. Civil engineering works.

2. Maintenance of civil engineering, mechanical, electrical and marine equipment works.

3. Supervision of ship repair workshops.

3.9.4 Marketing functions

1. Sales correspondence and complaints.

2. Market research.

3. Market planning.

4. Promotion of the port and customer relations.

5. Managing customer contracts (Gazaseaport, 1998), (Sofremer, 1996).

3.9.5 Safety functions

1. Organization of personal safety and the safety of goods.

2. Contingency planning and Crisis management.

3. Fire-fighting and pollution control.

4. Environmental control.

5. Medical and first-aid services.

6. Preparation of safety reports.

3.9.6 Financial functions

1. Budget preparation and control.

2. Warehouse management.

3. Collection of revenues.

4. Preparation of salaries and invoices.

5. Payment of public bills.

6. Preparation of reports (statistics / regular financial reporting).

3.9.7 Administrative functions

1. Personnel files and performance.

2. Archives and library.

3. Social affairs.

4. Management of personnel recruitment procedures.

5. Personnel development and training.

6. Insurance (Gazaseaport, 1998), (Sofremer, 1996).

3.10 ORGANIZATIONAL CHART

The draft organizational chart drawn up by the (PNA) is repeated below .The organizational chart provides three directorates, each responsible for a number of services.

3.10.1 Nautical Affairs Directorate (NAD)

1- Vessel Traffic Management.

2- Pilotage.

3- Towage.

4- Mooring.

5- Bunkering.

6- Law and Order.

7- Environment.

8- Crisis Management.

3.10.2 General Affairs Directorate (GAD)

1- General Administration.

2- Training.

3- Legal Affairs.

4- Tariffs (shared with PDMD).

5- Marketing (shared with PDMD).

6- Public Relations (shared with PDMD).

7- Contracts.

8- Financial Administration (Gazaseaport, 1998), (Sofremer, 1996).

3.10.3 Port Development and Maintenance Directorate (PDMD)

1- Infrastructure development and maintenance.

2- Statistics.

3- Strategic Planning, Master Planning.

4- Tariffs (shared with GAD).

5- Marketing (shared with GAD).

6- Public Relations (shared with GAD) (Gazaseaport, 1998), (Sofremer, 1996).

CHAPTER (4)

SIMULATION & MODELING

This chapter consists of the following sections:

CHAPTER FOUR

SIMULATION & MODELING

4.1 DEFINITION OF SIMULATION TECHNIQUE

Simulation is one of the most powerful tools available to decision-makers responsible for the design and operation of complex processes and systems. It makes possible the study, analysis and evaluation of situations that would not be otherwise possible. In an increasingly competitive world, simulation became an indispensable problem solving methodology for engineers, designers and managers (Shannon, 1998).

Modeling methodologies may vary depending on the nature of the system to be modeled. In the construction domain, simulation techniques can be used to model a wide spectrum of operations while accounting for their associated randomness and uncertainty (Hajjar & AbouRizk, 2002).

Kelton et al. (2007) defined simulation as a method used to create a model with the characteristics of a real system on a computer with the appropriate software. Simulation is a powerful problem-solving technique that is concerned with statistical sampling theory and analysis of complex and probabilistic physical systems (Kelton et al., 2007).

4.2 DIFFERENT KINDS OF SIMULATION

There are many different ways to classify simulation models, but a useful way is along these three dimensions:

a. Dynamic or static: Time plays a natural role in dynamic models but does not in static ones. Most operational models are dynamics and Arena was designed to best fit with this kind of models (Kelton et al., 2007).

b. Discrete or continuous: In a discrete model changes occur only at specified points in time while in a continuous model the state of the system changes continuously over time. A discrete model can be a manufacturing system where parts arrive and leave following a specific timetable; a water reservoir with water flowing in and out is a perfect example of a continuous model. In the same model can be present elements of both discrete and continuous change: these models are called mixed continuous-discrete models (Kelton et al., 2007).

c. Deterministic or stochastic: Models with no random inputs are called deterministic models while stochastic models operate with at least some random inputs. Due to the randomness of the inputs, even the outputs of a stochastic model are uncertain and the analyst has to consider this carefully in designing and interpreting the results of this kind of projects (Kelton et al., 2007).

A model can have both deterministic and random inputs in different components. It is often a must to allow for random inputs in order to make the model a valid representation of reality. Random inputs can be generated through specifying probability distributions from which observations are sampled (Kelton et al., 2007).

4.3 MODELING CONCEPTS

There are several concepts underlying simulation. These include system and model, events, system state variables, entities and attributes, list processing, activities and delays, and finally the definition of discrete-event simulation.

4.3.1 SYSTEM, MODEL AND EVENTS

A model is a representation of an actual system. Immediately, there is a Concern about the limits or boundaries of the model that supposedly represent the system. The model should be complex enough to answer the questions raised, but not too complex. Consider an event as an occurrence that changes the state of the system (Carson, 1993)**.**

4.3.2 SYSTEM STATE VARIABLES

The system state variables are the collection of all information needed to define what is happening within the system to a sufficient level (i.e., to attain the desired output) at a given point in time. The determination of system state variables is a function of the purposes of the investigation, so what may be the system state variables in one case may not be the same in another case even though the physical system is the same. Determining the system state variables is as much an art as a science. However, during the modeling process, any omissions will readily come to light. (And, on the other hand, unnecessary state variables may be eliminated.) Having defined system state variables, a contrast can be made between discrete-event models and continuous models based on the variables needed to track the system state. The system state variables in a discrete-event model remain constant over intervals of time and change value only at certain well-defined points called event times. Continuous models have system state variables defined by Differential or difference equations giving rise to variables that may change continuously over time. Some models are mixed discrete-event and continuous. There are also continuous models that are treated as discrete-event models after some reinterpretation of system state Variables, and vice versa .

4.3.3 ENTITIES AND ATTRIBUTES

An entity represents an object that requires explicit definition. An entity can be dynamic in that it "moves" through the system, or it can be static in that it serves other entities. An entity may have attributes that pertain to that entity alone. Thus, attributes should be considered as local values .

4.3.4 RESOURCES

A resource is an entity that provides service to dynamic entities. The resource can serve one or more than one dynamic entity at the same time, i.e., operates as a parallel server. A dynamic entity can request one or more units of a resource. If denied, the requesting entity joins a queue, or takes some other action (i.e., diverted to another resource, ejected from the system). (Other terms for queues include files, chains, buffers, and waiting lines.) If permitted to capture the resource, the entity remains for a time, and then releases the resource. There are many possible states of the resource. Minimally, these states are idle and busy. But other possibilities exist including failed, blocked, or starved .

4.3.5 LIST PROCESSING

Entities are managed by allocating them to resources that provide service, by attaching them to event notices thereby suspending their activity into the future, or by placing them into an ordered list. Lists are used to represent queues. Lists are often processed according to FIFO (first-in first-out), but there are many other possibilities. For example, the list could be processed by LIFO (last-in-first out), According to the value of an attribute, or randomly, to mention a few (Carson, 1993)**.**

4.3.6 ACTIVITIES AND DELAYS

An activity is duration of time whose duration is known prior to commencement of the activity. Thus, when the duration begins, its end can be scheduled. The duration can be a constant, a random value from a statistical distribution, the result of an equation, input from a file, or computed based on the event state (Carson, 1993)

4.3.7 DISCRETE-EVENT SIMULATION MODEL

Sufficient modeling concepts have been defined so that a discrete event simulation model can be defined as one in which the state variables change only at those discrete points in time at which events occur. Events occur as a consequence of activity times and delays. Entities may compete for system resources, possibly joining queues while waiting for an available resource. Activity and delay times may "hold" entities for durations of time. A discrete-event simulation model is conducted over time ("run") by a mechanism that moves simulated time forward. The system state is updated at each event along with capturing and freeing of resources that may occur at that time. DES is used to model systems that change states dynamically, stochastically, in discrete intervals (Gunal, 2012).

DES models are useful for quantifying the effectiveness of certain operating policies for systems with flexible workers. In addition they are also ideal for study of short-term transient effects that may not be discernible with analytic models (Brown, 2012).

4.4 ADVANTAGES OF SIMULATION:

Simulation has a number of advantages over modeling and analyzing systems. First, the basic concept of simulation is easy to comprehend and hence often easier to justify to management or customers than some of the analytical and mathematical models. In addition, a simulation model may be more credible, because its behavior has been compared to that of the real system or because it requires fewer simplifying assumptions and hence captures more of the true characteristics of the system under study (Chung, 2004).

Simulation enables to test every aspect of a planned change without committing resources to their acquisition. This is critical, because when the construction has begun, changes and corrections can be very expensive (Banks, 2000).

Shannon (1998) mentioned “Simulation provides cheap insurance and a cost effective decision making tool for managers. It allows us to minimize risks by letting us discover the right decisions before we make the wrong ones”.

In simulation, it is possible to manipulate time. By compressing and/or expanding time, simulation allows one to speed up or slow down phenomena so that one can thoroughly investigate them. It is very important to understand why certain phenomena occur in a real system (Chung, 2004).

Shi (2001), handled simulation usefulness from the perspective of describing complicated processes, where the relations are difficult to define causally, or an analytic model would be too difficult to solve. In addition, he added, “Simulation method can be recommended for firms engaged in construction of repetitive projects, especially large projects where sufficient funds for planning are available”.

With simulation, one can determine the answer to the “why” questions by reconstruction and examine the scene thoroughly to determine why the phenomenon occur. In addition, it clarifies how a modeled system actually works and understanding of which variables are most important to performance (Chung, 2004).

AL-Tabbaa and Rustom (2011) found simulation is an effective approach for developing multiuse simulation modules for estimating project durations at the planning phase for infrastructure projects.

4.5 DISADVANTAGES OF SIMULATION

Despite its advantages, simulation may not be a perfect tool for system analysis. This is because many real systems are affected by uncontrollable and random inputs, many simulation models involve random, or stochastic, input components, causing their output to be random too. Although modelers think carefully about designing and analyzing simulation experiments, simulation output may still be uncertain. This uncertainty might be solved by making a lot of oversimplifying assumptions about the system. Unfortunately, though, such an oversimplified model will probably not be a valid representation of the system. In general, modelers would prefer an approximate answer to the right problem rather than an exact answer to the wrong problem (Bahtiyar, 2005).

Nevertheless, the disadvantages of simulation are that creating a model requires special knowledge in simulation concepts and can be time-consuming. Furthermore, most simulation output are essentially random variables (they are usually based on random inputs). Consequently, it may be hard to determine whether a simulation output is a result of system interrelationships or a result of randomness (Banks, 2000). Simulation cannot compensate for inadequate data or poor management decisions (Shannon, 1998).

4.6 STEPS IN A SIMULATION STUDY

The purpose of simulation modeling is to help the ultimate decision-maker to solve a problem. Therefore, to be a good simulation modeler, you must merge good problem solving techniques with good software engineering practice. The following shows a set of steps to guide a model builder in a thorough and sound simulation study (Banks, 2000; Kelton, et al., 2007; Chung, 2004).

Problem Formulation: every simulation study should begin with a statement of the problem. If the statement is provided by the policy makers or those that have the problem client, the simulation analyst must take extreme care to ensure that the problem is clearly understood. If a problem statement is prepared by the simulation analyst, it is important that the client understands and agrees with the formulation.

Setting of objectives and overall project plan: the objectives indicate the questions that are to be answered by the simulation study. The project plan should include a statement of the various scenarios that will be investigated. The plans for the study should be indicated in terms of time that will be required, personnel that will be used, and hardware and software requirements.

Conceptual model : the real-world system under investigation is abstracted by a conceptual model, a series of mathematical and logical relationships concerning the components and the structure of the system. It is recommended that modeling begins simple and that the model grows until a model of appropriate complexity has been developed.

Data collection: identifying and collecting the input data needed by the model. In a simulation project, the ultimate use of input data is to drive the simulation. This process involves the collection of input data, analysis of the input data, and use of the analysis of the input data in the simulation model .

Model translation: the conceptual model constructed is coded into a computer recognizable form, an operational model (Banks, 2000). The objective of the model translation phase is to translate the system into a computer model that can be used to generate experimental data. This is a two-step process. The first part of this process requires that the modeler decides what type of computer program to utilize to model the system. The second part of the model translation phase is to actually perform the programming of the simulation model .

Verification: verification concerns the operational model. Is it performing properly? It is highly advisable that verification takes place as a continuing process. It is well advised for the simulation analyst to wait until the entire model is complete to begin the verification process .

Validation: validation is the determination that the model is an accurate representation of the real system. Can the model be substituted for the real system for the purposes of experimentation? .

Experimental design: once the simulation model of the actual system has been properly validated, the developer can turn his attention to determining how to design additional models for subsequent experimental analysis .

Documentation and reporting: the final step in the simulation process is to write a report and create a presentation on the simulation project recommendations and conclusions (Chung, 2004). If the simulation model is going to be used again by the same or different analysts, it may be necessary to understand how the program model operates. This will enable confidence in the simulation model so that model users can make decisions based on the analysis. Also, if the model is to be modified, this can be greatly facilitated by adequate documentation. The result of all the analysis should be reported clearly and concisely .

4.7 PORT SIMULATION MODELS

Simulation has applications, from space flight, aircraft to cars and ships and from nuclear power to the process industry. Simulation has been used to study such wide ranging topics in different systems such as: urban economic, production, business, social, transportation, health care delivery, and many more systems.

Simulations are a mimic of reality that exists or is contemplated. In mathematical simulations we usually attempt to represent a system for which closed mathematical solution do not exist or where a series of sequential simulated decision is easier to derive than solution to a number of differential or difference equation that represent the system **.**

Simulation is most effectively used as a stage in port operation analysis or planning. It is particularly at that stage that we should not, extrapolated data or results beyond their range of validity. If this is necessary, then confidence measures in probabilistic terms should be introduced . In maritime field, simulation is used for port design, port planning, port productivity improvements, port capacity expansion study, economic impact study navigation risk evaluation, management training, staff education and training, simulation of ship and cargo operations, short and long future study simulation of a container terminal, and port activity simulation.

4.7.1 PORT AS A COMPLEX SYSTEMS

Port can be viewed as a complex system containing several entities. The physical entities include, port space, berths, channels, warehouses, equipment, technical, ships, cargoes, passengers, manpower, transportation means, gates, companies, agencies and customs. The financial entities include, cost and revenue. Other entities that affect port operation are environment, control and inspection, planning, administration, research and development, manpower training, pollution, security, communication, regulations operating methods and politics.

Figure (4.1) described the major entities affecting the port operation together with some detailed attributes (factor and parameters) for each entity. that is why we should look for another tool of analyzing such a system. We can generally divide the port operation into four main categories.

a. Ship transport mode operation

b. Cargo handling operation

c. Warehousing operation

d. Inland transport mode operation

Ship transport mode operation usually begins with the ship arrival to the port area and depending on the state of congestion. The ship may or may not have to wait in the anchorage area .

Cargo handling operation is concerned with the cargo-handling activities. It begins with preparing the ship for unloading. Then completing cargo inspection if necessary, paying charges, completing documentation …etc. (Said, 1993).

