Developing a Decision Support System for Seaport Management (Case Study: Iraqi Seaports)

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Master Degree in
Computer Information Systems

By

Ammar Abdul Wahhab Abdul Hakeem

Supervisor

Dr. Hazim A. Farhan

Faculty of Information Technology
Department of Computer Information System
Middle East University

April, 2012

Middle East University

Examination Committee Decision

This is to certify that the thesis entitled " Developing a Decision Support System for Seaport Management (Case Study: Iraqi Seaports) " was successfully defended and approved on 2012.
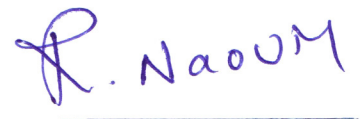
Examination Committee Members	Signature

Chairman of the Committee discussion

Prof. Reyadh S. Naoum

Dean of Faculty of information Technology

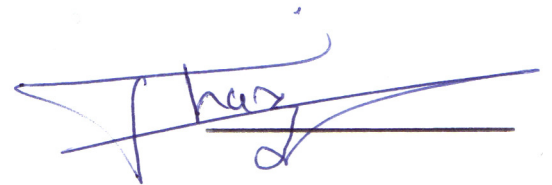Middle East University

Supervisor

Dr. Hazim A. Farhan

Faculty of Information Technology

Department of Computer Science
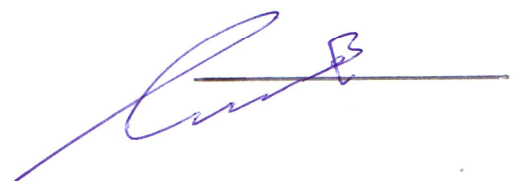
Al-Zaytoonah University

External Examiner

Dr.Basim M. Alhadidi

Associate Professor and Department Chair

Department of Computer Science

Prince Abullah Bin Ghazi Faculty of Information Technology

AlBalqa' Applied University.

Middle East University

Authorization Statement

I, Ammar Abdul Wahhab Abdul Al Hakeem, authorize Middle East University to supply copies of my thesis to libraries, establishments or individuals upon request, according to the university regulations.

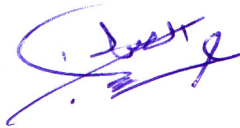Name   : Ammar Abdul Wahhab Abdul Al Hakeem.

Signature: -

Date: 13 - 5 - 2012

DECLARATION

I do declare hereby that the present research work has been carried out by me under the supervision of Dr. Hazim A. Farhan, and this work has not been submitted elsewhere for any other degree, fellowship or any other similar title.

Signature:

Date: 14-4-2012

Ammar Abdul Wahhab Abdul Hakeem

Department of Computer Information System

Faculty of Information Technology

Middle East University

DEDICATIONS

I dedicate this work to my:

- Father and Mother.

- Wife and Children's.

- Brothers and Sisters.

- Teachers and Friends.

For their love and support; they were the light in my academic path and without them nothing of this would have been possible.

ACKNOWLEDGEMENTS

I would like to express my gratitude to Prof. Reyadh Shaker Naoum, for his expertise, his help to me in addition to his support of this thesis.

I would like to express my sincere appreciation to my supervisor Dr. Hazim A. Farhan for his guidance, support and motivation throughout my master's thesis.

I would like to give this thesis big thanks for my father, and my mother و my cousin and my brother, Dr. Safa Al-Din Muhammad Al-safi to feel proud of me always, because they are the one who planted in me the spirit of perseverance and ambitious.

I would further like to acknowledge all of the Information Technology faculty members at the Middle East University for Graduate Studies for helping and encouraging my efforts.

Above all, I would like to especially thanks my dear wife for her love, support and being always there for me.

To my lovely family for supporting me during the time I was writing this thesis, I hope they feel that I make this for them.

You all make the journey worthwhile …. Thank you all

LIST OF CONTENTS

Contents page#

Contents   page#

Contents   page#

LIST OF FIGURES

LIST OF FIGURES

LIST OF Tables

LIST OF ABBREVIATIONS

DSSSPM   **Decision Support System for Seaport Management**

UNCTAD   **United Nations Conference on Trade and Development**

TULS   **Time to Unload the Shipment**

ATULS   **Average Time to Unload the Shipment Unit**

SC   **Shipment Capacity**

EDDT   **Expected Departure Date and Time**

EADT   **Expected Arrived Date and Time**

NNT   **Number of Needed Track**

NUPT   **Number of Units Per Track**

MCYS   **Management Container Yard System**

KBMS   **Knowledge-Based Management**

MBMS   **Model Based Management system**

DBMS   **Database Management system**

DSS   **Decision Support System**

RTG   **Rubber Tyred Gantry**

QC   **Quay Cranes**

VMES   **Vessel Management Expert System**

VTS   **Vessel Traffic System**

MANTIS   **Namely Maritime Avoidance Navigation Totally Integrated System**

MILP   **Mixed-Integer Linear Programming**

VTMIS   **Vessel Traffic Management Information System**

ERP   **Entity Relationship Diagram**

SVM   **support vector machine**

BPN   **Back-Propagation Neural Network**

ERP   **Enterprise Resource Planning**

ABSTRACT

The Seaports are important organizations in international shipping transport and are more than just piers. It is also the cheapest means of transport and more a load and the least damage, as well as, its cargo will be secured. The expert's human, in seaport management, are usually getting their experience through practice. Most often those expert people do not have available experience at the time needed, so it is reasonable to develop a Decision Support System (DSS) to support the decision maker so to take the right decision for solving the problems that may occur in the seaport. The developed DSS attempt to help the seaport managers to reduce costs by efficiently utilizing resources, including human resources, berths, container yards, container cranes, various trucks, and equipments. Among all the resources, berths are the most important resource and cargo schedules of berths improve customers' satisfaction and increase seaport throughput, leading to higher revenues to seaport.

Our Develop Decision Support Systems (DSSs) in this thesis is called Decision Support System for Seaport Management (DSSSPM), and it consists of three main components, which are, *User Interface*, *Model Base Management System* (MBMS) and *Database Management System* (DBMS). The main characteristic of the DSSSPM system are, the simplicity of use, high efficiency, quick response for critical situations and generating dynamic query and reports. Finally, The DSSSPM system is a portable and can easily configure to work with various databases, as well as, can be integrated with other systems in the seaport such as the management container yard system (MCYS) and the vessel traffic system (VTS).

الملخص

الموانئ البحرية هي المنظمات الهامة في مجال النقل البحري الدولي، وهي أكثر من مجرد ارصفة. كما أنها أرخص وسائل النقل وأكثرها حمولة وأقلها ضررا ، فضلا على ذلك ، تكون حمولتها مؤمنة. لـذا فـان الانسان الخبير ضرورة في مجال إدارة الموانئ ، وعادة ما يتم الحصول على الخبرة مــن خـلال الممارسـة العملية. في معظم الأحيان هؤلاء الناس الخبراء لاتوجد لديهم الخبرة المتاحة في الوقت المناسب ، لذلك فمـن الضروري تطوير نظام دعم القرار لصانع القرار لاتخاذ القرار المناسب من أجل حل المشاكل التي قد تحـدث في الميناء . نظم دعم القرار وضعت لمساعدة مدراء الموانئ البحرية لخفض التكاليف من خلال الاستفادة من الموارد بكفاءة، بما في ذلك الموارد البشرية، والأرصفة، وساحات الحاويات، ورافعات الحاويـات والـشاحنات المختلفة، والمعدات. علما بان بين جميع الموارد السابقة ، الارصفة هي أهم مورد وان جدولة البـضائع علـى الارصفة ، لتحسين رضا العملاء وزيادة إنتاجية الموانئ ، مما يؤدى الى زيادة الايـرادات الماليـة للمـوانئ البحرية .

نظم دعم القرارالمطورة في هذه الأطروحة تدعى نظم دعم القرار لإدارة الموانئ البحرية ، ويتألف من ثلاثة عناصر رئيسية ، وهي ، واجهة المستخدم، ونظام إدارة قاعدة نموذج ، ونظــام إدارة قواعـد البيانـات. الخصائص الرئيسية للنظام الذي تم تطويره (نظم دعم القرار لادارة الموانئ البحرية) هو سهولة الاستخدام ، كفاءة عالية ، والاستجابة السريعة للحالات الحرجة وتوليد متميز بفاعلية مستمرة للاستعلام والتقارير. أخيـرا، إن نظام نظم دعم القرار لادارة الموانئ البحرية هو متنقل، ويمكن بسهولة تهيئته للعمل مع قواعـد البيانـات المختلفة، وكذلك، يمكن أن يكون متكامل مع الأنظمة الأخرى في الموانئ البحريـة مثـل نظـام إدارة سـاحة الحاويات ونظام حركة السفن .

Chapter 1

Introduction

1.1. Overview.

1.2. The Problem Statement.

1.3. Objectives.

1.4. Motivations.

1.5. The Importance of DSS in Seaports.

1.6. Methodology

1.7. Thesis Organization.

Chapter 1

Introduction

1.1 Overview

The seaports are important organizations in international shipping transport and are more than just piers. The UNCTAD secretariat in 2004 report that "The widespread use of computer equipment and software programmers have led to efficient scheduling of transport movements and equipment utilization, efficient management of inventory and stock levels, and better communication systems both within firms and between firms and other market players (suppliers, customer, intermediaries, etc.) " . Also (Winklemans, 2002) said "The transfer of goods from one state of transport to another state has been the primary function of seaports and more specifically, terminals. The terminals are the most important part of a seaport where specialized cargoes are handled, such as passengers, autos, containers, oil and so on. More than 90% of international cargo is moving between seaports".

(Notteboom and Winklemans, 2002) claim that "The increasing growing trend containerization has become the dominant method of moving unitized cargo in the world with many adverse effects such as the requirement for increasing space and causing congestion. The needs for higher operational productivity, faster exchange of information, and speedier vessel turn-around times are just a few of many critical factors that are currently pressing seaport's nodal position within logistics systems. Cargoes and shipments from all over the world have been increasing exponentially. In fact, many seaports are experiencing difficulties. There exist many bottlenecks in terms of information and physical status of the cargo leading to low productivity within the terminal. There are many obstacles in increasing terminal capacity through expansion".

Seaport managers attempt to reduce costs by efficiently utilizing resources, including human resources, berths; container yards, container cranes, various trucks, and various yard equipments. Among all the resources, berths are the most important resource and cargo schedules of berths improve customers' satisfaction and increase seaport throughput, leading to higher revenues of seaport. Port 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. They attempt to maximize the utilization of a wharf and to satisfy various constraints for berthing container vessels by using an analytical approach, (Kap Hwan Kim & Kyung Chan Moon, 2003).

Since most of the knowledge related to the seaport managing processes are uncertain and usually depends on the human behavior, so it requires a method for representing this knowledge. The expert's people, in seaport management, are usually accumulating the Intelligent Information from different resources. Most often those expert people are not available at the time needed so it is reasonable to develop a decision support system (DSS) to give support to the decision maker.

1.2   The Problem Statement

There are many problems in the seaport management, related to the vessels, berths, and cargos, such as:

A. It is difficult to predict the actual situation of seaport status and preparation of exceptional or undesirable accidents because of the lack of simulation the decision support systems for vessel and cargos management in the seaport,

also the status of the equipments such as container, transfer cranes, interference between schedules.

B. The most notable problem is how to deal with the vessels that do not arrive at the correct time. So there is no quick answer from the seaport operators to decide if the seaport capacity can accommodate this vessel. Also check if there is a suitable berth for this vessel to meet its size and deals with its shipment.

Finally from the study of the literature survey in this area, there are few systems capable of a decision making or decision support system. Since the expectation of the approximate time to load or unload a vessel cargo or to predict the resources necessary to complete these processes depend on many resources, which are usually not available at the right time.

1.3 Objectives

The objective of this thesis 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 his work in the seaport. Also it helps to predict problems that may occur in order to avoid them.

Moreover, our 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.

1.4   Motivations

From my experience and the interviewing of many people working in the Iraqi seaports, I have noted the absence of the applications of DSSs which are used specifically in the department of loading/unloading; therefore, we need to develop a DSS to help the seaport manager to take the right decisions.

Most of the existing DSSs, in the field of seaport management, not support decision making for the vessels and cargos operations such as assigning the vessel, resources, and cargos to the suitable berth for loading and unloading.

1.5   The Importance of DSS in Seaports

The DSS is very important for planning and managing all operations of the seaport to help the seaport manager to make a decision quickly, through applying the right knowledge and introduce the proper solutions to problems that may occur during his work in the seaport. Also it helps to predict problems that may occur in order to avoid them.

The DSS also will help seaport operators to enhance the performance, increase the productivity and efficiency, as well as, solving the occurrence of conflicts at the seaport. This leads to increase customer satisfaction, reduce the cost, and minimize the vessels waiting time.

1.6 Methodology

The methodology in short is what actions we are going to have in order to solve our problem statement, also, putting the hypothesis and methods to be undertaken. Methods are divided into qualitative, quantitative, or mixture of the two is adequate. The methodology that will be used to develop our DSS contains the following phases:

1.6.1 Analysis Phase

The first step in the analysis will be the collection of data, acquiring information and knowledge from their sources. Since the role of seaport manager depends on the variety of data, information and knowledge and they have many sources and the most important source is the human experts.

Usually, for data collection, the most important way is to collect the forms that are used by seaport; therefore, all types of forms and from many sources will be collected and analyzed to give the right information, which help in building the data base.

There are many methods used for collecting the data from experts and the most common method used is the interviewing, which will be used in this thesis. Finally, after finishing the analysis phase, we will be using a CASE tool, such as, Rational Rose, Edraw Max, and e.t.c. for designing the system models.

1.6.2 Design and Implementation Phase

There are many tasks in the design and implementation phase and the most important is the database and model management representation in addition to the usability of the user interface. The power of any DSS depends on its database design and all other parts are implemented relatively to the created database.

The port management processes are depending on many types of data (such as graphs, images, and links), information, and knowledge, from different sources in the seaport environment. Therefore the knowledge representation form used in our system will be the rule based form that entered by the system's users as a record in the tables of the relational database that is useful in decision making by the Model-base management system.

1.6.3 Testing Phase

Our DSS will be tested according to the knowledge acquired from the seaport (Iraqi Seaport as a case study), then comparing the generated decisions and advice with the existing manual system in order to check its performance and accuracy.

1.7   Thesis Organization

In addition to this chapter, there are other four chapters in this thesis. Thus in this section we will describe briefly the contents of these chapters.

Chapter two provides a general description to decision support system by mentioning its characteristics, benefits, types, and importance, in addition to the "Literature Surveys and Related Work" section.