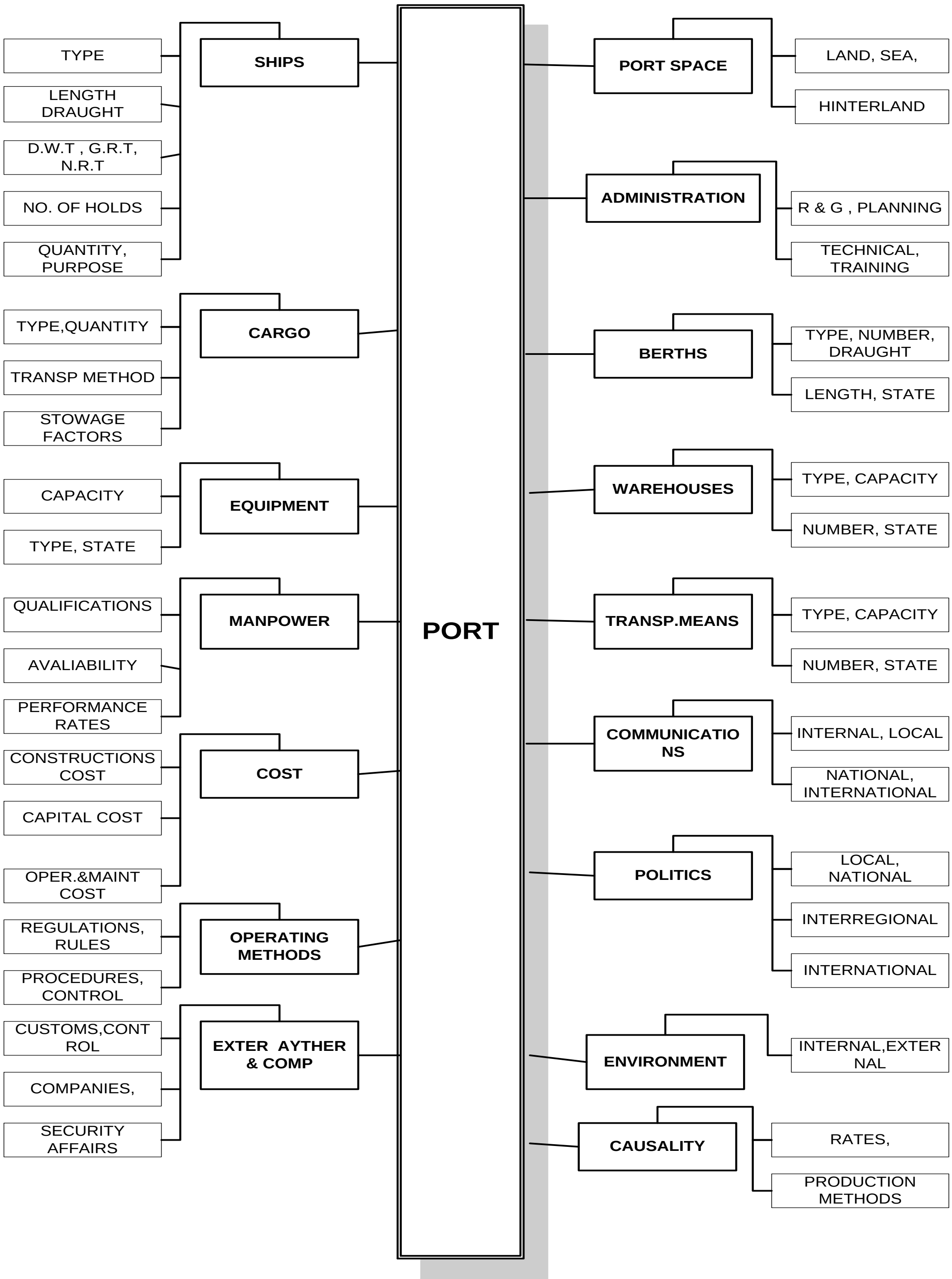


FIGURE 4.1 MAJOR ENTITIES AND ATTRIBUTES OF PORT SYSTEM

Source: World Bank (2006)

4.7.2 SIMULATION AS A DECISION SUPPORT TOOL

Simulation can be used Port Management Decision Support Tool (PMDST) , for studying, analyzing, evaluating, and improving the port performance. The input data to the model are port facilities, ship and cargo characteristics, operating rules, operating conditions and historical operational data. The model can calculate the port performance indicators, the critical indices of the parallel paths and the facility utilization factors.

The simulation model can then be used as a (PMDST) for port performance evaluation, port improvement studies, port expansion studies, economic impact evaluation and system optimization.

To facilitate the use of the (PMDST), the computer model is better to be designed and programmed as an interactive graphic animated system and includes several aids for the user in the form of messages and instructions on the screen and/or line printer (Said, 1993).

4.8 WHAT SEAPORT SIMULATOR CAN DO?

A simulation program generates four output files. All of these files have standard . (Andrzej, 2002)

1. File containing data of storage and yard usage, StorData.out.
2. File containing data of terminal equipment usage, ResData.out.
3. File containing data of simulated vehicles usage, Vehcall.out.
4. File containing some additional information, results.txt.

Files one to three contain more than ten specific factors. These factors are related to simulated parts of port (storage, crane, quay, etc.) at the constant time interval. Below we can see the list of the most important factors contained in the reports, in example week-reports.

<u>Set of output files factor</u>

1. **File StorData.out**

Factors in:

- Number of shipments in.
- Mean of number of shipments in.

- Standard deviation of number of shipments in.
- Variance of number of shipments in.
- Time weighted mean of number of shipments in.
- Time weighted standard deviation of number of shipments in.
- Time weighted variance of number of shipments in.

2. File ResData.out

Factors in:

- Number of times number of units of resource allocated was updated.
- Mean of number of units of resource allocated.
- Variance of number of units of resource allocated.
- Standard deviation of number of units of resource allocated .
- Time weighted mean of number of units of resource allocated.
- Time weighted variance of number of units of resource allocated.
- Time weighted standard deviation of number of units of resource allocated.
- Number of customers, which had to wait.
- Mean of queue length.
- Variance of queue length.
- Standard deviation of queue length.
- Time weighted mean of queue length.

3. File Vehcall.out

Factors in:

- DWT .

- Draught on arrival at the port.
- Draught on departure from the port.
- Arrival time at the pilot on the approaches.
- Anchoring times on the approaches(if it takes place).
- Arrival time off berth .
- Arrival time at the berth.
- Start of unberthing procedures .
- Departure time from the berth.
- Departure time after leaving the pilot on the approaches.
- Time used for clearing of the vessel and crew.
- Vehicle turnaround time .

4.9 ARENA SIMULATION TOOLS

Arena software is used to simulate and represent the real system which allows the planners to observe the behavior of the system when changes are made in the system. Also Arena enables the planners to bring the power of modeling and simulation to their planning (Rockwell Automation, 2012).

There are several simulation tools used in simulating real systems in construction industry for different objectives. Some of these tools are Monte Carlo Simulation, Micro Cyclone, AutoMod, Simscript, SimPak and Arena (Wales & AbouRizk, 1996).

The Arena simulation software package is one of the most advanced and sophisticated simulation tools employed in business and industrial engineering. It includes a “drop and drag” feature that makes it suitable for a visual network model construction that parallels the nodes and arcs of a typical network representation (Cosgrove, 2008).

There are several researches used Arena software as simulation tool, the following will describe their works.

Al-Hams (2010) developed Arena simulation model to for change orders occurrences and their impact on cost, time, and productivity for building projects in the Gaza Strip.

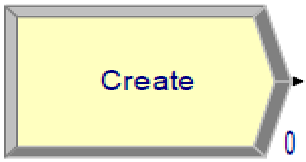
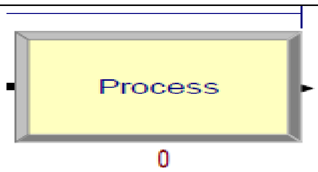
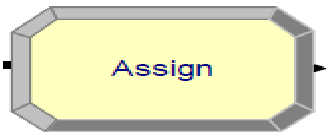
Cosgrove (2008) employed Arena features to simplify model construction for activity time networks based on PERT. This reduction in the burden of model construction should enhance the use of Arena in network simulation, permitting users to tap additional modeling features not typically found in more specialized network simulation packages.

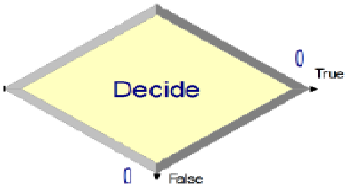
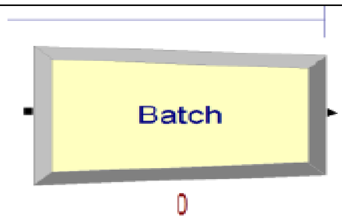
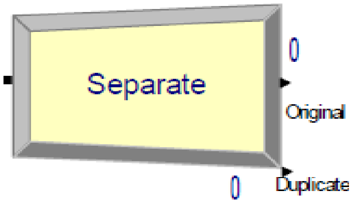
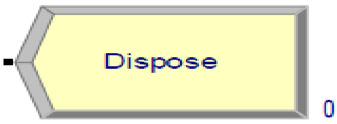
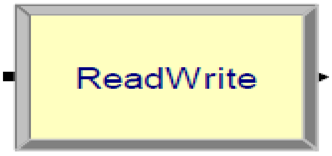
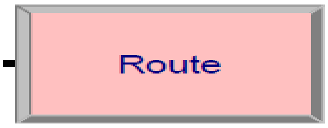
4.10 ARENA MODULES

Modules are the basic building blocks for Arena models. These are the flowchart and data objects that define the process to be simulated that are chosen from panels in the Project Bar in Arena (Kelton, et al., 2007; Altiok & Melamed, 2007). The modules used in this research are described in Table (4.1) and Table (4.2).

Flowchart Modules: describe the dynamic process in the model. Their shapes are placed in the model window and connected to form a flowchart, describing the logic of a process.

Table (4.1) Flowchart arena modules .

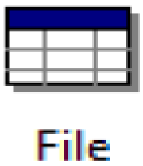
I. Basic Modules		
Module	**Symbol**	**Description**
Create		The starting point for entities in a simulation model. Entities then leave the module to begin processing through the system.
Process		Processing method in the simulation. Options for seizing and releasing resource constraints are available. Additionally, there is the option to use a "sub-model" and specify hierarchical user-defined logic.
Assign		Is used for assigning new values to variables, entity attributes, entity types, entity pictures, or other system variables.

Decide		Allows for decision-making processes in the system. It includes options to make decisions based on one or more conditions or based on one or more probabilities
Batch		Described as the grouping mechanism within the simulation model. Batches of entities can be permanently or temporarily grouped.
Separate		Used either to copy an incoming entity into multiple entities or to split a previously batched entity.
Record		Used to collect statistics in the simulation model.
Dispose		Is intended as the ending point for entities in a simulation model. Entity statistics may be recorded before the entity is disposed
II. Advance Modules		
ReadWrite		Used to write data to an output device, such as the screen or a file.
III. Advanced Transfer Modules		
Route		Used for transferring an entity to a specified station, or the next station in the station visitation sequence defined for the entity.

Station		Defines a station corresponding to a physical or logical location where processing occurs. It receives the entity that comes from any location to go through another location in the model.

Data Modules: define the characteristics of various process elements. Only three of them are taken into consideration during the model building: (Kelton, et al., 2007; Altiok & Melamed, 2007).

Table (4.2) Data arena modules .

Module	Symbol	Description
Entity		Defines the various entity types and their initial picture values in a simulation. Initial costing information and holding costs are also defined for the entity.
Resource		Defines the resources in the simulation system, including costing information and resource availability.
File		Identifies the system file name and defines the access method, formatting, and operational characteristics of the files.

4.11 What is DSS?

Decision support systems are earning an increasing popularity in different domains, including engineering, business, and medicine. They are important especially in situations when the amount of available information is prohibitive for the feeling of an unaided human decision maker, and in which precision and optimality are very important. Decision support systems can help human cognitive deficiencies by integrating various information sources, providing intelligent access to relevant knowledge, and helping the process of structuring decisions. They can also employ artificial intelligence methods to heuristically address problems that are intractable by formal techniques. They can also support choice among well-defined alternatives and build on formal approaches, such as the methods of operations research, engineering economics, statistics, and decision theory (Marek J. Druzdzel and Roger R. Flynn 2010).

4.12 BENEFITS OF DSS

Suitable application of decision support system increases efficiency, productivity, quality and effectiveness, speed up the process of decision making , increases organizational control, encourages exploration and discovery on the part of the decision maker, and gives many businesses a reliable and comparative advantage over their competitors, allowing them to increase output, make optimal choices for parameters and their technological processes, planning business logistics, operation in hazardous environments, or investments, speeds up problem solving in an organization, facilitates interpersonal communication , promotes learning or training, generates new evidence in support of a decision, Helps automate managerial processes , in addition to improve customer and employee satisfaction (Wikipedia,2014).

4.13 TYPES OF DSS

There are varieties of DSSs; these can be categorized into five types as follows:

4.13.1 Communication-driven DSS

A communication-driven DSS use network and communication technologies to facilitate collaboration on decision making. It supports more than one person working on a shared task.

4.13.2 Data-driven DSS

A data-driven DSS or data-oriented DSS emphasizes access to and manipulation of a time series of internal company data and, sometimes, external data. Simple file systems accessed by query and retrieval tools provides the elementary level of functionality.

4.13.3 Document-driven DSS

A document-driven DSS uses storage and processing technologies to document retrieval and analysis. It manages, retrieves and manipulates unstructured information in a variety of electronic formats. A search engine is a primary tool associated with document driven DSS.

4.13.4 Knowledge-driven DSS

A knowledge-driven DSS provides specialized problem solving expertise stored as facts, rules, procedures, or in similar structures. It suggests or recommends actions to managers.

4.13.5 Model-driven DSS

A model-driven DSS emphasizes access to and manipulation of a statistical, financial, optimization, or simulation model. Model-driven DSS use data and parameters provided by users to assist decision makers in analyzing a situation; they are not necessarily data intensive (Dan Power, 2011).

CHAPTER (5)

CONSTRUCTION THE SIMULATION MODEL FOR SEAPORT

This chapter consists of the following sections:

CHAPTER(5)

COUNSTRUCTION OF THE SIMULATION MODEL FOR SEAPORT

(Case Study: Development of Gaza Seaport in Subphase IA)

5.1 INTRODUCTION

The Gaza Seaport is considered as one of the most important facilities for the Palestinian economy as it is used to import and export directly to Palestine instead of going through neighboring countries. Through negotiation between the (PNA) and the government of Israel, an agreement has been reached to develop and operate Gaza Seaport, as explained in chapter three.

The Palestinian foreign trade is passing through a very difficult and many problems facing the beginning of the problems of border crossings and Israeli hegemony to the closure policy and security hoops that are imposed on the Palestinian territories and ending the terms of matching imports to the Palestinian-Israeli specifications and other obstacles placed in front of Palestinian imports and exports.

The establishment of the Gaza Seaport change is pivotal to the Palestinian economy and to be fully independent from the occupation by the Israeli. And that the establishment of the Gaza Seaport will be singing the Gaza Strip from the entry of goods through Gaza crossings wild and completely indispensable.

The seaport is considered a very complex system, where every part is connected to the other. Within this research, it aims at improving the management or tasks related to such a complex system.

This research chose one of those systems which depends on the activity operation of the seaport. Where this research designed a simulation model for service berth activity. It defined the variable berths and special serve ices, all types of ships that are expected bulk, and equipment which is located on these berths in chapter three.

During this research , it presented suggestions for Gaza Seaport using the simulation module; to make the movement of sea going ships better and easier.

5.2 GAZA SEAPORT CAPACITY

The Gaza Seaport project, designed by EGDG, consists of six development sub-phases: IA, IB, IC, ID, IE and IF. The capacity of the six development sub phases appear with the traffic estimates in the Economic and Technical study performed by the consortium (Sofremer, 1996). Subphase "IA" is chosen to be for evolution using simulation to develop Gaza Seaport.

Capacity of Subphase IA

The implementation of Subphase IA corresponds to year 1 of traffic, as presented in table (5-1).

TABLE 5.1 CAPACITY OF SUBPHASE IA

		Estimated traffic for year 1 No. of ships	Capacity (% of estimated traffic for year 1)	Capacity of subphase 1A
Break bulk	**RO-RO**	34	100	34
	LO-LO	103	29	30
Container	**RO-RO**	53	100	53
	LO-LO	159	29	46
Grain bulk	**LO-LO**	263	29	76
Total		**612**	**39**	**239**

Source: (Sofremer,1996)

The capacity of Subphase IA is: (Ministry of planning, 1996)

- Break bulk:64.000 tons (47% of the estimated break bulk traffic in Year 1)
- Containers: 99.000 tons (47% of the estimated container traffic in Year 1)
- Grain bulk :76.000 tons (29% of the estimated grain bulk traffic in Year 1)
- <u>Total:</u> 239.000 tons (33% of the estimated traffic for year 1)

5.3 BASIC ASSUMPTIONS FOR GAZA SEAPORT

5.3.1 TRAFFIC

Assumptions lead to the distribution of traffic for six years as presented in table (5-2) below (in thousand tons):

TABLE 5.2 DISTRIBUTION OF TRAFFIC (IN THOUSAND TONS)

Years		Y1	Y2	Y3	Y4	Y5	Y6
Break bulk	RO-RO	34	38	44	50	54	60
	LO-LO	103	115	133	150	161	179
Container	RO-RO	21	25	32	41	48	60
	LO-LO	191	223	288	368	432	541
Grain bulk	LO-LO	263	285	298	448	496	554
Liquid bulk		0.0	150	300	500	500	500
Total		**612**	**836**	**1096**	**1557**	**1962**	**1892**

5.3.2 PRODUCTIVITY

Average productivity presented in table (5-3) below is based on United Nation for Cooperation, Trade and Development (UNCTAD, 2006), recommendations and EGDG estimates:

TABLE 5.3 AVERAGE PRODUCTIVITY

Type of Packaging	Type of berth	Productivity in tons/berth/day
Break bulk	RO-RO	2500
	LO-LO	700
Container	Cranes	7000
	LO-LO	2000

Grain bulk	Grain terminal	2500 6000
liquid bulk	Oil terminal	20 000

5.4 A QUEUING NETWORK MODEL FOR SEAPORT

Simulation is often used in the analysis of queuing models. A description of the outer model is shown in figure (5-1).The arrival process of primary and secondary ships belonging to various companies have been represented by a pure delay station having several groups of servers, equivalent to the number of companies visiting the container terminal. Within any given group, one server corresponds to one ship, and the time between the ships arrival is viewed as the service time of the server. Upon their arrival at the terminal, ships can be forced to wait at the roadstead (terminal admission queue) until an adequate space slot gets free at the berth (Rina M. Mazza, 2000).

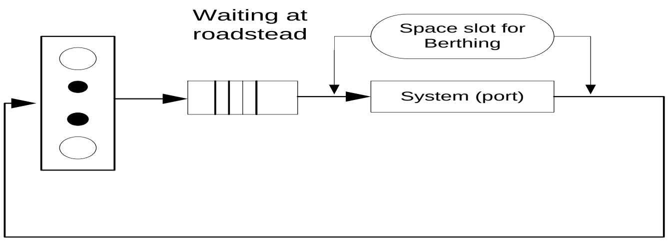


FIGURE 5.1 THE OUTER MODEL

Berth slots are therefore represented as a pool of passive resources that must be obtained before some available tug can start moving the ship from the roadstead to the crane (activity resources) location.

The inner model description is presented in figure (5.2). It shows a number of central servers representing tugs that are available for driving ships from the roadstead to the assigned berth slots, and vice versa. In addition, the figure shows two peripheral service stations that represent the primary berth area and the secondary one.

Finally, the return path to the central servers accounts for the second transfer service of the ship from the berth to the terminal exit offered by a tug, after a possible waiting time (physically spent at the berth).

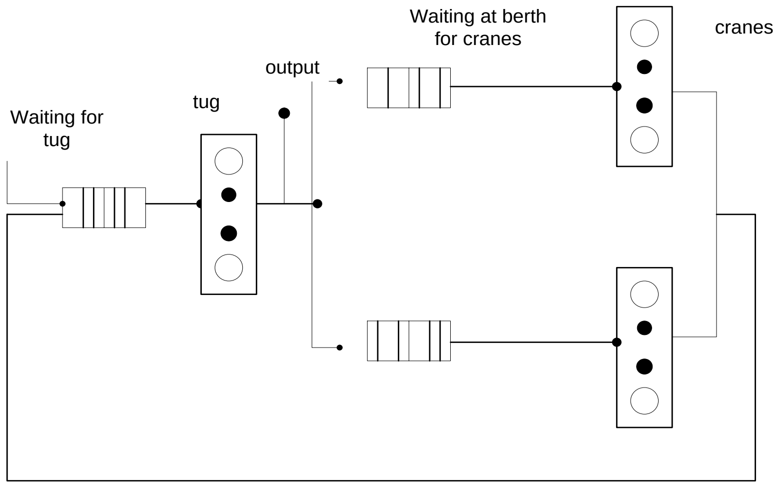


FIGURE 5.2 THE INNER MODEL (PORT)

5.5 SHIP SERVICING METHODS

There are two optional methods for servicing ships. In both cases a cargo load is calculated for a ship. One method incorporates the effects of the equipment used in loading and unloading operations.

Where the ship's cargo load is calculated then divided equally among the specified number of hatches. The model can differentiate between incoming and outgoing cargo and gives a summary of loaded/unloaded tonnages for each ship type.

The second ship servicing method treats the ship as an entity meaning, that is no hatch or crane/derrick activity is considered. The service time of a ship is determined bowed on the service time distribution defined for that ship type. Within an application of the model, different ship types may use either method .

Berthing a ship. Several criteria must be met before a ship will be berthed

1. The berth must be declared usable for that ship type.
2. The draught of the ship must be less than the berth depth.
3. Enough space must be available at the berth to accommodate the size of the ship (ship "length" is the length of berth it requires).
4. All ships with higher priority and competing-for the same space, if using the queue management rule that adheres to strict priorities, must have been berthed previously.

5. At least one berth crane must be available to start loading/unloading a ship, in the situation where the ship has no gear of its own and berth cranes must service it. When the ship has no gear of its own and none is available, that is all berth gear is busy, the ship will not be allowed to take up berth space until it can begin service.

If berth equipment is simulated, berth cranes are preferred, when available, to the ships gear. The number of pier cranes assigned to a ship is the smallest of either the:

1. Number of cranes

2. Number of cranes the ship needs

5.6 CASE DEFINITION FOR GAZA SEAPORT

Four different types of ships arrive at a seaport comprised of two berths; berth "A" and berth "B". The capacity of berth "A" is two ships while that of berth "B" is one ship. The arriving ships are unloaded at one of the two berths depending on the type of the arriving ship. Ships arrive to the port with an Exponential distributed (Bruzzone, Giribone) inter arrival times having a mean of 15 hours .The probability of arrival for each ship type is shown in Table (5.4) (Bruzzone A.G., 1998) (Giribone P., 1996) (Gaza Seaport Master Plane, 1998).

TABLE 5.4 SHIPS TYPE VS PROBABILTY ARRIVAL

Ship Type	Cargo	No. of Ships	% of Total No. of Ships
One	Wood	34	5
Two	Grain	263	43
Three	Cement	103	17
Four	Containers	212	35
Total		**612**	**100%**

5.7 CRANES AND CARRYING ABILITY ON THE PIERS

On the Port's piers are spread out heavy engineering vehicles, the most conspicuous ones are the cranes and derricks. The state of the art mechanical equipment is controlled by complex systems requiring knowhow and great experience.

Scores of jib cranes and STS cranes operate in the Port of GAZA, among them also the highest and broadest cranes in Gaza, providing an answer to almost all types of sea crafts. The cranes are maintained by the personnel of the Port's Equipment Department, staffed by first class professionals, among them mechanical and electrical engineers, supervisors, forklift operators and crane operators. The cranes serve on the docks alongside which the ships are anchored as well as the storage areas for the containers on the piers. Upon arrival, the ships first wait in a queue outside the port till a tug is free. Then the ship is pulled to either berth "A" or berth "B" taking an average time with a Uniform distribution of (30, 40) minutes. Ships of type one, two and three are pulled to berth "A" only while ships of type four are pulled to berth B only.

The capacity of ships of type one, two and three are from 15,000 to 30,000 tons per ship. The capacity of ships of type four is 700 containers per ship. Ships are unloaded on berths using cranes; four cranes for berth "A", and only two cranes for berth "B". The unloading rates per crane and the service time for each ship type are shown in Table (5.5)

TABLE 5.5 SHIP TYPE VS UNLOADING RATE

Ship Type	service Rate	service Time
Wood	50 ton per hour	ERLA(56.25, 1)
Grain	40 ton per hour	ERLA(70.3125, 1)
Cement	120-160 ton per hour	ERLA(19.53125, 1)
Containers	25-30 container per hour	ERLA(28, 1)

After the ship is unloaded, it is pulled from the berth to the outside of the seaport taking an average time with a Uniform distribution at (30, 40) minutes. The seaport works three shifts, of eight hours each, all over the year. The simulation model developed is used to simulate the operation of the seaport for one complete year. Where each run is replicated 100 times.

5.8 STEADY STATE ANALYSIS:

For most simulation studies of manufacturing systems, it is important to study the long-run (or steady-state) behavior of the system, i.e., its behavior when operating in a "normal" manner. However, simulations of these kinds of systems generally begin with the system in an empty and idle state. This result in the output data from the beginning of the simulation run that does not represent the desired "normal" behavior of the system. Therefore, simulations are often run for a certain amount of time, the warm-up period, before the output data are actually used to estimate the desired performance measure.

5.9 RESEARCH VARIABLES

The researcher selected many variables which will be used for the model to help in using simulation with regards to Arena Program.

a) **Dependent variable**: Berthing facilities .

b) Independent variable:

Number of berths, types of berths, Number of ships, types of ships, number of pump charges , types of pump charges and number of cranes.

5.10 MODEL STEPS

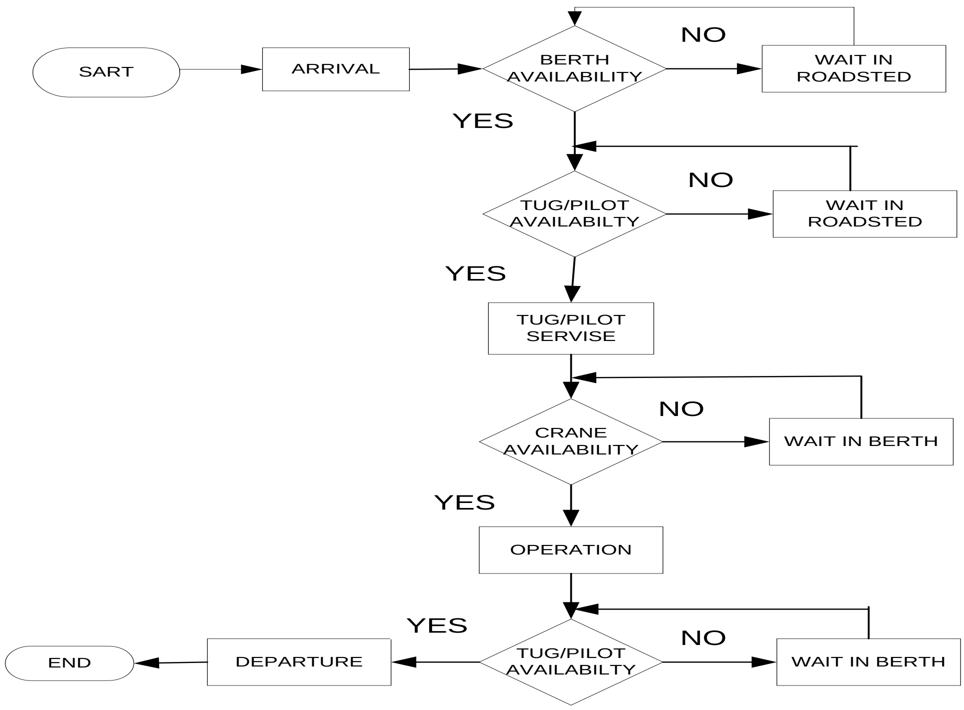


FIGURE 5.3 SHIPS ACTIVITY PROCESS

5.11 Model Construction

The model is constructed according to the following procedures:

(a) The simulation model layout is constructed as illustrated in Figure (5.4).

FIGURE 5.4 MODEL LAYOUT OF SEAPORT

(b) The arrive module is defined; where the time between arrivals is exponentially distributed with a mean of 15 hours as illustrated in Figure (5.5).

(c) Inside the arrive module-assign tab, the probability of arrivals for each ship type is defined; 5% for ship type one, 43% for ship type two, 17% for ship type three and 35% for ship type four as illustrated in Figure (5.5).

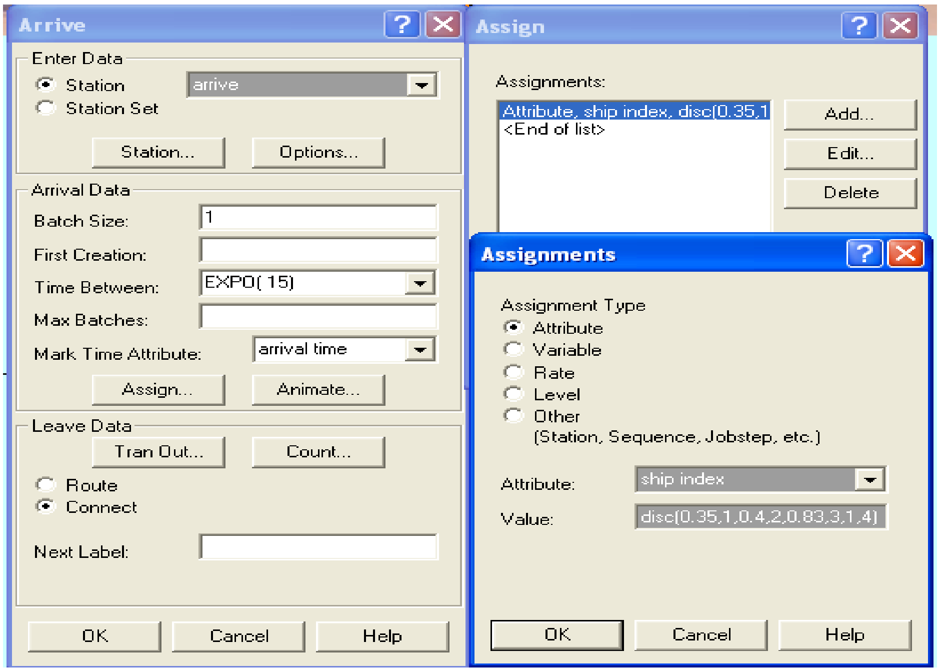


FIGURE 5.5 ARRIVE MODULE AND ASSIGNMENTS

(d) A PickStation module is added to ensure that the ship is pulled to either berth "A" or berth "B" taking an average time with Uniform distribution of (30, 40) minutes. Ships of type one, two and three are pulled to berth A only while ships of type four are pulled to berth B only as illustrated in Figure (5.6).

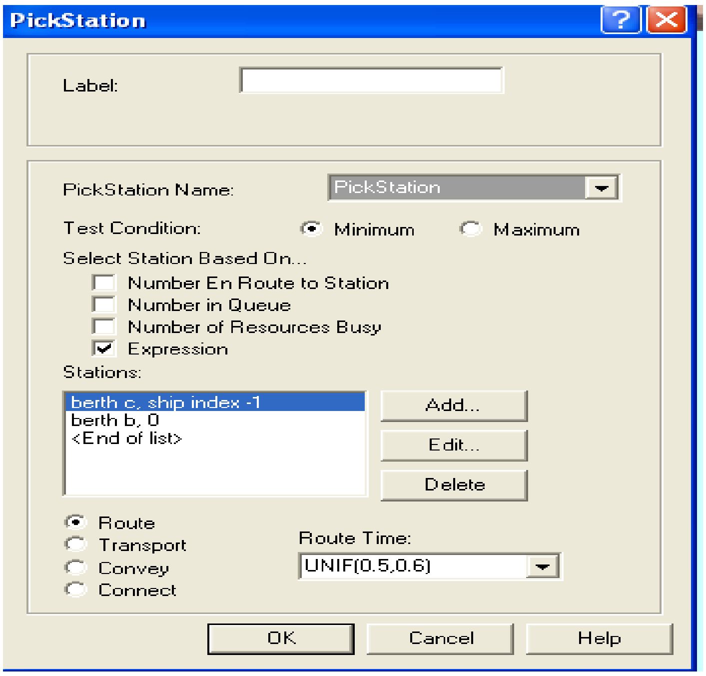


FIGURE 5.6 PICKSTATION MODULE

(e) A Queue module is used; where upon arrival, the ships first wait in a queue, outside the port, till a tug is free.

(f) A Sever module is used; where the unloading time for ships of type four is defined as an expression and the time for pulling a ship from the berth out of the seaport is defined by a Uniform distribution of (30, 40) minutes, as illustrated in Figure (5.7).

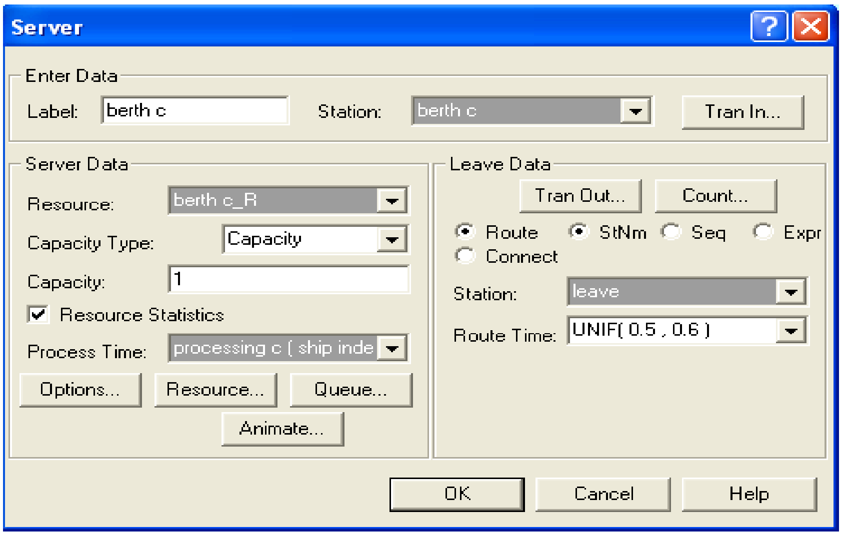


FIGURE 5.7 SERVER MODULE

(g) Enter, Process and Leave modules act as server modules; where the unloading time for ships of types one, two and three are defined as an expression and the time for pulling these ships from the berth to outside the seaport is defined as 30 minutes as illustrated in Figure (5.8).