In chapter three, we cover the analysis phase and then consider information for DSSSPM, system requirement that includes the functional and non-functional requirements, definitions of the system tables, and Entity Relationship Diagram.

Chapter four includes a description of the design and implementation of the developed system "Developing a Decision Support System for Seaport Management".

Chapter five is divided into two sections which are:

- Section 5.1 summarizes the main conclusions on our developed system.
- Section 5.2 lists the suggestions that we recommend for future research work.

Finally, the appendix contains the detailed description of the System's user interfaces and case studies to show the system capabilities.

Chapter 2

Decision Support System and Related Work

2.1. What is DSS

2.2. Characteristics and Capabilities of DSS

2.3. Benefits of DSS

2.4. Types of DSS

2.5. Components of DSS

2.6. Literature Survey and Related Work

Chapter 2

Decision Support System and Related Work

2.1   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 importances. 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 (2002)).

2.2   Characteristics and Capabilities of DSS

Actually, there is no exact definition for DSS, therefore, we can summarize and constitute an ideal set of characteristics and capabilities of DSS as follows (Turban, E., Aronson, J.E., and Liang, T.P. 2005):

1. Support semi-structured and unstructured problems.

2. Support management, individuals, and groups at all levels.

3. Interdependent or sequential decisions.

4. Support intelligence, design, choice, implementation, monitoring.

5. Support variety of decision processes and styles.

6. Adaptable and flexible.

7. Reduced response time for complex situation.

8. Have user friendly interfaces.

9. Standalone, integration and Web-based.

2.3 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,2011).

2.4 Types of DSS

There are varieties of DSSs; these can be categorized into five types as follows (Dan Power, 2011)**:**

2.4.1 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.

2.4.2 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.

2.4.3 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.

2.4.4 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.

2.4.5 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.

2.5 Components of DSS

In this section we will cover the architecture and component for the Decision Support Systems, while a variety of DSS exists, the below five components can be found in many decision support system architectures and play a prominent role in their structure. Interaction among these components will be illustrated in Figure 2.1.
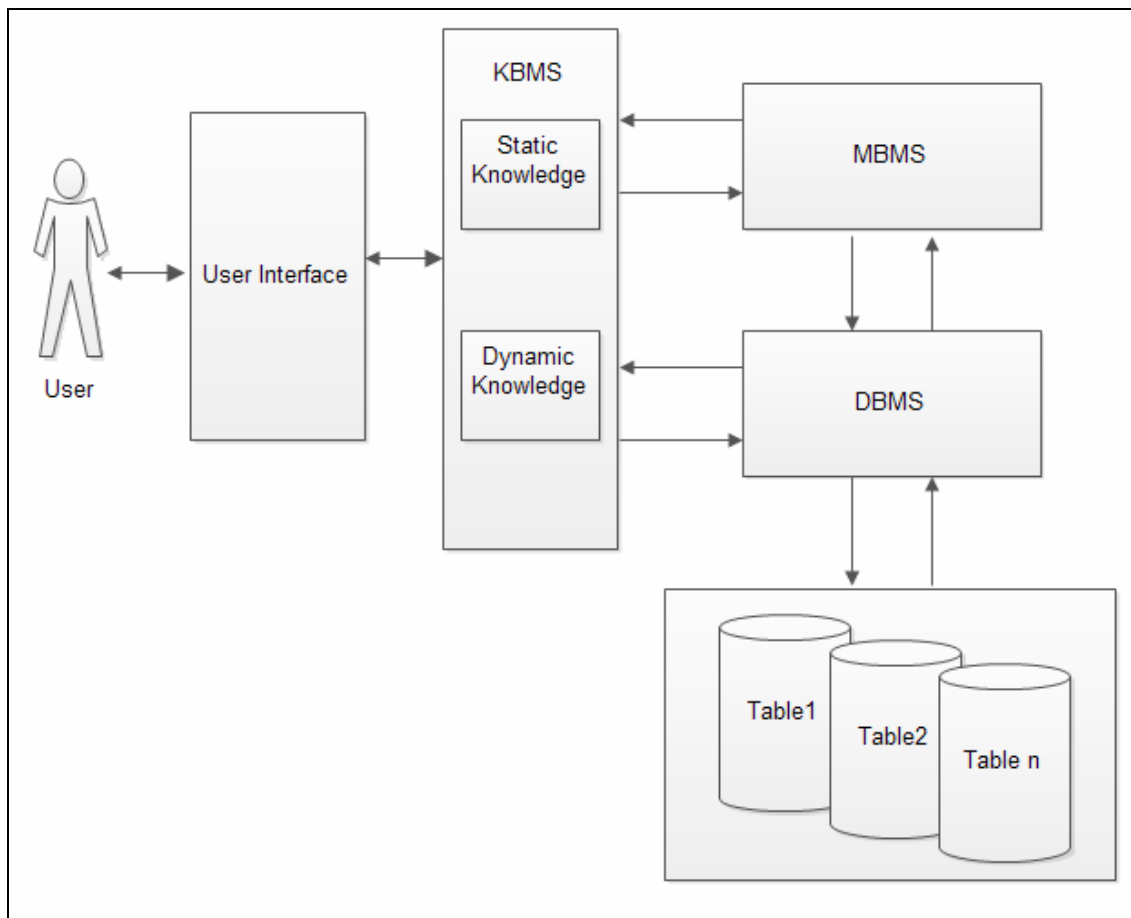

Figure 2.1: The Architecture of a DSS (Designed by the Author)

Essentially, the user interacts with the DSS through the user interface to communicate with the DBMS and MBMS, which screen the user and the user interface from the physical details of the model base and database implementation.

The DSS contains the following components:

2.5.1 Database Management System (DBMS)

A DBMS serves as a data bank for the DSS. It stores large quantities of data that are relevant to the class of problems for which the DSS has been designed and provides logical data structures (as opposed to the physical data structures) with which the users interact. A DBMS separates the users from the physical aspects of the database structure and processing. It should also be capable of informing the user of the types of data that are available and how to gain access to them. The Data Management Component stores information which can be further subdivided into that derived from an organization's traditional data repositories, from external sources such as the Internet, or from the personal insights and experiences of individual users. (Allen Kent, 2002)