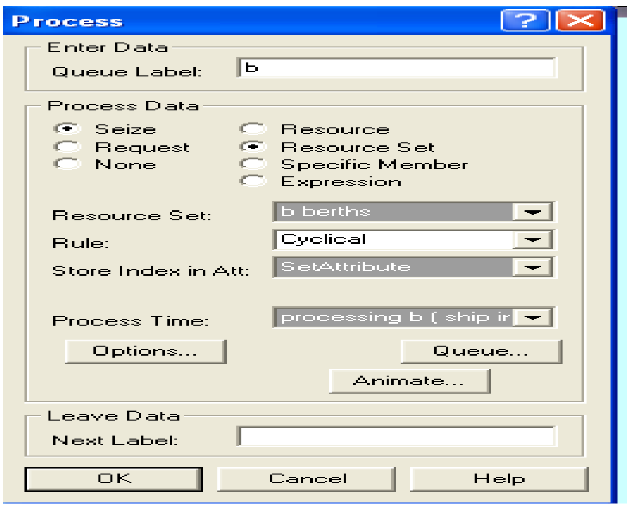


FIGURE 5.8 PROCESS MODULE

(h) An Expression module is used to define the unloading times for each ship type as illustrated in Figure (5.9).

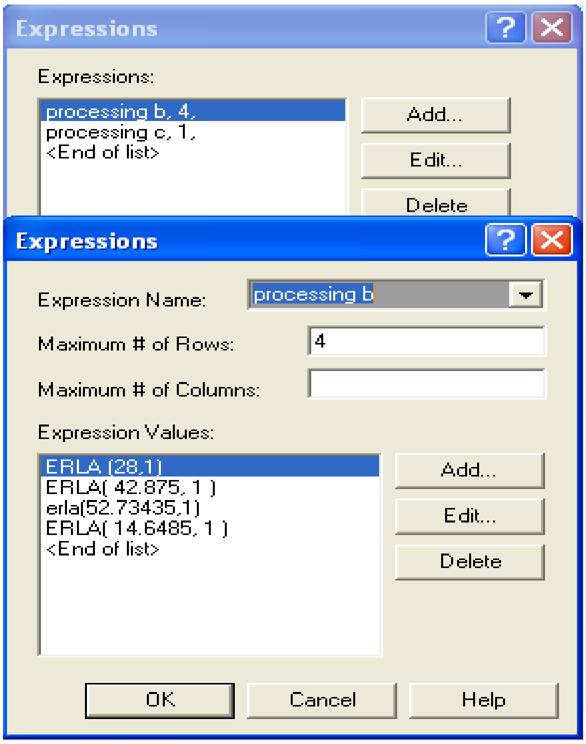


FIGURE 5.9 EXPRESSION MODULE

(i) A Depart module is used where in the departure terminal is defined.

(j) A Simulate module is used; where the number of replications, simulation length and the warm up period are defined, as illustrated Figure (5.10). The warm-up period is determined by plotting the cycle time versus simulated time, as shown in figure (5.11). From the figure the warm-up period is estimated to be approximately 1800 hours.

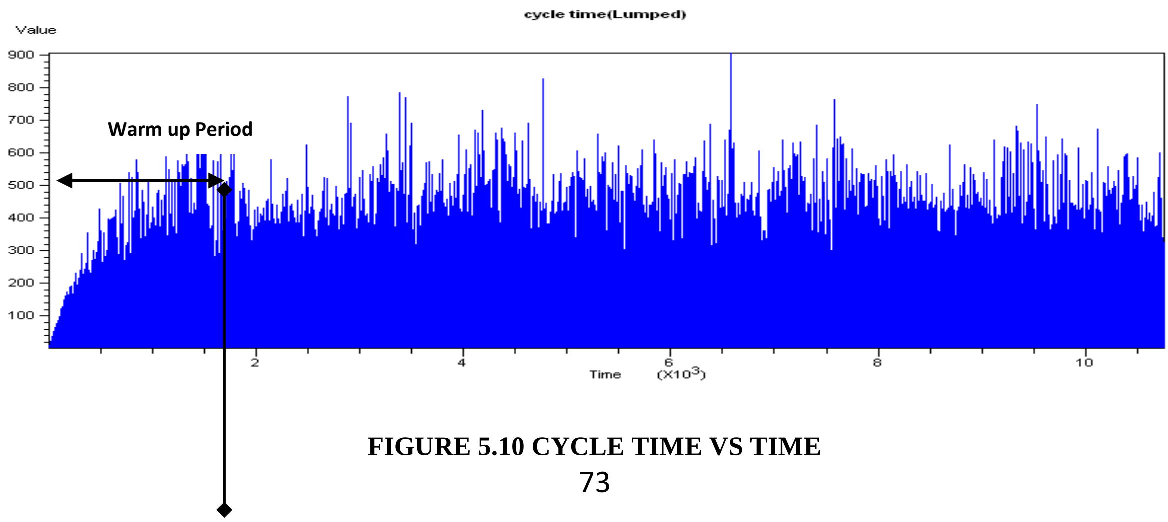


FIGURE 5.10 CYCLE TIME VS TIME

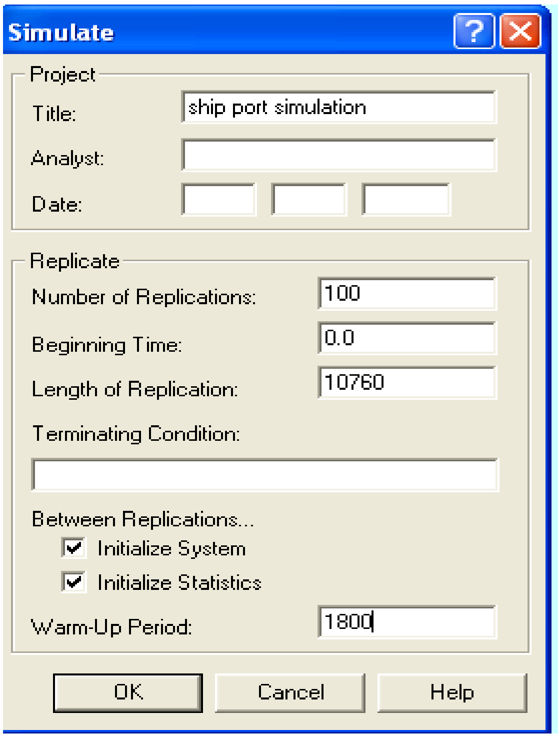


FIGURE 5.11 SIMULATE MODULE

5.12 VERIFICATION OF SIMULATION MODELS

Verification is utilized to compare a conceptacle model to its translation in computer format .The verification of the model developed using Arena Software has been carried out as indicated by the chart shown in figure (5-3).

5.13 VALIDATION OF SIMULATION MODELS

Validating a simulation model is the process of ensuring that it behaves the same as the real system (Kelton et al., 2007). Since this model is an approximation or representation of the real port system, it can never be absolutely validated. The goal in validation is to ensure the accuracy of the model results and to gain the confidence from the subject matter experts that the model is accurate for decision making purposes.

Model validation is critical in the development of a simulation model. Unfortunately is when still, there is no set of specific tests that can easily be applied to determine the "correctness" of the model specially the system under developed. Furthermore, no algorithm exists to determine what techniques or procedures to be used, refer to Appendix (A) (Sargent, 1999).

5.14 Verification and Validation of the SeaPort Model

The validation and verification stages are concerned with evaluating the credibility the simulation model. The verification task determines whether the translated model blares on the computer as intended by the modeler. Or not this is typically done by manual checking of calculations and impairing output of formulas implemented on the computer with the results obtained by calculations. The validation task consists of determining that the simulation model is an accurate representation of the system. Validation is normally performed on different level; on data inputs, model elements, subsystems, and interface points.

5.14.1 Degenerate Test

The degeneracy of the model's behavior is tested on the inter arrival time of ships. Exponential distribution with different mean values of 15, 12 and 8hours is used. The average time in queue and average cycle time corresponding to each mean value is shown in figure (5.12), and figure (5.13), respectively. The figures clearly show that by decreasing the inter arrival time, the average cycle time and average time in queue increase.

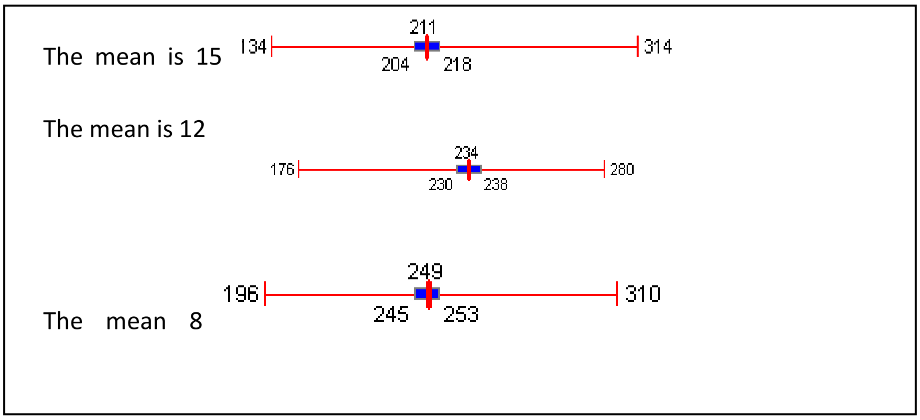


FIGURE 5.12 AVERAGE TIME IN QUEUE AT DIFFERENT MEANS OF ARRIVALS

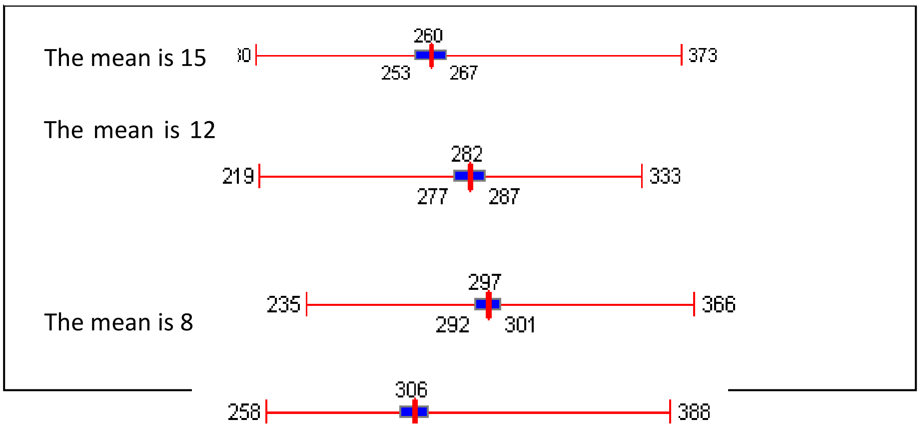


FIGURE 5.13 AVERAGE CYCLE TIME AT DIFFERENT MEANS OF ARRIVALS

It can be observed that by comparing the means of the average cycle time, there is a significant difference between means. Also, when comparing the means of the average time in queue, there is a significant difference between means. Therefore, the outputs agree with the expected results. The model is considered valid from this test point of view shown in Figure (5.14) and Figure (5.15).

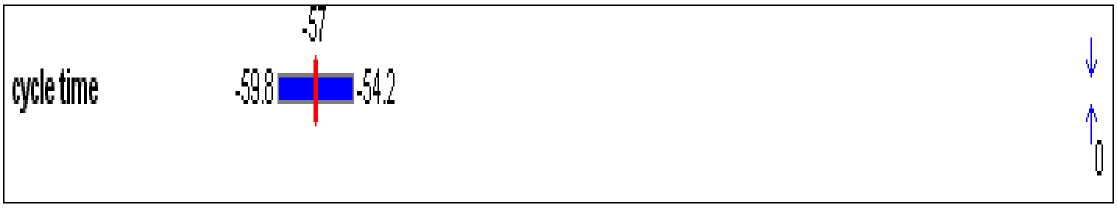


FIGURE 5.14 COMPARISON OF MEANS FOR AVERAGE CYCLE TIME

FIGURE 5.15 COMPARISON OF MEANS FOR AVERAGE TIME IN QUEUE

5.14.2 CONSTANT VALUES TEST

Randomness in inter arrival time and processing time is removed to test the behavior of the model under deterministic conditions. Inter arrival time is set at 10 hours (constant) and the processing time is set at 20 hours. Running the model for 1000 hours resulted in the value listed in table (5.6). These values are equal to the results obtained by manual calculations. Therefore, the model is valid from this test point of view.

TABLE 5.6 PERFORMANCE MEASURES

Performance Measure	Value
Average number of ships entered	877
Average time in queue (hours)	254.44
Average cycle time (hours)	302.49

5.14.3 FACE VALIDITY

Face validity is asking people who are knowledgeable about the system whether the model and/or its behavior is reasonable . This technique can be used in determining if the logic in the conceptual model is correct and if a model's input-output relationships are reasonable.

The first goal of the simulation modeler is to construct a model that appears reasonable on its face to model users and others who are knowledgeable about the real system being simulated. The potential users of a model should be involved in model construction from its conceptualization to its implementation, to ensure that a high degree of realism is built into the model through reasonable assumptions regarding system structure, and reliable data (Banks, 2000).

Sensitivity analysis can also be used to check model face validity. The model user is asked if the model behaves in the expected way when one or more input variable is changed.

5.15 PERFORMANCE MEASURES

A set of performance measures are selected to judge the performance of the system which are:

- Average cycle time: It is the time spent by the ship in the system, including the time spent in queue, the unloading and the transfer times.
- Average time in queue: It is the time spent by the ship at the roadstead until a place at berth is available for the waiting ship.
- Average number of ships in the system: It is the number of ships arriving at the seaport.
- Average number of served ships: the number of the ships that entered the system, unloaded their cargo, and left the system.
- Port performance = (Average number of served ships) / (Average number of ships in the system).

5.16 RESULTS AND ANALYSIS

The next stages in the simulation development processes are experimentation and analysis of results. These phases of simulation development involve the exercising of the simulation model and the interpretation of the outputs.

After running the model, the results shown in Table (5.7) are obtained, the probability of unloading each bulk ship type and average number of bulk ships served shown is table (5.7). Results are these plotted within a confidence level of 95%, as illustrated in Figure (5.16) and Figure (5.17).

TABLE 5-7 PERFORMANCE MEASURES

Performance Measure	Value
Average cycle time (hrs)	243.64
Average time in queue (hrs)	196.74
Average number of ships in the system	595.72
Average number of ships served	488.64
Average number of container ships	170.70
Average number of bulk ships	317.95

TABLE 5-8 BULK SHIP TYPES VS THE PROBABILITY OF ARRIVAL AND AVERAGE NUMBER SERVED

Types of Bulk Ships	Probability of Arrival at type's bulk ships (%)	Value
Average number of ships Wood	0.085	28
Average number of ships Grain	0.657	209
Average number of ships Cement	0.257	82

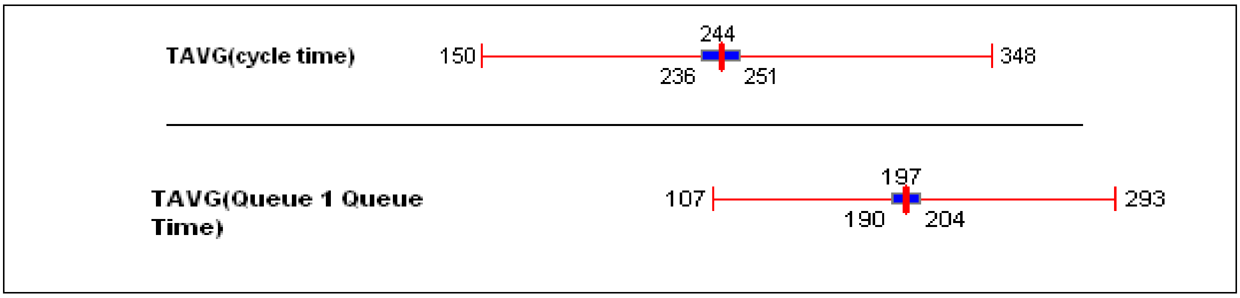


FIGURE 5.16 AVERAGE CUCLE TIME AND AVERAGE TIME IN QUEUE.

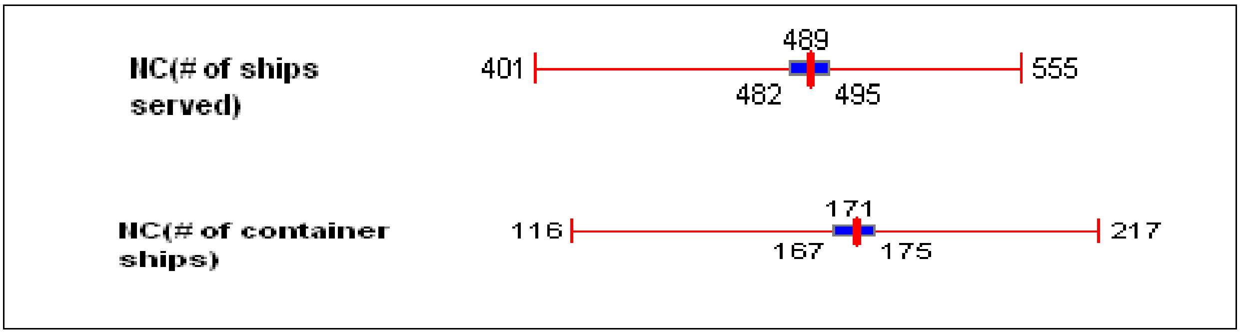


FIGURE 5.17 AVERAGE NUMBER OF SHIPS SERVED FOR DIFFERENT TYPES

To illustrate the relation between the performance measures, a graph is plotted for the average cycle time versus the average time spent in queue as illustrated in Figure (5.18). In addition another graph is plotted for the number of ships that entered the port versus the number of ships served as illustrated in Figure (5.19). Finally, a graph was plotted for the number of ships of type four versus ships of type one, two and three, as illustrated in Figure (5.20).

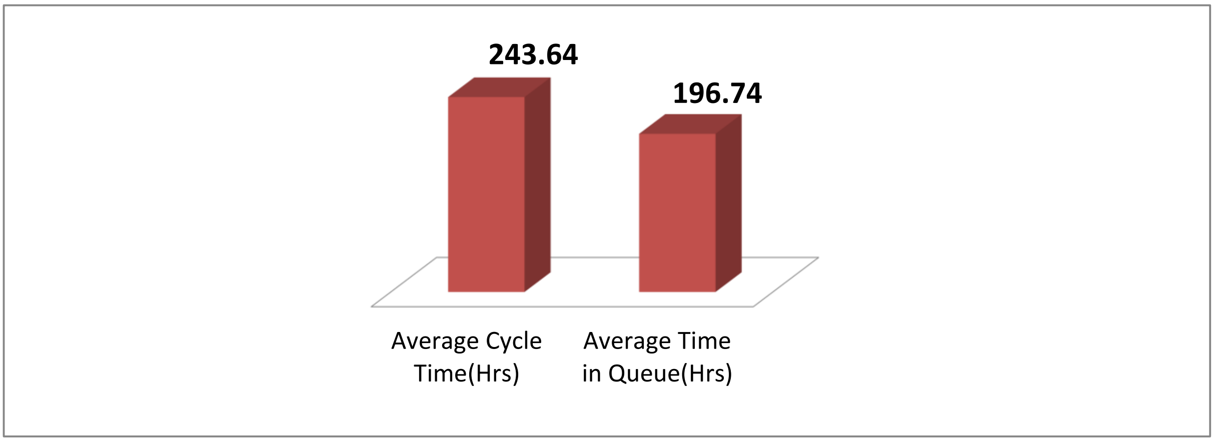


FIGURE 5.18 AVERAGE CYCLE TIME VERSUS AVERAGE TIME IN QUEUE

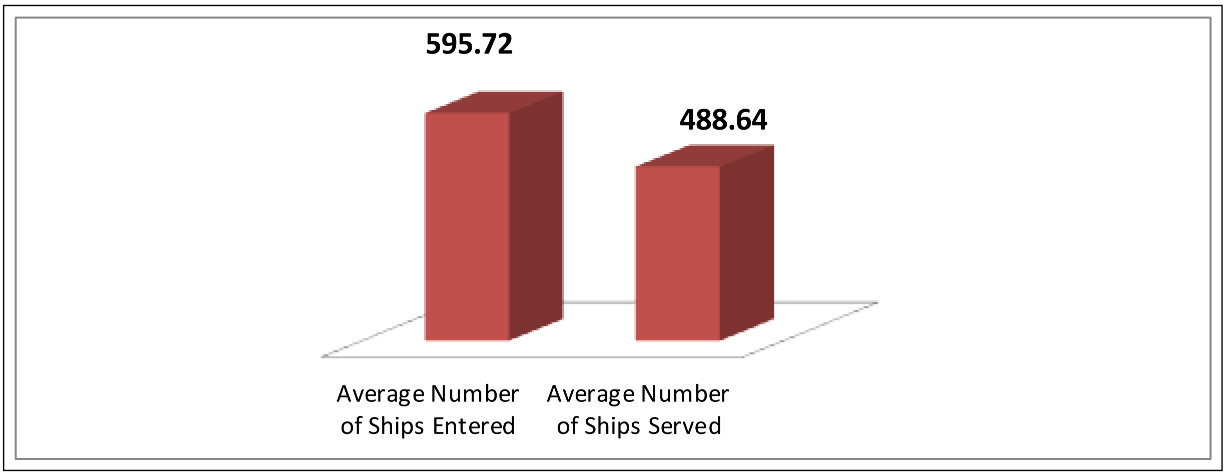


FIGURE 5.19 AVERAGE NUMBER OF SHIPS ENTERED VS AVERAGE NUMBER OF SHIPS

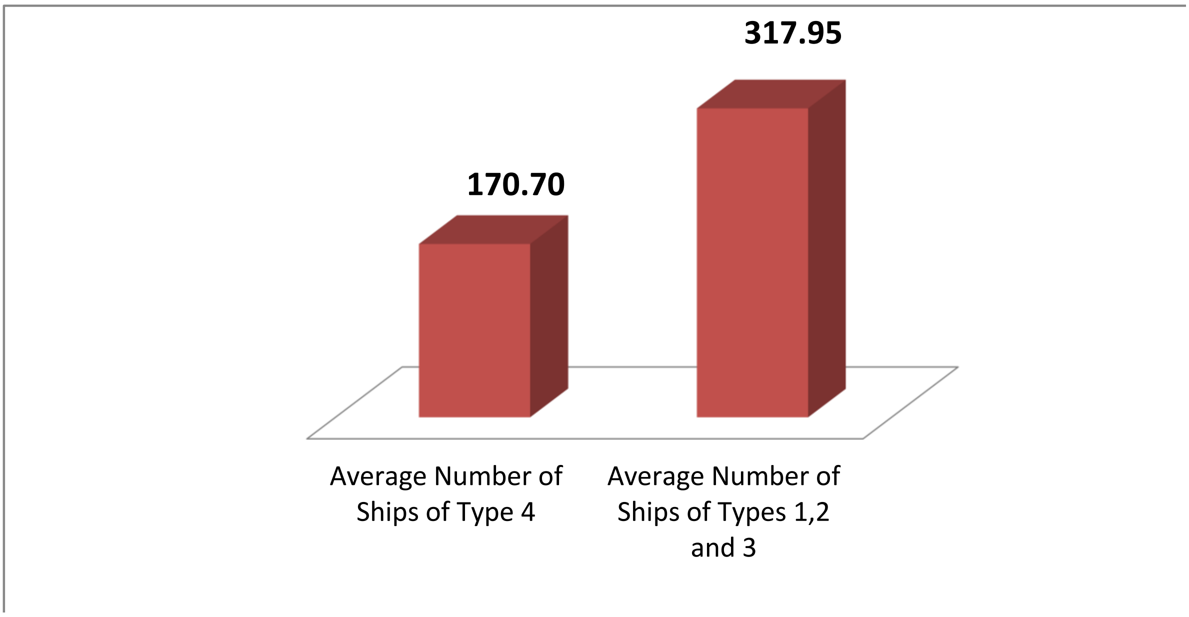


FIGURE 5.20 AVERAGE NUMBER OF SHIPS OF TYPE 4 VS AVERAGE NUMBER OF SHIPS OF TYPES 1, 2 AND 3

5.17 Improving Performance for Gaza Seaport

The conducted simulation process, showed that the performance of Gaza Seaport serve around (82%) of the incoming ships to discharge the cargoes in the first year, and to run the port in phase one. The model results are shown in table (5.7).

This study is conducted to improve the performance of Gaza Seaport. Therefore, solutions are proposed to serve larger numbers of incoming ships, reduce the average cycle time, and decrease the average time in queue, as follows:

5.17.1 CONSTRUCT A THIRD BERTH.

Constructing a new berth, will definitely increase the seaport capacity and improve its service performance. Yet, this solution is ignored at present as needs huge time and capital investment .

5.17.2 ADDING ONE CRANE IN BERTH "A"

Another proposed solution is adding a crane in berth "A" to serve the bulk ships, Which will serve two ships at the same time. This means having two cranes to serve a ship and one crane to serve the other ship at the same berth at the same time? This will improve the performance up to (90%). The model results are shown in table (5.9).

Table 5.9 Bulk Ship types Vs the probability of arrival and average number served after adding one Crane at Berth "A"

Performance Measure	Value
Average cycle time (hrs)	124..31
Average time in queue (hrs)	86.052
Average number of ships in the system	584.09
Average number of ships served	527.66
Average number of container ships	163.70
Average number of bulk ships	363.94

The probability of unloading each type of bulk ships and the average number of bulk ship types served after adding one crane at berth "A" ,are shown in table (5.10).

Table 5-10 RESULTS OF THE SIMULATED MODEL AFTER Adding one crane in berth "A"

Types of Bulk Ships	Probability of Arrival of types, of bulk ships (%)	Value
Average number of ships Wood	0.085	30.93
Average number of ships Grain	0.657	239.10
Average number of ships Cement	0.257	93.532

Figure (5.21) illustrates the average cycle time and the average time spent in queue after adding one crane. Also, a graph is plotted for the number of ships entered and the number of ships served, as illustrated in Figure (5.22). Finally, the number of ships of type four versus ships of type one, two and three is plotted in Figure (5.23).

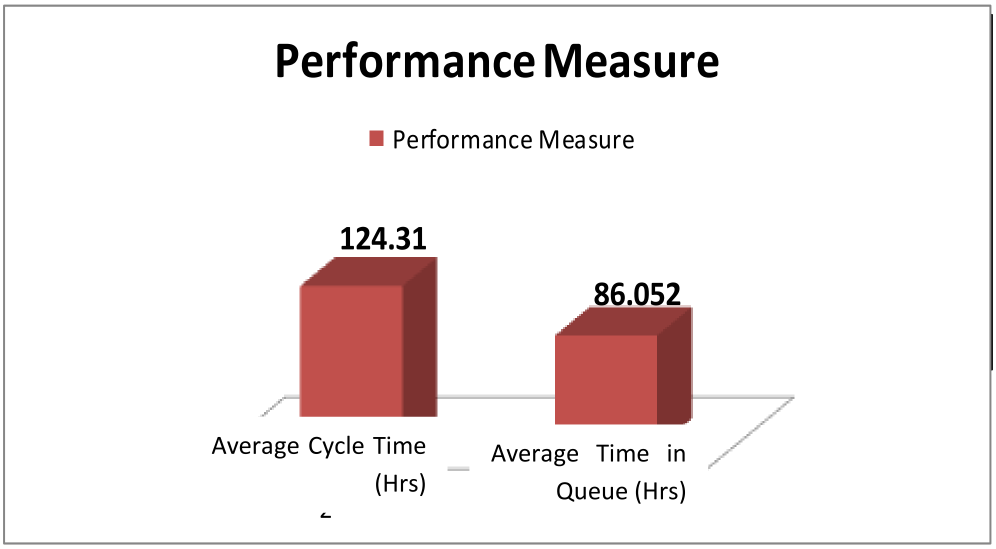


FIGURE 5.21 AVERAGE CYCLE TIME VERSUS AVERAGE TIME IN QUEUE AFTER ADDING ONE CRANE

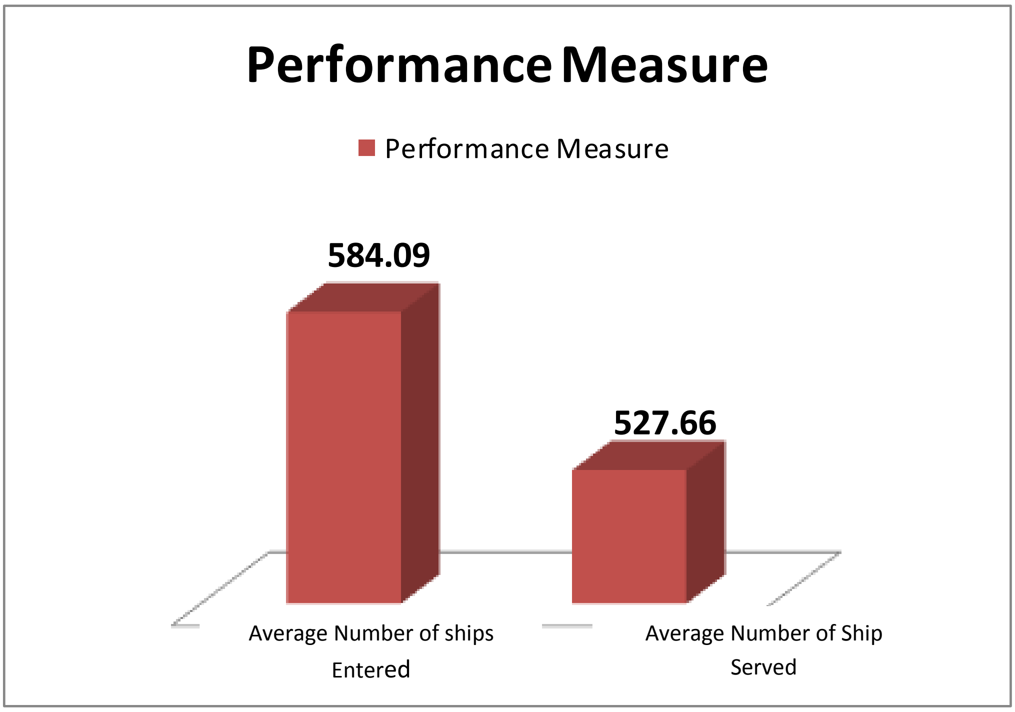


FIGURE 5. 22 AVERAGE NUMBER OF SHIPS ENTERED VS AVERAGE NUMBER OF SHIPS SERVED AFTER ADDING ONE CRANE.

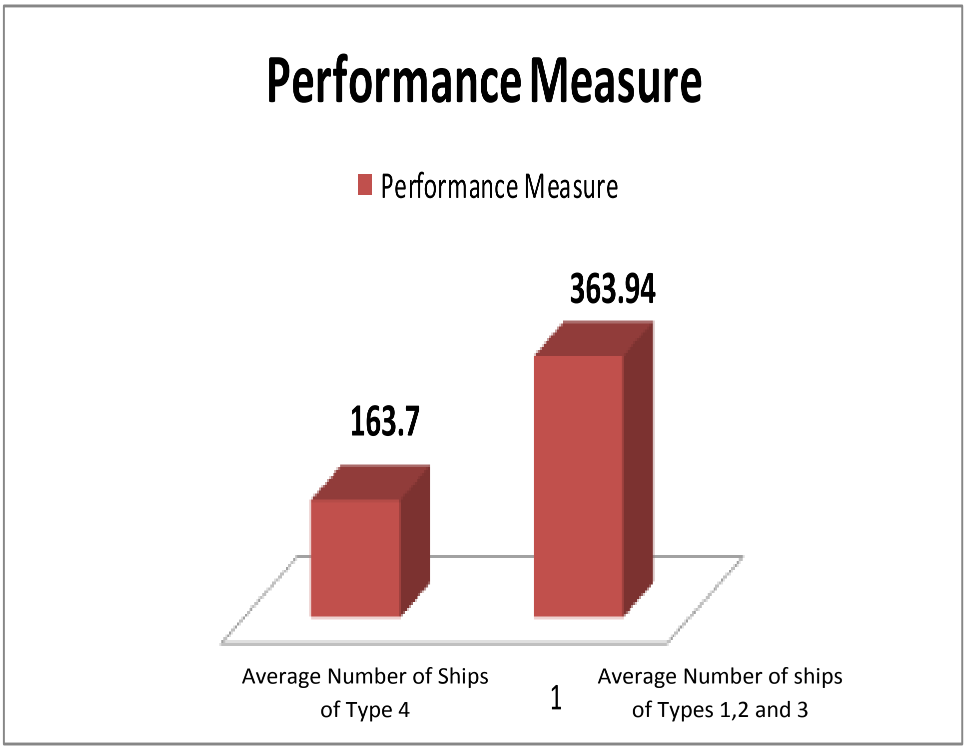


FIGURE 5.23 AVERAGE NUMBER OF SHIPS OF TYPE 4 VS AVERAGE NUMBER OF SHIPS OF TYPES 1, 2 AND3 AFTER ADDING ONE CRANE.