2.5.2 Model-base Management System (MBMS)

The role of MBMS is analogous to that of a DBMS. Its primary function is providing independence between specific models that are used in a DSS from the applications that use them. The purpose of an MBMS is to transform data from the DBMS into information that is useful in decision making. Since many problems that the user of a DSS will cope with may be unstructured, the MBMS should also be capable of assisting the user in model building. The Model Management Component handles representations of events, facts, or situations using various kinds of models, two examples being optimization models and goal-seeking models. (Allen Kent, 2002)
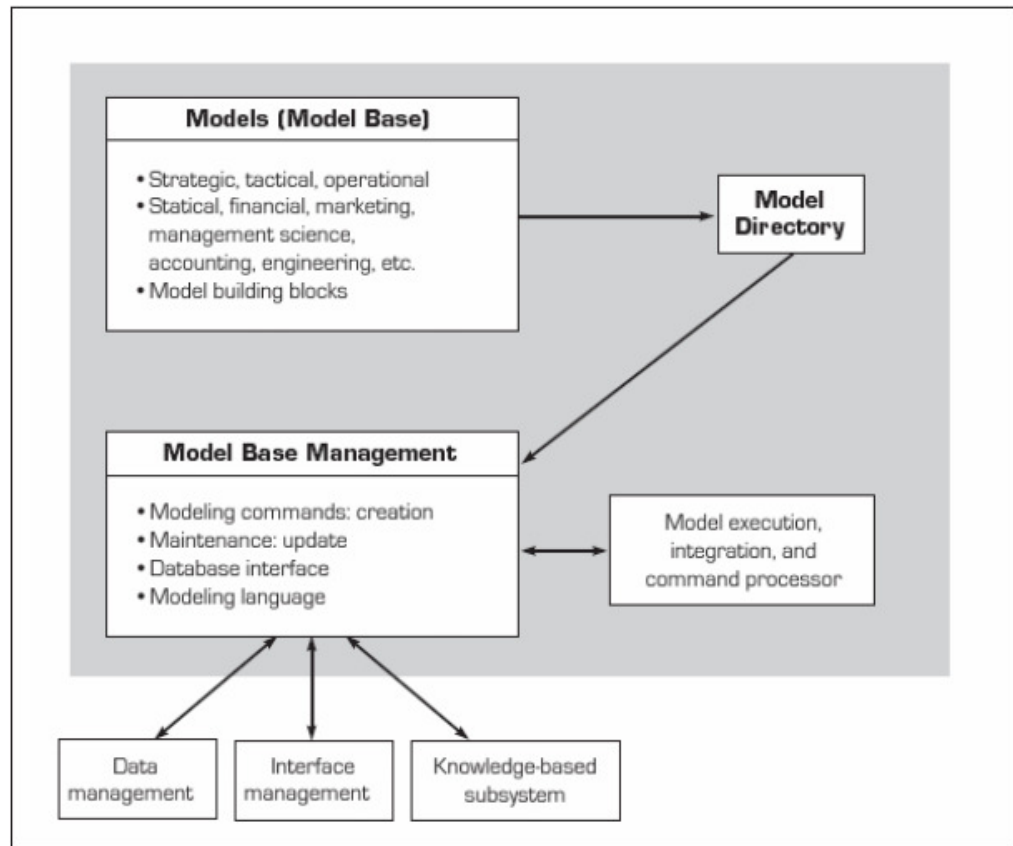
Figure 2.2: Schematic View of the Model Management System (Allen Kent, 2002)

2.5.3 Knowledge-based Management

Knowledge Based Management System is used in Advanced DSS 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 components.

The knowledge base represents the repository of knowledge for narrow and specific domain. The knowledge can be defined as a set of facts, rules, events and meta-knowledge. Usually the knowledge can be either declarative or procedural. So in this thesis we use both declarative, which is dynamic knowledge (Working Memory), and procedural, which is the static knowledge.

The static knowledge is the domain specific and narrow knowledge (the knowledge related to port control).

2.5.3.1 Static Knowledge

The knowledge is represented as a set of rules together with associated facts, each rule specifies a relation and has the form IF (conditions) THEN (action). The basic structure of the static knowledge is a knowledge base that contains the domain knowledge used for problem solving.

2.5.3.2 Dynamic Knowledge

The dynamic knowledge contains knowledge acquired during the run time of the system via the interaction of the user with the proposed system. This knowledge will be as assertions for the specific problem or facts. The basic structure of dynamic knowledge is the database that includes a set of facts used to match with the (condition) part of rules stored in the knowledge base.

2.5.4 User Interface

The User Interface Management Component is of course the component that allows a user to interact with the system. The main product of an interaction with a DSS is insight. As their users are often managers who are not computer-trained, DSS need to be equipped with intuitive and easy-to-use interfaces (Dr.Saeed Shiry,2011).These interfaces help in model building, but also in interaction with the model, such as gaining insight and recommendations from

it. The primary responsibility of the user interface is to enhance the ability of the system user to utilize and benefit from the DSS (Allen Kent, 2002).
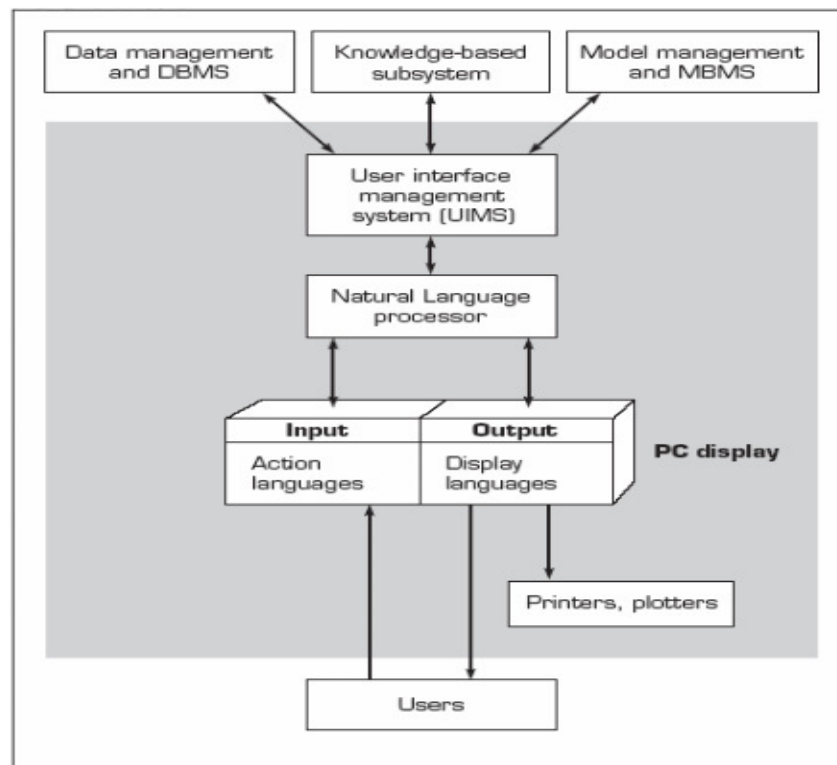
Figure 2.3: Schematic View of the User Interface System (Allen Kent, 2002)

2.5.5 The User

The user (decision maker) is the person that is faced with a decision designed to support. There are the following types of users:

- Managers.

- Staff specialists: They use the system much more frequently than manager and tend to be mode detail-oriented.

- Intermediaries:

    1. Staff assistant: Often intermediaries between managers and specialists.

    2. Expert tool user.

    3. Business (system) analyst.

2.6   Literature Survey and Related Work

In this section we survey previous work, research literature, and publications done by others related to the topic covered in this thesis. There are good reasons for spending time and effort on a review of the works and literature before embarking on a research project. These reasons include (Bourner, 1996):

- Establish the importance of the topic.

- Identify background information and ideas that may be relevant to the research.

- Identify gaps between our work and the previous works.

- Avoid reinventing the wheel (at the very least this will save time and it can stop us from making the same mistakes as others).

- Carry on from where others have already reached (reviewing the field allows us to build on the platform of existing knowledge and ideas).

- Identify other people working in the same fields.

- Increase our breadth of knowledge of the subject area.

- Provide the intellectual context for our own work, enabling us to position our project relative to other work.

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. We can summarize the researches in the field of seaport management and decision support systems, which are more related to the DSS in the seaport management in the following subsections.

2.6.1 Support System for Container Shipping Operation

There are two types of cargo transported via vessels around the world, the first one is bulk shipping which are that ships huge quantities of coal, ores, oil, etc. and the second one is containerized shipping which are that ships different goods using steel containers with standard sizes.

This research applied in the Hong Kong seaport, the most common active container seaport, and concentrates on the important type of containerized shipping. This research provides the details description of the daily operations, by dividing the day into 48 half-hours (half-hour intervals). Thus allows the equipments supervisors make decision for determining which equipment is busy and which one is ready to move from its initial block in this period, and determine at which the time it can move (Katta G. Murty, et al, 2000).

2.6.2 Distributed Agent Architecture for Port Automation

Thurston and Hu (2002) described that increase the movement of containers in the seaport will make the container seaport is no longer able to expand in the surrounding lands and will thus be unable to meet the storage requirements due to increased movement in world trade. And the solution to this problem is to reduce the amount of time required to load and unload the ship. That Thurston and Hu (2002) said "presents distributed agent architecture to achieve this task. Under such architecture, an intelligent planning algorithm is continuously optimized by the dynamic and co-operative rescheduling of yard resources such as quay cranes and container vehicles".

Therefore, this research focused on ships bound for the seaport of destination which has the face of the other. That process of loading and unloading will be a maximum of efficiency and will become the largest transport companies, continue to increase both the size of their fleets and the ability of new ships added to them. So the only solution is to reduce the amount of time needed to ship to stay on berth. This study developed a simulation agent written in Java, in the Implementation phase and the initial results, (("the system has been prototyped in Java. First a yard map is created using the map editor, and then simulation runs can be created and viewed, using custom or randomly generated loading schedules. Statistics from the simulation run are then exported to Microsoft Access. All agents in the system inherit from a simple Agent Base Class we have created")), or loading and unloading of containers onto vessels, also known as the ship-to-shore system. And pouring their attention on the quay Cranes to perform their work in full container stevedoring and have a great advantage in unloading the container first, and shipped after the completion of the unloading process Secondly, the time and one which led to the rapid completion of work and reduce the time required, where the assessment system in the simulation with data Random. But the problem remained that the process of unloading and organizing storage containers in areas where the container yards that my work is an integrated environment between ports.

In reality most seaports around the world, that loading of each container requires three separate processes, therefore, as claimed "is concerned specifically with the loading process; however the standard unloading process is similar, just in reverse , and the processes are follows as:

- Retrieval of Container from Stacking Lane -- An efficient use of yard storage space is to stack the containers in a lane. These stacks may be four or five containers high and are typically seven containers across. Each lane has a Rubber Tyred Gantry Crane (RTG), which can retrieve or handle these containers.

- Transport of Container from Stack to Quay -- Two main categories of vehicle will perform this operation. One is a lorry or motorized platform, which will have to be loaded by the RTG in process 1. Another is a Straddle Carrier or other vehicle capable of self loading, which is able to collect the container from the ground. The containers loaded onto these vehicles can then be transfer to the Quayside.

- Transfer of Container from Quay Side to Sea Vessel -- When the vehicle arrives at the target QC, depending on its type, it will either unload itself and clear out the way, or wait to be unloaded by the QC. Once the QC has picked up this container, it is loaded onto the ship into its designated storage slot".

2.6.3   A Vessel Management Expert System

T. Tran, C. J. Harris and P. A. Wilson (2002), claimed proposed a new system (MANTIS) to improve the efficiency and safety of ship transport, namely maritime avoidance navigation totally integrated system. The main objective is to remove the difficulties and uncertainties involved in ship navigation through a system structure that makes ship transport clear without any conflicts. The proposed system is a strategic interactive expert system that can determine safe and efficient navigation routes for all vessels as part of

journey planning and en route conflict avoidance. Non-navigable areas must be determined, conflict regulations, ship characteristics, sea state and sensor accuracy during evaluation. An outline of the MANTIS infrastructure is given, followed by a description of the vessel management system (VMES). Simulation results exemplify the significance of the system for future exploitation.

Ship accidents result in environmental damage, loss of life, and loss millions of pounds every year and rising. The underlining cause of the majority of marine collisions can be put down to human decision failure. Humans are known to be inefficient and error prone in the task of coordinating and controlling vessels, especially when time is a contributing factor. Having skilled navigators (through better training schemes will help reduce the number of conflicts, but will never eliminate the problem due to the continual increase in traffic density and the speed and size of vessels. Current vessel traffic services (VTS) can presently only give general guidance to ships of the risk ahead; it cannot suggest precise navigation routes. This is because of the complexity of the associated management task. Due to the huge number of ships, it is humanly impossible to plan the paths of all ships into and out of port even with a large task force of human operators (akin to air traffic control). In the majority of cases, it is left to the ship navigator to perform avoidance actions en route .

There are three modes defining a vessel navigation status and its responsibility during evaluation: edit, active and fixed. Vessel modes reflect the different levels of precedence, meaning that routes already established (active) have a higher priority over newly planned routes (edit) and fixed routes are given the utmost priority during multiple ship encounters, which caters for constrained or emergency vessels. Ships that need to avoid land areas are given

a high precedence to maneuver because their avoidance maneuver is necessary regardless of whether or not they face threats from other target ships. Ships with the largest number of target threats have a higher priority to maneuver compared to ships with fewer threats (given that all the above factors are equal). This approach is the key to minimizing the number of ships that would need to alter course in multiple threat situations.

A system has been presented to tackle the illusive problem of marine collision avoidance, namely maritime avoidance navigation, totally integrated system (MANTIS). Its infrastructure ensures that the states of all ships are known and can be controlled. This has paved the way for the development of a vessel management expert system (VMES) capable of concurrently scheduling the paths of all ships, their journey plans and en route modifications. The system satisfies collision regulations, ship and environment constraints and sensor measurement accuracy. The transparency of the method allows the results to be easily validated visually, analytically and quantitatively reinforcing user confidence in the system capabilities.

2.6.4 Berth Scheduling by Simulated Annealing

Kap Hwan Kim & Kyung Chan Moon (2003), 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 said "Managers in many container terminals 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".

2.6.5   A Computer-Based DSS for Vessel Fleet Scheduling

Kjetil Fagerholt (2004), claims that "Most shipping companies do the planning of fleet schedules manually based on their experience.

Very few use optimization-based decision support systems. There has also been little work on this subject, and the majority of the published work on vessel fleet scheduling has been on the theoretical and experimental level with a focus on optimization algorithms".

Also he said, "The most important experience is that when designing such systems, the focus should be directed more to the interaction between the user and the system than the optimization algorithm".

2.6.6 A Fuzzy Method for Solving Marine Transshipment Container Port Selection Problems

In reality most shipping companies choose the best transshipment container seaport In order to reduce the international trade container transportation operation cost Therefore the ''Transshipment'' is a very popular and important issue in the present international trade container transportation market Chien, (2007).

The above research developed a new Fuzzy Multiple Criteria Decision Making Method for solving the transshipment container seaport selection problem under fuzzy environment. The work was based on the proposed canonical representation for the knowledge using the fuzzy set theory; the decision maker of shipping company can determine quickly the ranking order of all candidate transshipment container seaports and select easily the best one.

2.6.7 A Decision Support Method for Truck Scheduling and Storage Allocation Problem at Container

CAO, SHI & Der-Horng, (2008), develop an integer programming model handling two problems which are Truck scheduling and storage allocation. The model can reduce congestion and waiting time of container trucks in the terminal so as to decrease the make span of discharging containers.