5.17.3 ADDING TWO CRANES IN BERTH "A"

Adding two cranes in berth "A" to serve the bulk ships, is another solution that has been evaluated .The additional cranes will serve two ships at the same time which means having four cranes, two cranes to serve a ship and two cranes to serve another, at the same berth at the same time. This will further improve the performance up to (96.8%). The model results are shown in table (5.11).

TABLE 5.11 RESULTS OF THE SIMULATED MODEL AFTER ADDING TWO CRANES AT BERTH "A"

Performance Measure	Value
Average cycle time (hrs)	57.851
Average time in queue (hrs)	28.979
Average umber of ships in the system	584.09
Averagenumber of ships served	564.01
Average number of container ships	165.11
Average number of bulk ships	398.9

The probability of unloading each ship type of bulk ships and the average number of bulk ship types served after adding two cranes at berth "A" ,are shown in table (5.12).

TABLE 5-12 BULK SHIP TYPES VS THE PROBABILITY OF ARRIVAL AND AVERAGE NUMBER SERVED AFTER ADDING TWO CRANES

Types Bulk Ships	Probability of Arrival of types of bulk ships (%)	Value
Average number of ships Wood	0.085	33.906
Average number of ships Grain	0.657	262.077
Average number of ships Cement	0.257	99.725

Figure (5.24) illustrates the average cycle time and the average time spent in queue after adding two cranes. Also, a graph is plotted for the number of ships entered and the number of ships served, as illustrated in Figure (5.25). Finally, the number of ships of type four versus ships of type one, two and three is plotted in Figure (5.26).

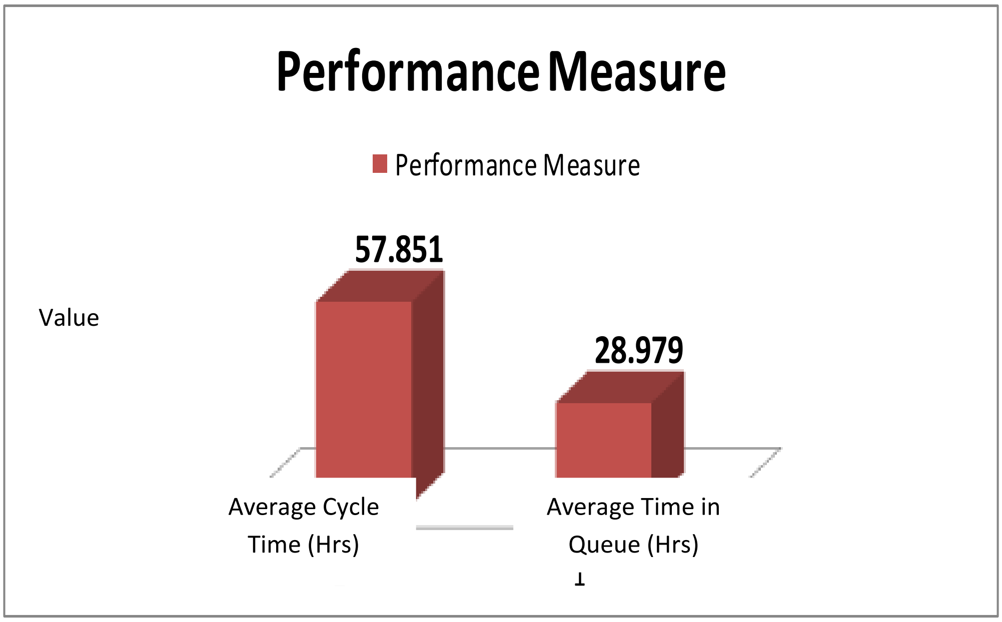


FIGURE 5.24 AVERAGE CYCLE TIME VERSUS AVERAGE TIME IN QUEUE AFTER ADDING TWO CRANES

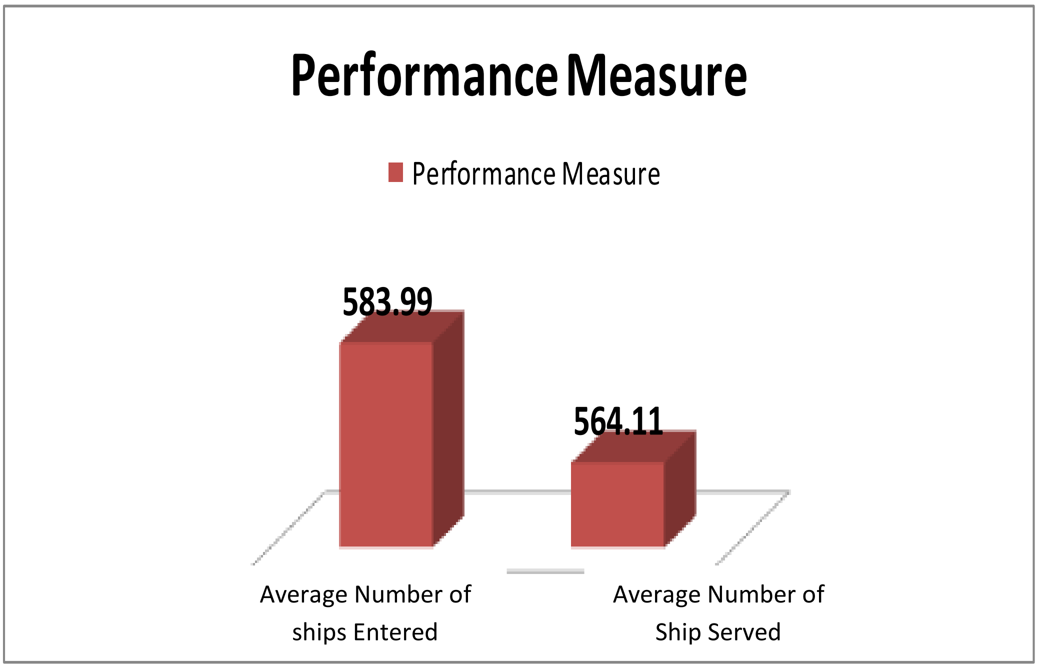


FIGURE 5.25 AVERAGE NUMBER OF SHIPS ENTERED VS AVERAGE NMBER OF SHIPS SERVED AFTER

ADDING TWO CRANES AT BERTH “A"

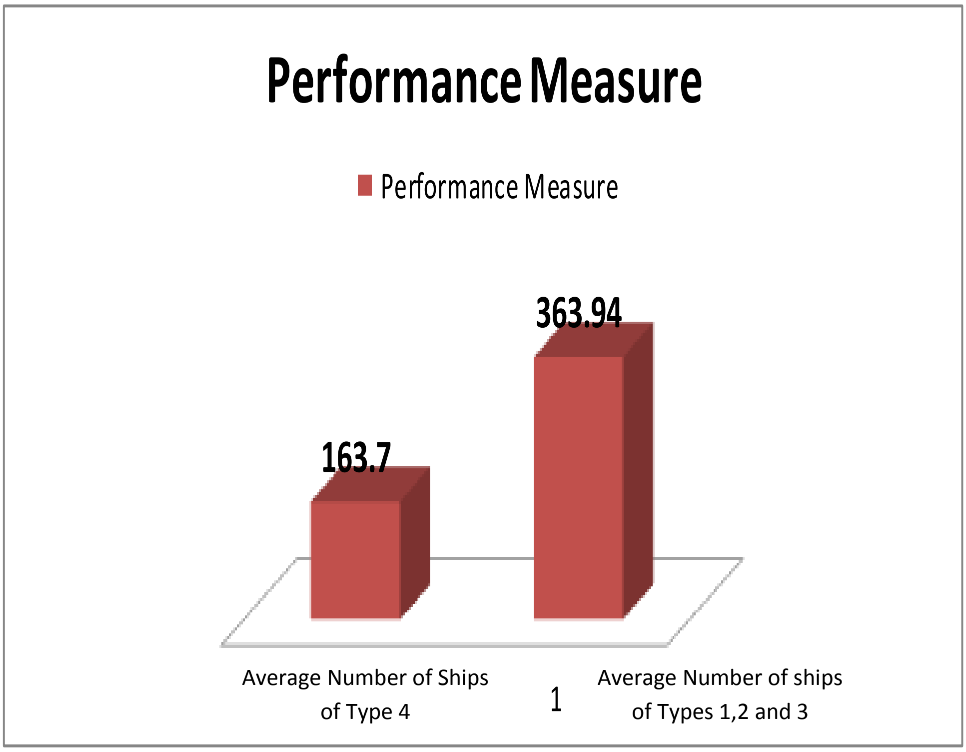


FIGURE 5.26 AVERAGE NUMBER OF SHIPS OF TYPE 4 VS AVERAGE NUMBER OF SHIPS OF TYPES 1, 2 AND 3 AFTER INCREASE TWO CRANES AT BERTH “A”

5.17.4 ADDING ONE CRANE IN BERTH "B"

An additional crane is added in berth "B" to serve the Container ships . A ship in this berth will be served by two crane that will improve the performance up to (%84.2). The model results are shown in table (5.13).

TABLE 5-13 RESULTS OF THE SIMULATED MODEL AFTER ADDING TWO CRANES AT BERTH "B"

Performance Measure	Value
Average cycle time (hrs)	226.82
Average time in queue (hrs)	186.08
Average number of ships in system	583.81
Average number of ships served	491.68
Average number of container ships	202.47
Average number of bulk ships	289.39

Figure (5.27) illustrates the average cycle time and the average time spent in queue after (5.27) illustrates the average cycle time and the average time spent in queue after adding one crane. Also, a graph is plotted for the number of ships entered and the number of ships served, as illustrated in Figure (5.28). Finally, the number of ships of type four versus ships of type one, two and three is plotted in Figure (5.29).

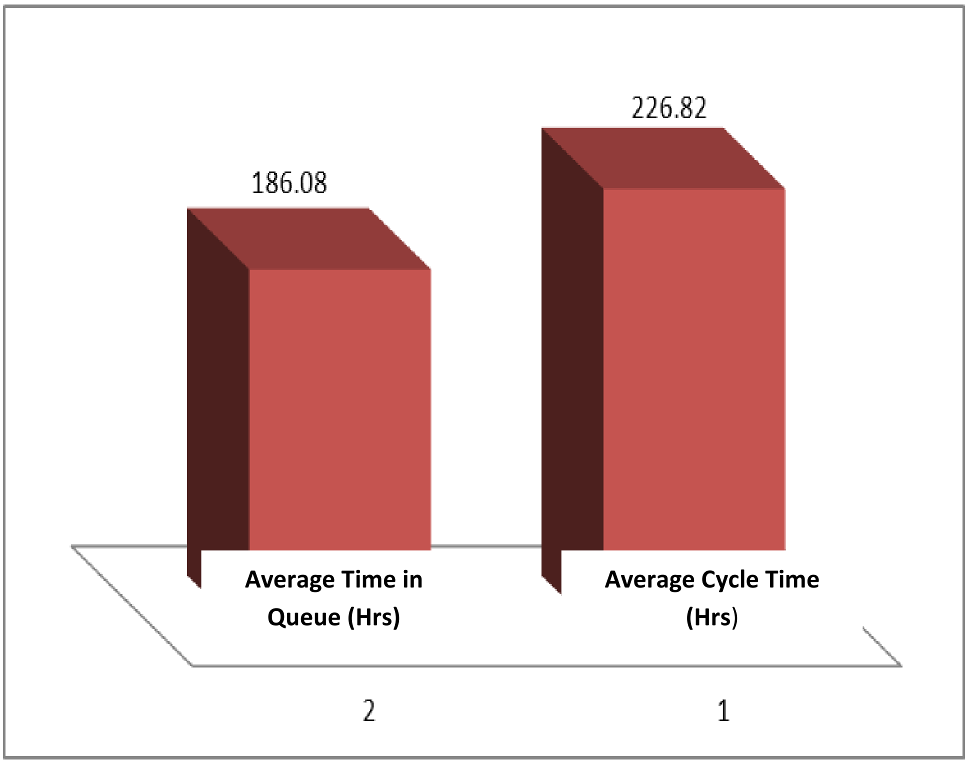


FIGURE 5.27 AVERAGE CYCLE TIME VERSUS AVERAGE TIME IN QUEUE AFTER ADDING ONE CRANE AT BERTH "B"

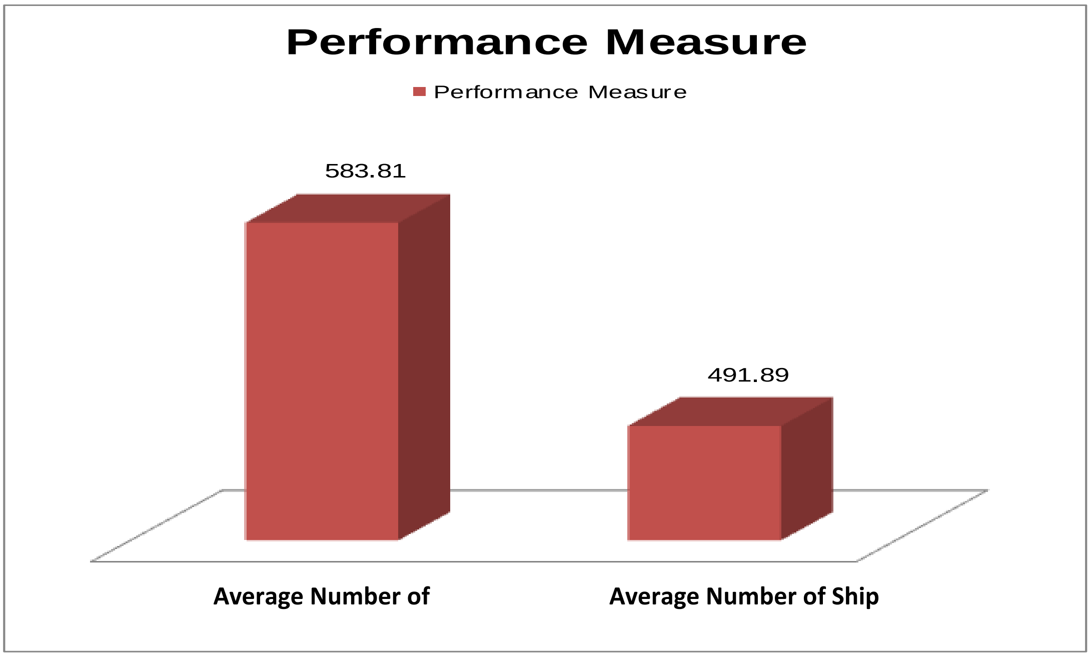


FIGURE 5.28 AVERAGE NUMBER OF SHIPS ENTERED VS AVERAGE NUMBER OF SHIPS SERVED AFTER ADDING ONE CRANE AT BERTH "B"

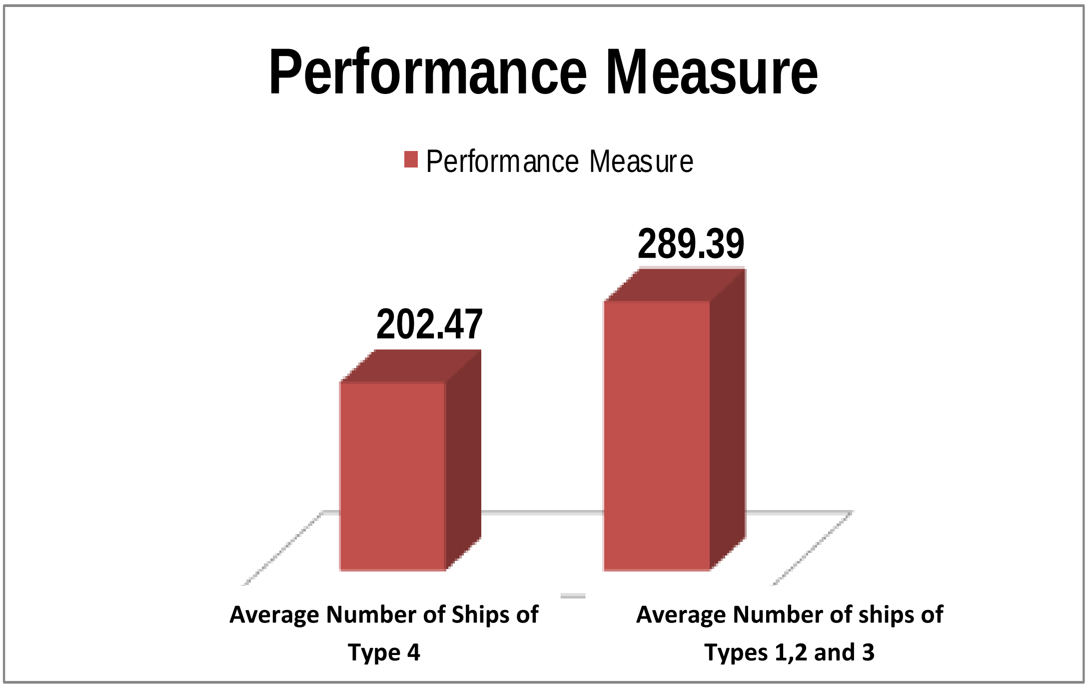


FIGURE 5.29 AVERAGE NUMBER OF SHIPS OF TYPE 4 VS AVERAGE NUMBER OF SHIPS OF TYPES 1, 2 AND 3 AFTER ADDING ONE CRANE AT BERTH "B"

5.18 DISCUSSION OF THE RESULTS

From the obtained results, it can be observed that the ships inter-arrival time is relatively , long when compared to the average cycle time. Resulting in queue format Despite of the long time spent in queue, the average number of ships served is high. Finally the number of ships served of type four is higher than that served from type one, two and three. That will improve the performance. The model results are shown in figure (5.30).