In this research the waiting time and time consuming travel will become clear through the achievement of the objective to be reached, and by achieving the minimum to make the stretch for all unloading containers so you must set the trucks to transport unloaded containers from the ship-to-one mass storage yard. The time for loading and unloading of containers consists of travel time on the network and the waiting time at the quay and the yard side. This is a pier in the waiting time for the technical performance of the quay cranes and unloading sequence in a timely manner to different ready containers.

2.6.8 Using new attribute construction to incorporate the expertise of human experts into a smuggling vessels classification system

Tsung-Yuan Tseng, et al, (2009), claimed in their research they attempt to create a model to help the expertise of human experts into an insufficient database by adding attribute construction and increase the accuracy rate of the data classifier based on the newly-modified database. Several existing condition attributes function in the database is applied to create a new attribute that demonstrates the intrinsic meaning of the artificial rule.

In this study, we took the VTMIS system which is originally designed for seaport transportation and vessel safety management, as an example, and incorporated the artificial smuggling detection rule of ''vessels sail fast towards shore" in order to improve the accuracy rate of the smuggling detection data classifier. There is no extra reference point of the terrain with the limiting condition that could be added into system. The radar station in this research used as the reference point of the shore coordinates, and defines a new attribute, the difference between the target azimuth and anti-course, to represent the ''vessels

sail approximately towards radar station or sea" concept. The results show that the accuracy rate of the two data classifiers, support vector machine **(SVM**) and the back-propagation neural network **(**BPN), increases by 14% and 22%, respectively, after the creation of the new attribute. It is valuable that helping of the expertise of human experts after data conversion would participate to the effective learning of the data classifier.

2.6.9   An ERP Approach for Container Terminal Operating Systems

Hyung, R.C, Hyun, S.K, and Byung, J.P (2003), claimed in Vessels are becoming more large-scale and high-speed because of the increasing quantity of cargo transported, shipper's requirements for lower transportation fee and shipping companies' effort toward retrenchment of transport cost per shipping unit. Furthermore, shipping companies become more interested in maximizing vessel turnover by minimizing the length of staying time at ports for economic reasons.

With this background, this paper suggests a container terminal ERP system that can solve problems of existing container terminal operating systems such as high developing cost, prolonged developing time and non-integration.

For this purpose, one has analyzed the existing terminal business processes to produce a new one for reducing data redundancy, and suggested an ERP framework for the integrated terminal operating system.

2.6.10 A Unified Approach for the Evaluation of Quay Crane Scheduling Models and Algorithms

Frank, M., Christian B. (2010), claimed and presented anew platform for the comparison of models and algorithms with application to quay crane scheduling. It provides a scalable, reproducible, and unbiased test environment, which reflects many important features of crane scheduling that are met in practice as well as in research.

In total, 400 test instances have been generated and solved by a powerful heuristic, which can serve as a benchmark for future researching the field.

Yet, we consider the main contribution of this paper in opening a unified approach for the evaluation of distinct scheduling models. The conducted experiments reveal that there is no model available, which is dominant with respect to arbitrary constellations met at the vessel side or the quay side of a terminal. We identified situations where spending effort in solving a complex model pays off in terms of reducing vessel handling times in significant percentages. Still, we observed other situations, where a detailed model promises only a few advantages, which makes simpler models the preferred policy. These findings verify quantitative analysis and further research on a cross model evaluations for scheduling applications.

Chapter 3

Analysis of the DSSSPM System

3.1   Introduction.

3.2   Gathering information for DSSSPM.

3.3   System Requirement.

3.4   Definitions of the System Tables.

   Entity Relationship Diagram

Chapter 3

Analysis of the DSSSPM System

3.1 Introduction

In this chapter we will show in detail the steps of analysis of the decision support system for seaport management. The analysis phase is the most important phase of system development life cycle. It starts with gathering requirement from the client to know the system expectation, then the system analyst will analyse this information and use them in designing the system, which will be used in implementing the required system. As we mentioned before that the analysis phase is the most important phase, so we will take into consideration that the other system phases also depend on this phase.

The analysis phase will reflect the importance of the implementation phase, thus if we have any problem with this phase then it will be inherited to the other phases which mean that we have to do a deep analysis to the system.

3.2 Gathering information for DSSSPM

There are various techniques that can be used for gathering requirements. These techniques will help the participants in a meaningful discussion that gets their thoughts and draws a better picture for what the client is looking for.

We did some visits to Aqaba port and some of Iraqi ports like UM Qaser and Khour Al-Zubair ports, and gained information using various ways, Formal and informal requirements gathering interviews are a great place to start gathering information. These may occur face to face, over the phone, or in writing. A good requirements interview begins with good preparation. The interviewer must have a

thorough understanding of the issues involved in order to ask the right questions and know when appropriate answers have been given. Obtaining a physical item such as forms can act as visual aids to simplify questions and answers.

Moreover, interview many responsible persons, such as:

1- Port Managers.

2- Stores Managers, Head of Marketing and Internals and Affairs Division.

3- Managers of loading and unloading.

4- Department officials responsible for sending ships.

Also, we met some naval experts, freight forwarders and unloading in Iraq and Jordan asking them some questions such as, what they are doing to give information to the seaport, and how is any pre-planning and lay the ships unloaded and shipped in order to avoid delay.

During the interviews, many relevant materials will probably be presented from the mentioned persons, these are, a combination of hard copy and soft copy documents which includes very important information and also daily and monthly reports, guidelines, procedures, and Cargo Manifests.

Moreover, the Observation is another gathering information technique defined as: "Observation is either an activity of a living being, such as a human, consisting of receiving knowledge of the outside world through the senses, or the recording of data using scientific instruments. The term may also refer to any data collected during this activity".

During our visits to the Iraqi and Aqaba ports we get the required data from watching the process of loading and unloading. Also, watch the techniques and mechanisms that are used in the different department. From my experience as an employee in the Iraqi ports was the heart of my interest therefore the mechanism of

gathering information and the required data and analysis more accurately to support the interview process in order to come up with a system facilitates, the operation and management of ports.

3.3   System Requirement

The main purpose of this section is to identify the requirement and constraints for the system we developed, it mainly consists of two subsections.

3.3.1   Functional Requirements

In the functional requirements we will explain what has to be done by identifying the necessary task, action or activity that must be accomplished. A function is described as a set of inputs, the behavior, and outputs. Functional requirements may be calculations, technical details, data manipulation and processing and other specific functionality that define what a system is supposed to accomplish.

In our system the main functional requirements, for our system, which is obtained from the previous section, gathering information, according to the users of the system. The following are a list of some function requirements for our system:

1- Entering information about: Ports, Berths, Vessels, Agents, Stores, Trucks, Yards and Equipments.

2- Entering the types of information about: Shipment, Berth, Store, Truck, and Vessel.

3- Entering travel information and checking the berth and resources availability for the vessel based on its shipment.

4- Displaying reports for Port Managers about the port status that will enable him to take a correct decision.

The system will help all users to manage and control the transaction in the port for the come in and come out vessels.

3.3.2 Non-Functional Requirements

A non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviors.

A non-functional requirement includes system performance, reliability, manageability, security, response time, quality of service, and system availability. As well as, it includes prescribed technology and development standards, portability characteristics, maintainability, and architectural constraints to be applied. Therefore, our system like another good systems takes into account all mention non-functional requirement and standard.

3.4 Definitions of the System's Tables

In this section we will define and describes our database system. However, the system database contains a series of tables, done by us, which will be use to store the data needed by our proposed system (DSSSPM).