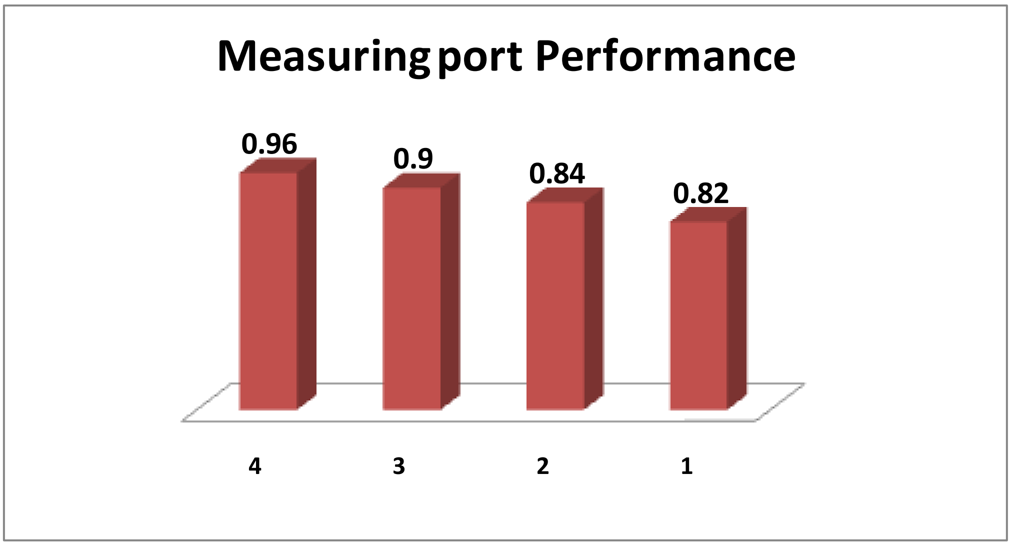


FIGURE 5.30 THE INCREASE OF PORT PERFORMANCE

CHAPTER (6)
CONCLUSIONS AND RECOMMENDATIONS

This chapter consists of the following sections:

6.1. Introduction
6.2. Conclusions
6.3. Recommendations
6.4. Future research directions

CHAPTER(6)

CONCLUSIONS AND RECOMMENDATIONS

2.14 INTRODUCTION

The main objective of this research aims to help decision makers to manage berths facility services at the highest performance that may reduce total service time of the ships entered the planned Gaza seaport. This chapter will consolidate the main results of the previous chapters in the light of research problem and objectives. Research recommendations will be directed towards using Arena simulation model to manage berths facility services of the planned Gaza Seaport effectively and efficiently.

2.15 CONCLUSIONS

Simulation is considered an actually copy model of the real system on which experiments or scenarios can be run to evaluate various strategies. It is a representation of a system or process, a representation incorporates time and the changes that occur over time.

This research concentrates on discrete event simulation method which is widely adopted method to model system operations in a discrete time manner ; so the model can be modified more easily and flexibly without affecting the simulator much.

The first phase of building Gaza Seaport will cost around 70 million $, that's why, this research prepared to be ready from technician side to establish and operate the planned seaport at the best efficiency with high performance at any moment where political constants are removed. After completion of the phase II and III the number of berths will be increased , types of berths will be multi-purposes , number of ships will increase at the capacity in berths will be more , many types of ships according to their drought will get into the port as the depth will be increased , number of pump charges and it's type will affect the facilities of the seaport. Nevertheless, the research focused the efforts on the number of cranes which will deeply effect on the Berthing facilities of Gaza seaport .

To recapitulate , the test results show that the simulation model is very well as the system is capable of producing good management decisions. Through the research, it gained an important insight into berths facility services for the planned Gaza Seaport management problem.

As the first objective of building a simulation model for helping decision makers to establish an improved system for the planned Gaza Seaport considering the number of berths for each type of ships and the number of cranes used in port operation. This model will be a flexible interactive visualized tool which enables Palestinian National Port authority decision makers to deal with the problems efficiently by developing berths facilities services to reduce cost and efforts needed and effectively to get high performance.

The second objective is to decide if the cranes of the vessels are sufficient to serve efficiently the coming vessels. In order to enhance loading and unloading operation, to be completed without tardiness and with the least cycle time and this established through the comparison between different scenarios and choosing the best suitable scenario as shown:

As a detailed research of the proposed plan is presented and discussed, a simulation model for Gaza Seaport is developed by using the software "Arena" the efficiency of the port was analyzed and found to be 82% according to the original proposed plan and facilities.

Also by increasing the proposed number of cranes fitted on the container berth "Berth B" by one crane, the efficiency of the port is improved and reaches 84.2%.

By increasing the proposed number of cranes fitted on the bulk berth "Berth A" by one crane, the efficiency of the port is improved and reaches 90% more over.

While by increasing the proposed number of cranes fitted on the bulk berth "Berth A" by two crane, the efficiency of the port is improved and reaches 96.8% more over. Hence, it is best to add two crane on cargo berth "Berth A" to get higher performance.

The third objective is to provide a decision support system based on simulation to be a useful tool in development of berths facility Services of the planned Gaza Seaport and this is represented clearly through the combined simulation module to deeply express and represent the real system as required.

The fourth objective which is evaluate the performance of using the simulation model by Palestinian National Port Authority decision makers and this is achieved through providing many alternatives and scenarios for the selection of the best fit scenario to finish the loading and unloading based on the minimizing of waiting times and reducing response and service times. Finally the fifth objectives which is provide recommendations that will contribute to sorting out issues to the operations managers of planned Gaza Seaport in designing freight systems and this done by enabling decision makers to manage berths facilities services, by enhancing their knowledge of the optimal solution to reduce time, cost and efforts as much as possible with high performance.

In summary , the work in this research can be used as a significant contribution to the simulation modeling in general, and for the optimization of planned of Gaza Seaport in the first phase of its establishment in particular.

2.16 RECOMMENDATIONS

The port problems arise from the traditional system, which encourages us to establish a computer system to run the port, a communication system to facilitate the port operation, asset the logistics center in the port & to establish a third generation port . On the other hand, quantitative and computerized models are more precise and reliable . So this shed the light on the importance of using the simulation model to develop berths facility services for the planned Gaza Seaport as follows:

1. It is recommended to increase the number of cranes on bulk berth by two crane to increase the efficiency of Gaza Seaport.
2. The proposed model must be updated according to different phases of the planned Gaza Seaport development.
3. There must be a well training program for the employees .
4. The developments of other port in the region affect the planned Gaza Seaport and must be considered for further development in the port.
5. There should be integrated information system for the planned Gaza Seaport able to cooperate with other ports.
6. Using this simulation model by decision makers in Palestinian port authorities and local government institutions to manage the planned Gaza Seaport at high performance.

2.17 FOR FUTURE RESEARCH

Further research could modify this model and go deep into building an integrated simulation-based on DSS and improving the model in order to deal with phase II and phase III.

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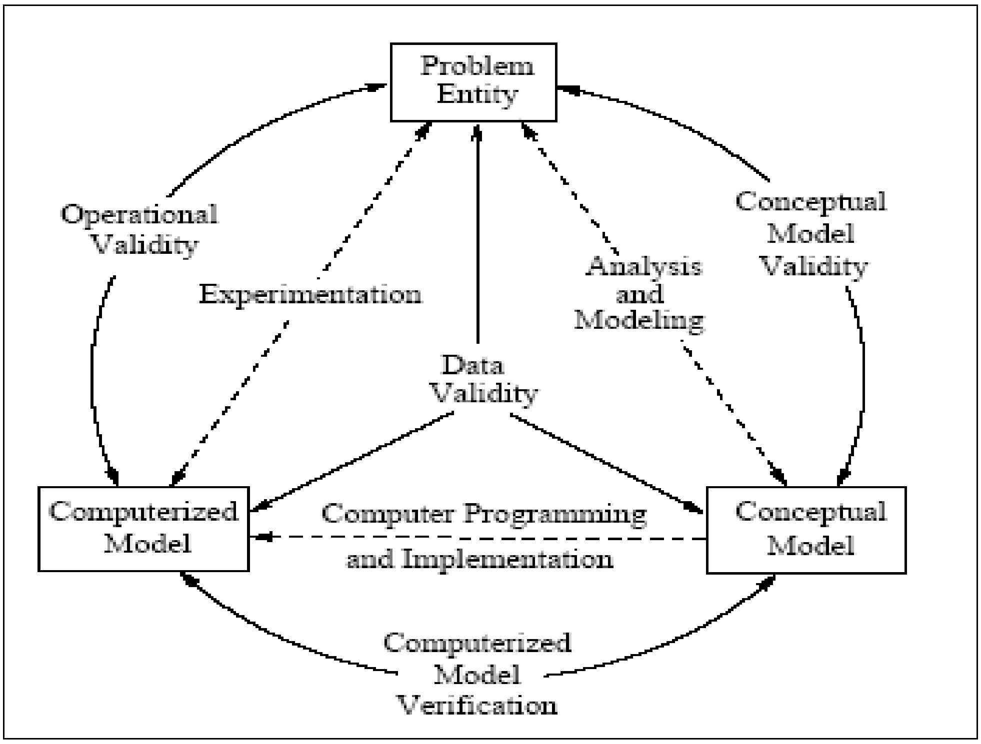
APPENDIX (A)

1 -Validation Process

Considering the modeling process, as shown in figure below. there are some terms to be defined (Sargent, 1999).



VALIDATION PROCESS

Problem entity is the system (real or proposed), idea, situation, policy, or phenomena to be modeled.

Conceptual model is the mathematical/logical/ verbal representation (mimic) of the problem entity developed for a particular study;

Computerized model is the conceptual model implemented on a computer.

Conceptual model is developed through an analysis and modeling phase, the computerized model is developed through a computer programming and implementation phase, and inferences about the problem entity are obtained by conducting computer experiments on the computerized model in the experimentation phase.

Conceptual model validity is defined as determining that the theories and assumptions underlying the conceptual model are correct and that the model representation of the problem entity is "reasonable" for the intended purpose of the model.

Computerized model verification is defined as ensuring that the computer programming and implementation of the conceptual model is correct.

Operational validity is defined as determining that the model's output behavior has sufficient accuracy for the model's intended purpose over the domain of the model's intended applicability.

Data validity is defined as ensuring that the data necessary for model building, model evaluation and testing, and conducting the model experiments to solve the problem are adequate and correct.

2- VALIDATION TECHNIQUES:

Animation: The model's operational behavior is displayed graphically as the model moves through time. For example, the movements of parts through a factory during a simulation are shown graphically. [Robert Sargent].

Comparison to other models: Various results (e.g., outputs) of the simulation model being validated are compared to results of other valid models.

Degenerate tests: The degeneracy of the model's behavior is tested by appropriate selection of values of the input and internal parameters. For example, does the average number in the queue of a single server continue to increase with respect to time when the arrival rate is larger than the service rate?

Event validity: The "events" of occurrences of the simulation model are compared to those of the real system to determine if they are similar.

Extreme condition tests: The model structure and output should be plausible for any extreme and unlikely combination of levels of factors in the system; e.g., if in-process inventories are zero, production output should be zero.

Face validity: "Face validity" is asking people knowledgeable about the system whether the model and/or its behavior are reasonable. This technique can be used in determining if the logic in the conceptual model is correct and if a model's input-output relationships are reasonable.

Fixed values: Fixed values (e.g., constants) are used for various model input and internal variables and parameters. This should allow the checking of model results against easily calculated values.

Historical data validation: If historical data exist (or if data are collected on a system for building or testing the model), part of the data is used to build the model and the remaining data are used to determine (test) whether the model behaves as the system does. (This testing is conducted by driving the simulation model with either sample from distributions or traces.

Historical methods: The three historical methods of validation are rationalism, empiricism, and positive economics. Rationalism assumes that everyone knows whether the underlying assumptions of a model are true. Logic deductions are used from these assumptions to develop the correct (valid) model. Empiricism requires every assumption and outcome to be empirically validated. Positive economics requires only that the model be able to predict the future and is not concerned with a model's assumptions or structure (causal relationships or mechanism).

Internal validity: Several replications (runs) of a stochastic model are made to determine the amount of (internal) stochastic variability in the model. A high amount of variability (lack of consistency) may cause the model's results to be questionable and, if typical of the problem entity, may question the appropriateness of the policy or system being investigated.

Operational graphics: Values of various performance measures, e.g., number in queue and percentage of servers busy, are shown graphically as the model moves through time; i.e., the dynamic behaviors of performance indicators are visually displayed as the simulation model moves through time.

Parameter variability–sensitivity analysis: This technique consists of changing the values of the input and internal parameters of a model to determine the effect upon the model's behavior and its output. The same relationships should occur in the model as in the real system. Those parameters that are sensitive, i.e., cause significant changes in the model's behavior or output, should be made sufficiently accurate prior to using the model. (This may require iterations in model development.)

Predictive validation: The model is used to predict (forecast) the system behavior, and then comparisons are made between the system's behavior and the model's forecast to determine if they are the same. The system data may come from an operational system or from experiments performed on the system. e.g., field tests.

Traces: The behavior of different types of specific entities in the model is traced (followed) through the model to determine if the model's logic is correct and if the necessary accuracy is obtained.

Turing tests: People who are knowledgeable about the operations of a system are asked if they can discriminate between system and model outputs.

a- Data Validity:

Data are needed for three purposes: for building the conceptual model, for validating the model, and for performing experiments with the validated model. In model validation only the first two types of data are of interest. To build a conceptual model sufficient data on the problem entity is required to develop theories that can be used to build the model, to develop the mathematical and logical relationships in the model that will allow it to adequately represent the problem identity for its intended purpose, and to test the model's underlying assumptions.

b- Documentation:

Documentation on model verification and validation is usually critical in convincing users of the "correctness" of a model and its results, and should be included in the simulation model documentation. Both detailed and summary documentation are desired. The detailed documentation should include specifics on the tests, evaluations made, data, results, etc. The summary documentation should contain a separate evaluation table for data validity, conceptual model validity, computer model verification, operational validity, and an overall summary.

c- Recommended Procedure:

a) Have an agreement made prior to developing the model between the model development team and the model sponsors and (if possible) the users, specifying the basic validation approach and a minimum set of specific validation techniques to be used in the validation process.

b) Specify the amount of accuracy required of the model's output variables of interest for the model's intended application prior to starting the development of the model or very early in the model development process.

c) Test, wherever possible, the assumptions and theories underlying the model.

d) In each model iteration, at least face validity is performed on the conceptual model.

e) In each model iteration, at least the model's behavior using the computerized model is explored.

f) In at least the last model iteration, make comparisons, if possible, between the model and system behavior (output) data for several sets of experimental conditions.

g) Develop validation documentation for inclusion in the simulation model documentation.

h) If the model is to be used over a period of time, develop a schedule for periodic review of the model's validity.

i) Models occasionally are developed to be used more than once. A procedure for reviewing the validity of these models over their life cycles needs to be developed.

3-ANALYSIS OF SEAPORT SIMULATION MODEL

The Gaza Seaport Simulation model is defined by the logic presented in figure (1). This simulation model permits analyzing a multipurpose port. The model element or data requirement are listed in table (1). Table (1) describes the ship definition and berth demand input routine used by the model.

There are two assignment program flowcharts, one where the assignment of ships is done on a one-by-one basis according to an order of priorities, and the other is related to the method discussed in the previous paragraphs, where several ships are assigned at the same time .