The following subsections will describe these tables:

3.4.1 Vessel Table:

This table contains information's about all the vessels in the system.

System:	**Port Management System**		
File name:	Vessel.		
Analyst:	Ammar Abdul Wahhab		
Date:	10/8/2011		

Element Name	Length	Data Type	Description
VesselID	Long Integer	Number	Automatic number for the vessel generated from the system.
IMONo	255	Text	The International Maritime Organization (IMO) number consists of the letters "IMO" followed by a unique, seven-digits
VesselName	255	Text	Name of vessel
Nationality	255	Text	Nationality of vessel
Displacement	Decimal	Number	The displacement of vessel by meters
VesselType	255	Text	The type of vessel
Length	Decimal	Number	The length of vessel
Width	Decimal	Number	The width of vessel
Draft	Decimal	Number	The draft of vessel
HasGear		Yes/No	This is a Boolean field to determine if the vessel has a gear of not
AgentID	Long Integer		Number of agent for the vessel from Agent table
TEUCapacity	Decimal	Number	Twenty foot Equivalent Unit for a container 20 feet long.
OwnerName	255	Text	Owner vessel name
VesselTypeID	Long Integer	Number	Auto generated number from the system for the vessel type number. From the Vessel Type table.

Key field:	VesselID.
Foreign key:	AgentID, VesselTypeID
Order of file:	Indexed by VesselID.

Table 3.1: Vessel Table

3.4.2 Port Table:

This table contains information's about all the ports in the system.

System:	*Port Management System*		
File name:	*Port.*		
Analyst:	*Ammar Abdul Wahhab*		
Date:	10/8/2011		
Element Name	*Length*	*Data Type*	*Description*
PortID	Long Integer	Number	Automatic number for the port generated from the system.
PortName	255	Text	Name of port.
PortType	255	Text	Type of port.
PortYard	Long Integer	Number	The capacity of port Yard. (i.e. how many containers can be stored in the yard).
Key field:	PortID.		
Foreign key:	------		
Order of file:	Indexed by PortID.		

Table 3.2: Port Table

3.4.3 Agent Table: This table contains information's about all the agents in the system.

System:	*Port Management System*		
File name:	*Agent.*		
Analyst:	*Ammar Abdul Wahhab*		
Date:	10/8/2011		
Element Name	*Length*	*Data Type*	*Description*
AgentID	Long Integer	Number	Automatic number for the agent generated from system.
AgentName	255	Text	Name of agent.
AgentSpecialization	255	Text	Specialization of agent.
OwnerName	255	Text	Owner name for the agency
Key field:	AgentID.		
Foreign key:	------		
Order of file:	Indexed by AgentID.		

Table 3.3: Agent Table

3.4.4 Berth Table:

This table contains information's about all the berths in the system.

System:	**_Port Management System_**		
File name:	Berth.		
Analyst:	Ammar Abdul Wahhab		
Date:	10/8/2011		
Element Name	_Length_	_Data Type_	_Description_
BerthID	255	Text	The number for the berth defined by user in the system.
BerthName	255	Text	Name of Berth
Length	Decimal	Number	The length of berth in meters
Width	Decimal	Number	The width of berth in meters
Draft	Decimal	Number	The draft of berth in meters
Displacement	Decimal	Number	The displacement of berth in meters
Description	255	Text	This text field to add a description of berth
PortID	Long Integer	Number	Auto generated number from the system for the port number. From the Port table.
BerthTypeID	Long Integer	Number	Auto generated number from the system for the berth type number. From the Berth Type table.
Key field:	BerthID.		
Foreign key:	PortID, BerthTypeID		
Order of file:	Indexed by BerthID.		

Table 3.4: Berth Table

3.4.5 Equipment Table:

This table contains information's about all the equipments in the system.

System:	**Port Management System**		
File name:	Equipment.		
Analyst:	Ammar Abdul Wahhab		
Date:	10/8/2011		
Element Name	*Length*	*Data Type*	*Description*
EquipmentID	Long Integer	Number	Automatic number for the equipment generated from the system.
EquipmentName	255	Text	Name of equipment.
ShippingCapacity	Decimal	Number	The capacity of shipping for each shipment
Key field:	EquipmentID.		
Foreign key:	-----		
Order of file:	Indexed by EquipmentID.		

Table 3.5: Equipment Table

3.4.6 Travel Stores Table:

This table contains information's about all stores that used in each travel in the system.

System:	**Port Management System**		
File name:	Travel Stores.		
Analyst:	Ammar Abdul Wahhab		
Date:	10/8/2011		
Element Name	*Length*	*Data Type*	*Description*
TravelID	Long Integer	Number	Automatic number for the travel generated from the system.
StoreID	Long Integer	Number	Automatic number for the store generated from the system.
Key field:	TravelID, StoreID.		
Order of file:	Indexed by TravelID.		

Table 3.6: Travel Stores Table

3.4.7 Shipping Types Table:

This table contains information's about all the shipping types in the system.

System:	**Port Management System**		
File name:	ShippingTypes.		
Analyst:	Ammar Abdul Wahhab		
Date:	10/8/2011		
Element Name	Length	Data Type	Description
ShippingTypesID	Long Integer	Number	Automatic number for the shipping types generated from the system.
ShippingTypesName	255	Text	Name of shipping types
Unit	50	Text	Name of the shipping types unit
Time	Long Integer	Number	The time needed to download the shipment from this type.
Truck	Long Integer	Number	Number of units can be shipped in one truck.
Key field:	StoreID.		
Foreign key:	BerthID, StoreTypesID		
Order of file:	Indexed by StoreID.		

Table 3.7: Shipping Types Table

3.4.8 Travel Table:

This table contains information's about all the travels in the system.

System:	**Port Management System**		
File name:	Travel.		
Analyst:	Ammar Abdul Wahhab		
Date:	10/8/2011		

Element Name	Length	Data Type	Description
TravelID	Long Integer	Number	Automatic number for the travel generated from the system.
BerthID	255	Text	The number for the berth. From the Berth table.
VesselID	Long Integer	Number	Auto generated number from the system for the vessel number. From the vessel table.
ExpArrivedTime		Date/Time	Expected arrived time for the vessel
ExpArrivedDate		Date/Time	Expected arrived date for the vessel
ArrivedTime		Date/Time	Actual arrived time for the vessel
ArrivedDate		Date/Time	Actual arrived date for the vessel
ExpDepartureTime		Date/Time	Expected departure time for the vessel
ExpDepartureDate		Date/Time	Expected departure date for the vessel
DepartureTime		Date/Time	Actual departure time for the vessel
DepartureDate		Date/Time	Actual departure date for the vessel
ShipmentCapacity	Decimal	Number	The capacity of shipment
ShipmentTypeID	Long Integer	Number	Auto generated number from the system for the shipment type number. From the shipping type table.
NeedsStore		Yes/No	This is a Boolean field to determine if the shipment need stores or not
NeedsEquipment		Yes/No	This is a Boolean field to determine if the shipment need equipment or not
Yard	Long Integer	Number	Number of containers that need to be stored in Yard.

Trucks	Long Integer	Number	Number of need trucks

Key field:	TravelID.
Foreign key:	BerthID, VesselID, ShipmentTypeID
Order of file:	Indexed by TravelID.

Table 3.8: Travel Table

3.4.9 Stores Table:

This table contains information's about all the stores in the system.