The Seaport is simulated as a multi -channel, multi-server system which is described by user specification of the following:

1. Number of berths and description of every berth (length, depth, equipment)
2. Berth eligibility and preferences for every type of ship
3. Ship berthing priorities
4. Unit costs for ships, berths, port equipment
5. Number of ship types, and description of every ship type (length, draft, number of hatches, number and pattern of arrivals, as well as pattern of total time at berth)

The results of the Seaport Simulation model are grouped as:

1. Summary of time-related operations (writing time, occupancy rations, total time in the port).
2. Summary of cost-related measurers, showing the cost measures of the Results in (1).
3. Miscellaneous operational results (probability of delays, maximum length of queue, etc.)

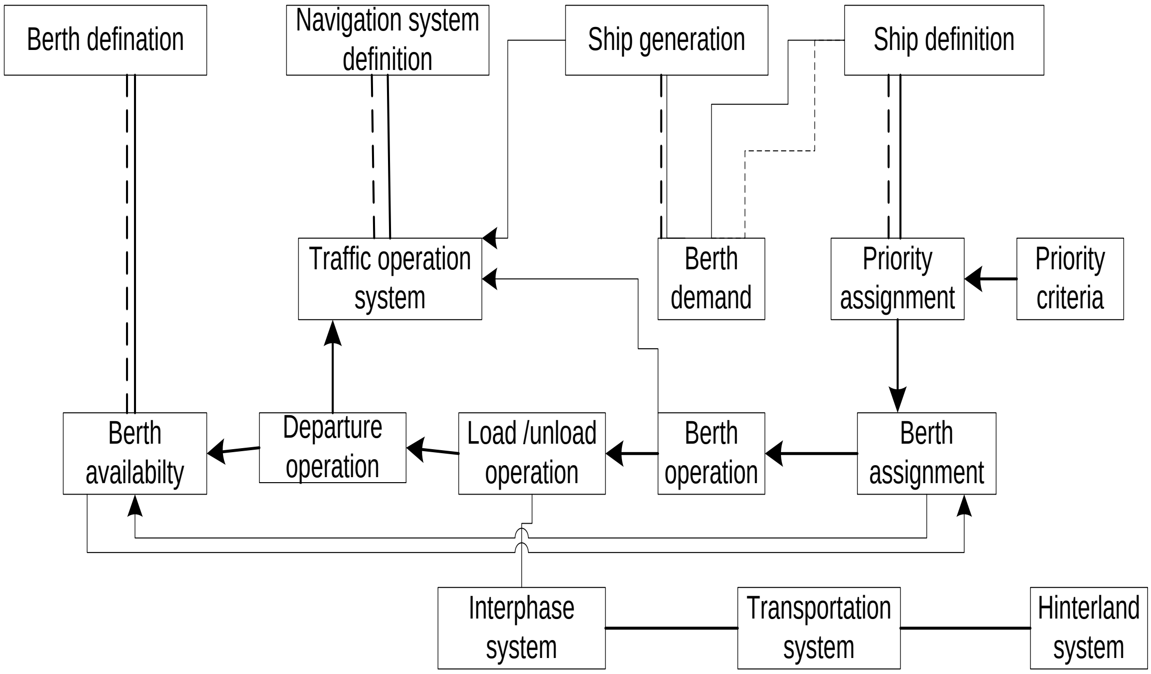


FIGURE (1) DEVELOPMENT OF SEAPORT SIMULATION MODEL LOGIC

- **Berth definition**

  - Length, depth, specialization, ownership, characteristics of equipment, transportation facilities, service facilities, storage, and handing capacity.

- **Navigation system definition**

  - Number of pilots, number of tugs, waterways capacity and depth, and tidal system.

- **ship generation**

  - Number of arrivals, distribution of arrivals p/t, and integrated arrival distribution

- **Ship definition**

- Type of ship, length, draught, quality of ship, operator, number of holds, number of hooks, Cargo import/ export, cargo type related to berth ownership, cargo type related with Transpiration mean, type

TABLE (1) SEAPORT SIMULATION MODEL ELEMENTS

Characterization	GRT	NRT	DWT	Length	Draft
I. <u>Ship Characterization</u>					
▪ **Type of ship**					
1. liner ship (BSC or Container)					
2. Tramp ship (general ship)					
3. Bulk ship					
4. Tanker					
5. Passenger					
6. Other					
▪ **Other characteristics**					
1. Length					
2. Holds (no.)					
3. Draft					
4. Hatches (no.)					
5. Operator					
6. Cranes (no.)					
II. <u>Berth Characterization</u>					
▪ Types of Berth					
1. Break of berth					
2. Containerized					
3. Dry bulk cargo					
4. Liquid bulk					
5. Passengers					
6. Others					

TABLE (2) SEAPORT SIMULATION MODEL ELEMENTS"COMITUNED"

Characterization	Type of Conts	No. off Decks	Capacity	Allowable Floor Load	Load (sq/ft)
I. Berth Characterization					
▪ **Facilities**					
1. Storage area					
2. Transit shed					
3. Warehouses					
4. Refrigerated warehouse					
5. Silos					
6. Tanks					
▪ **Physical characteristics**					
1. Operator					
2. Draft					
3. Depth					
4. Layout					
5. Width of apron					
6. Load capacity					
7. Height of deck					
II. Cargo characteristics					
▪ **Types of cargo**					
1. Break bulk cargo					
2. Container					
3. bulk cargo					

4. Refrigerated cargo

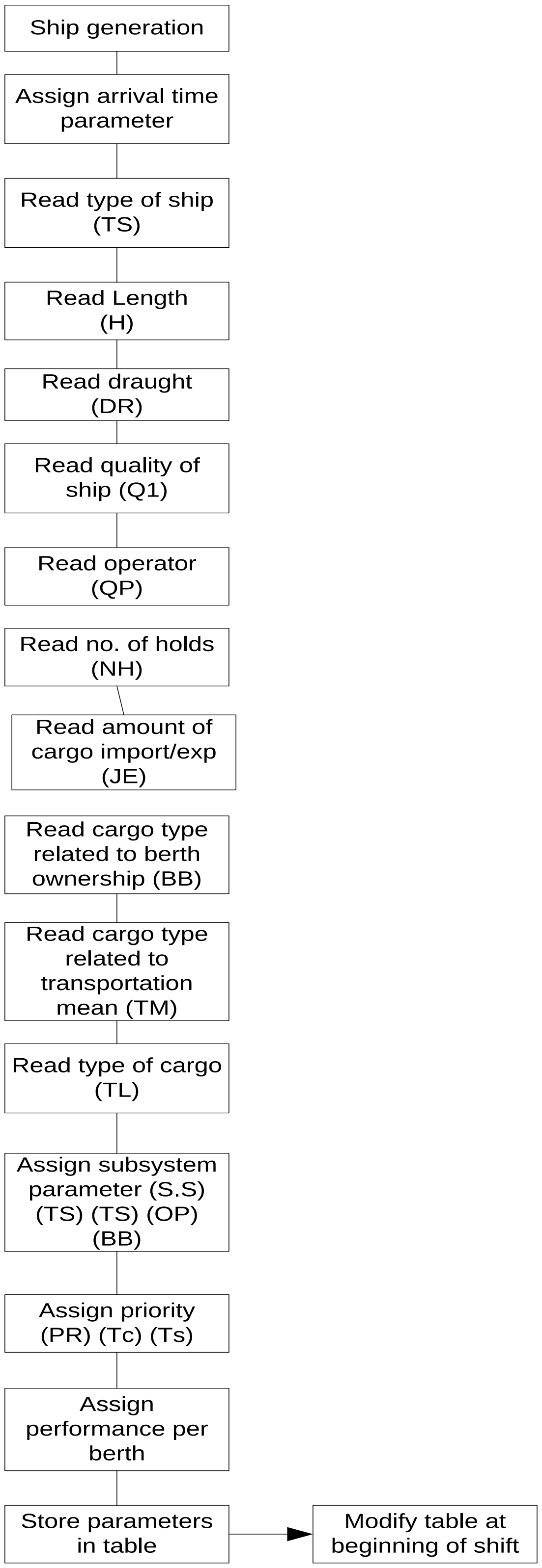
- **Cargo destination or transpiration requirements**

  1. Trucks
  2. Railcar
  3. Barges
  4. Storage

- **Physical characteristics**

  1. Owner ship
  2. Size of unit
  3. Unit weight
  4. Stowage factor

TABLE (3) SHIP DEFINITION AND BERTH DEMAND TABLE



Ship NO.	Arrival Time	TS	LH	DR	QL	NH	JE	BO	TM	TC	SS	PR
1												
2												
3												
4												
5												
6												
7												
8												

APPENDIX (B)

Table(1) Capacity of sub phase 1B

		Estimated traffic for year 4	Capacity (% of estimated traffic for year 4)	Capacity of subphase 1B
Break bulk	**RO-RO**	50	100	50
	LO-LO	150	100	150
Container	**RO-RO**	41	100	41
	LO-LO	368	100	368
Grain bulk	**LO-LO**	448	100	496
Liquid bulk		500	0.0	0.0
Total		**1557**	**68**	**1057**

The capacity of subphase 1B is:

- break bulk:200.000 tons (100% of the estimated of break bulk in Year 1)
- containers: 409.000 tons (100% of the estimated traffic of container in Year 1)
- grain bulk :448.000 tons 100% of the estimated traffic of grain bulk in Year 1)
- liquid bulk:.0.0 ton (0 of the estimated traffic of oil in year 1)
- Total: 1057.000 tons (68% of the estimated traffic for year 1)

Table(2) Capacity of subphase 1D

		Estimated traffic for year 6	Capacity (% of estimated traffic for year 6)	Capacity of subphase 1D
Break bulk	**RO-RO**	60	100	60
	LO-LO	179	100	179
Container	**RO-RO**	60	100	60
	LO-LO	541	100	541
Grain bulk	**LO-LO**	554	100	554
Liquid bulk		500	0.0	0.0
Total		**1894**	**73**	**1394**

The capacity of subphase 1D is:

- break bulk:239.000 tons (100% of the estimated of break bulk in Year 6)
- containers: 601.000 tons (100% of the estimated traffic of container in Year 6)
- grain bulk :554.000 tons 100% of the estimated traffic of grain bulk in Year 6)
- liquid bulk:.0.0 ton (0 of the estimated traffic of oil in year 6)
- Total: 1.393.000 tons (73% of the estimated traffic for year 6)

Table (3) Capacity of subphase 1F

		Estimated traffic for year 6	Capacity (% of estimated traffic for year 6)	Capacity of subphase 1F
Break bulk	**RO-RO**	60	100	60
	LO-LO	179	100	179
Container	**RO-RO**	60	100	60
	LO-LO	541	100	541
Grain bulk	**LO-LO**	554	100	554
Liquid bulk		500	100.0	500
Total		**1893**	**100**	**1893**

The capacity of subphase 1F is:

- break bulk:239.000 tons (100% of the estimated of break bulk in Year 6)
- containers: 601.000 tons (100% of the estimated traffic of container in Year 6)
- grain bulk :554.000 tons 100% of the estimated traffic of grain bulk in Year 6)
- liquid bulk:.500.00 ton (100% of the estimated traffic of oil in year 6)
- <u>Total:</u> 1893.000 tons (100% of the estimated traffic for year 6)

Table (4) Berth occupancy in days

Years		Y1	Y2	Y3	Y4	Y5	Y6
Break bulk	**RO-RO**	14	15	18	20	22	24
	LO-LO	147	164	190	214	230	256
Container	**RO-RO**	3	4	5	6	7	9
	LO-LO	95	111	144	184	216	270
Grain bulk							
1 st hypothesis LO-LO		105	114	119	179	199	221
2 nd hypothesis: Grain	**terminal**	44	48	50	75	83	921
Liquid bulk		5	8	15	25	25	25

Table (5) Berth occupancy rates

Sub Phase	Type of berth	Number of berths	Allowable berth occupancy	Years					
				Y1	Y2	Y3	Y4	Y5	Y6
1A	**RO-RO**	2	50%	2%	3%	3%	4%	4%	5%
	LO-LO	1	30%	**102%**	**114%**	**133%**	**170%**	**190%**	**220%**
	Grain terminal	0	-	0%	0%	0%	0%	0%	0%
	Oil terminal	0	-	0%	0%	0%	0%	0%	0%
1B	**RO-RO**	2	50%	2%	3%	3%	4%	4%	5%
	LO-LO	3	55%	102%	38%	44%	**57%**	**63%**	**73%**
	Grain	0	-	0%	0%	0%	0%	0%	0%

	terminal								
	Oil terminal	0	-	0%	0	0%	0%	0%	0%
1D	**RO-RO**	2	50%	3%	3%	3%	4%	4%	5%
	LO-LO	2	55%	34%	27%	33%	39%	44%	52%
	Grain terminal	1	30%	0%	14%	15%	22%	24%	27%
	Oil terminal	0	-	0%	0%	0%	0%	0%	0%
1F	**RO-RO**	2	50%	2%	3%	3%	4%	4%	5%
	LO-LO	3	55%	24%	27%	33%	39%	44%	52%
	Grain terminal	1	30%	13%	14%	15%	22%	24%	27%
	Oil terminal	1	30%	0%	2%	4%	7%	7%	7%

APPENDIX "C"
Arena Simulation Results

GTC - License: 0000000000

Output Summary for 100 Replications

Project: ship port simulation Run execution date : 26/ 6/2014

Analyst: Dreams Model revision date: 26/ 6/2014

OUTPUTS

Identifier	Average	Half-width	Minimum	Maximum	# Replications
NC(# ships entered)	595.72	5.0532	545.00	664.00	100
TAVG(cycle time)	243.64	7.5140	150.36	347.72	100
TAVG(Queue 1 Queue Time)	196.70	7.0513	106.74	293.35	100
NC(# of container ships	170.70	3.9757	116.00	217.00	100
NC(# of berth ships)	317.95	3.7663	264.00	371.00	100
NC(# of ships served)	**488.64**	6.4045	401.00	555.00	100

Simulation run time: 0.15 minutes.

Simulation run complete.

Increase on crane in berth "A"

ARENA Simulation Results

GTC - License: 0000000000

Output Summary for 100 Replications

Project: ship port simulation   Run execution date : 26/ 6/2014

Analyst: Dreams   Model revision date: 26/6/2014

OUTPUTS

Identifier	Average	Half-width	Minimum	Maximum	# Replications
NC(# OF BERTH SHIPS)	363.94	3.7794	328.00	416.00	100
NC(# OF CONTAINER SHIP	163.70	3.0244	159.00	236.00	100
TAVG(QUEUE 1 QUEUE TIM	86.052	3.7660	25.546	120.14	100
NC(# SHIPS ENTERED)	584.09	5.1824	516.00	642.00	100
TAVG(CYCLE TIME)	124..31	4.1397	67.337	174.62	100
NC(# OF SHIPS SERVED)	**527.66**	5.1468	506.00	631.00	100

Simulation run time: 0.02 minutes.

Simulation run complete.

Increase Two cranes in berth "A"

ARENA Simulation Results

GTC - License: 0000000000

Output Summary for 100 Replications

Project: ship port simulation Run execution date : 26/ 6/2014

Analyst: Dreams Model revision date: 26/ 6/2014

OUTPUTS

Identifier	Average	Half-width	Minimum	Maximum	# Replications
NC(# OF BERTH SHIPS)	398.90	4.6358	318.00	451.00	100
NC(# OF CONTAINER SHIP	165.11	2.6618	178.00	241.00	100
TAVG(QUEUE 1 QUEUE TIM	28.979	2.0253	12.269	64.944	100
NC(# SHIPS ENTERED)	584.09	5.5922	535.00	670.00	100
TAVG(CYCLE TIME)	57.851	2.3866	58.299	120.84	100
NC(# OF SHIPS SERVED)	**564.01**	5.4898	530.00	657.00	100

Simulation run time: 0.03 minutes.

Simulation run complete.

Increase one crane in berth "B"

ARENA Simulation Results

GTC - License: 0000000000

Output Summary for 100 Replications

Project: ship port simulation   Run execution date : 26/ 6/2014

Analyst: Dreams   Model revision date: 26/ 6/2014

OUTPUTS

Identifier	Average	Half-width	Minimum	Maximum	# Replications
NC(# OF BERTH SHIPS)	289.39	4.6358	318.00	451.00	100
NC(# OF CONTAINER SHIP	202.47	2.6618	178.00	241.00	100
TAVG(QUEUE 1 QUEUE TIM	186.08	2.0253	12.269	64.944	100
NC(# SHIPS ENTERED)	583.81	5.5922	535.00	670.00	100
TAVG(CYCLE TIME)	226.82	2.3866	58.299	120.84	100
NC(# OF SHIPS SERVED)	**491.68**	5.4898	530.00	657.00	100

Simulation run time: 0.03 minutes.

Simulation run complete.