System:	***Port Management System***
File name:	*Stores.*
Analyst:	*Ammar Abdul Wahhab*
Date:	10/8/2011

Element Name	*Length*	*Data Type*	*Description*
StoreID	Long Integer	Number	Automatic number for the store generated from the system.
StoreName	255	Text	Name of store
StoreTypesID	Long Integer	Number	Auto generated number from the system for the store type number. From the Store Types table.
Area	Decimal	Number	The area of store in meters
Capacity	Decimal	Number	The capacity of store in meters
BerthID	255	Text	The number for the berth. From the Berth table.

Key field:	StoreID.
Foreign key:	BerthID, StoreTypesID
Order of file:	Indexed by StoreID.

Table 3.9: Stores Table

3.4.10 Travel Equipments Table:

This table contains information about all equipments that used in each travel in the system.

System:	**Port Management System**		
File name:	TravelEquipment.		
Analyst:	Ammar Abdul Wahhab		
Date:	10/8/2011		
Element Name	Length	Data Type	Description
TravelID	Long Integer	Number	Automatic number for the travel generated from the system.
EquipmentID	Long Integer	Number	Automatic number for the equipment generated from the system.
NoofEquipment	Integer	Number	Number of required equipment.
Key field:	TravelID, StoreID.		
Order of file:	Indexed by TravelID.		

Table 3.10: Travel Equipment Table

3.4.11 Berth Types Table:

This table contains information's about all the berth types in the system.

System:	**Port Management System**		
File name:	BerthType.		
Analyst:	Ammar Abdul Wahhab		
Date:	10/8/2011		
Element Name	Length	Data Type	Description
BerthTypeID	Long Integer	Number	Automatic number for the berth type generated from the system.
BerthTypeName	255	Text	Name of berth type.
Key field:	BerthTypeID.		
Order of file:	Indexed by BerthTypeID.		

Table 3.11: Berth Types Table

3.4.12 Vessel Types Table:

This table contains information's about all the vessels types in the system.

System:	**Port Management System**		
File name:	VesselType.		
Analyst:	Ammar Abdul Wahhab		
Date:	10/8/2011		
Element Name	Length	Data Type	Description
VesselTypeID	Long Integer	Number	Automatic number for the vessel type generated from the system.
VesselTypeName	255	Text	Name of vessel type.
Key field:	VesselTypeID.		
Order of file:	Indexed by VesselTypeID.		

Table 3.12: Vessel Types Table

3.4.13 Store Types Table:

This table contains information's about all the store types in the system.

System:	**Port Management System**		
File name:	Store Type.		
Analyst:	Ammar Abdul Wahhab		
Date:	10/8/2011		
Element Name	Length	Data Type	Description
StoreTypeID	Long Integer	Number	Automatic number for the store type generated from the system.
StoreTypeName	255	Text	Name of store type.
Key field:	StoreTypeID.		
Order of file:	Indexed by StoreTypeID.		

Table 3.13: Store Types Table

The below ER diagram show the relationships between our system tables.
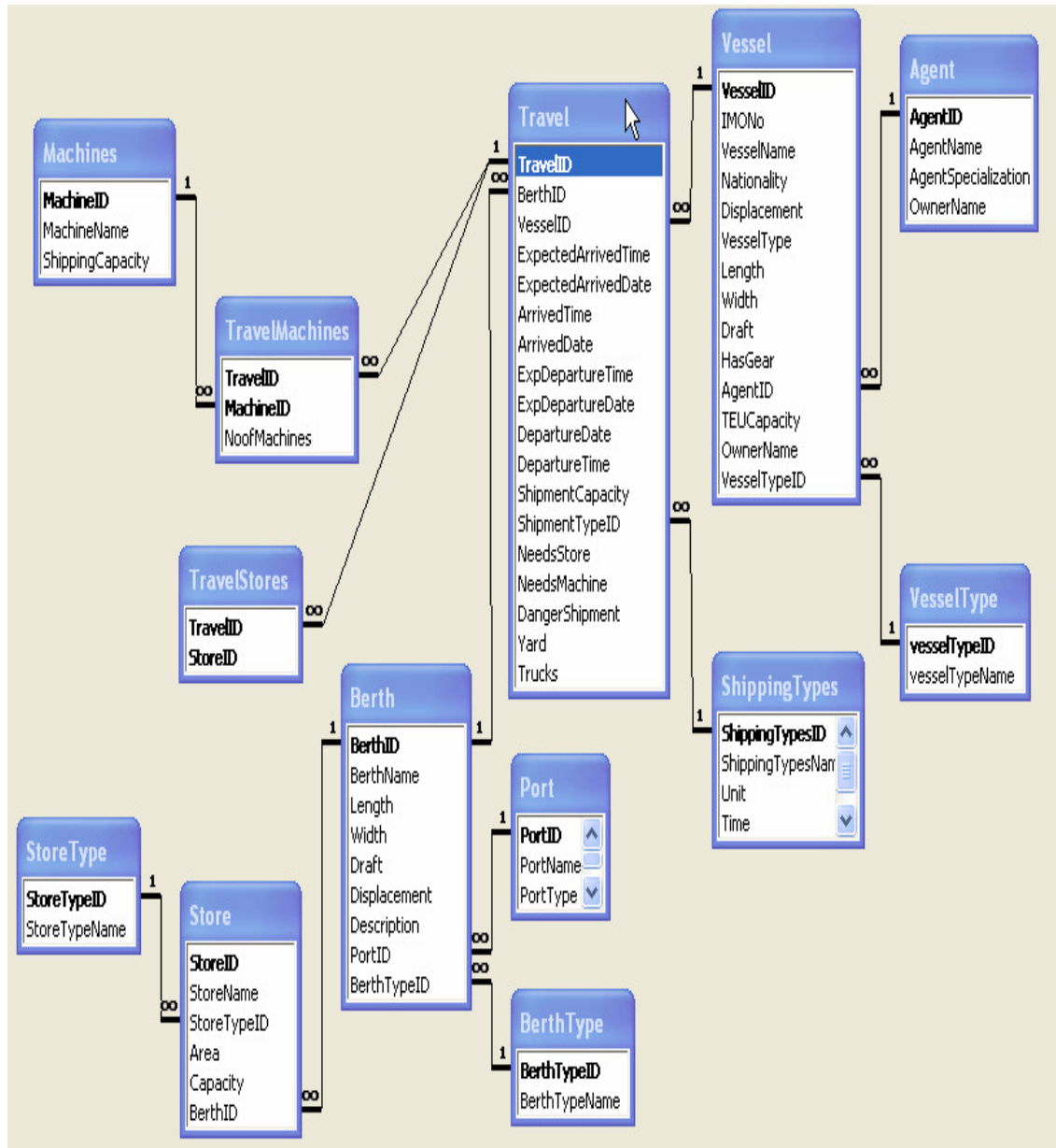
Figure 3.1: ER Diagram

Chapter 4

Design and Implementation of DSSSPM System

4.1. Introduction.

4.2. The DSSSPM System Components.

4.3. Travel Module.

Chapter 4

Design and Implementation of DSSSPM System

4.1 Introduction

In this chapter we will describe the design and implementation phase of DSSSPM system. The system represents a decision support system for seaport management to aid the seaport managers (decision makers) to take the most accurate decision quickly, and introduce the proper solutions to the problems that may occur during his work in the seaport. It also helps to predict the problems that may happen in order to avoid them. In figure 4.1 we represent the DSSSPM system structure; it consists of three main components (Model Management, Database Management, and User Interface).
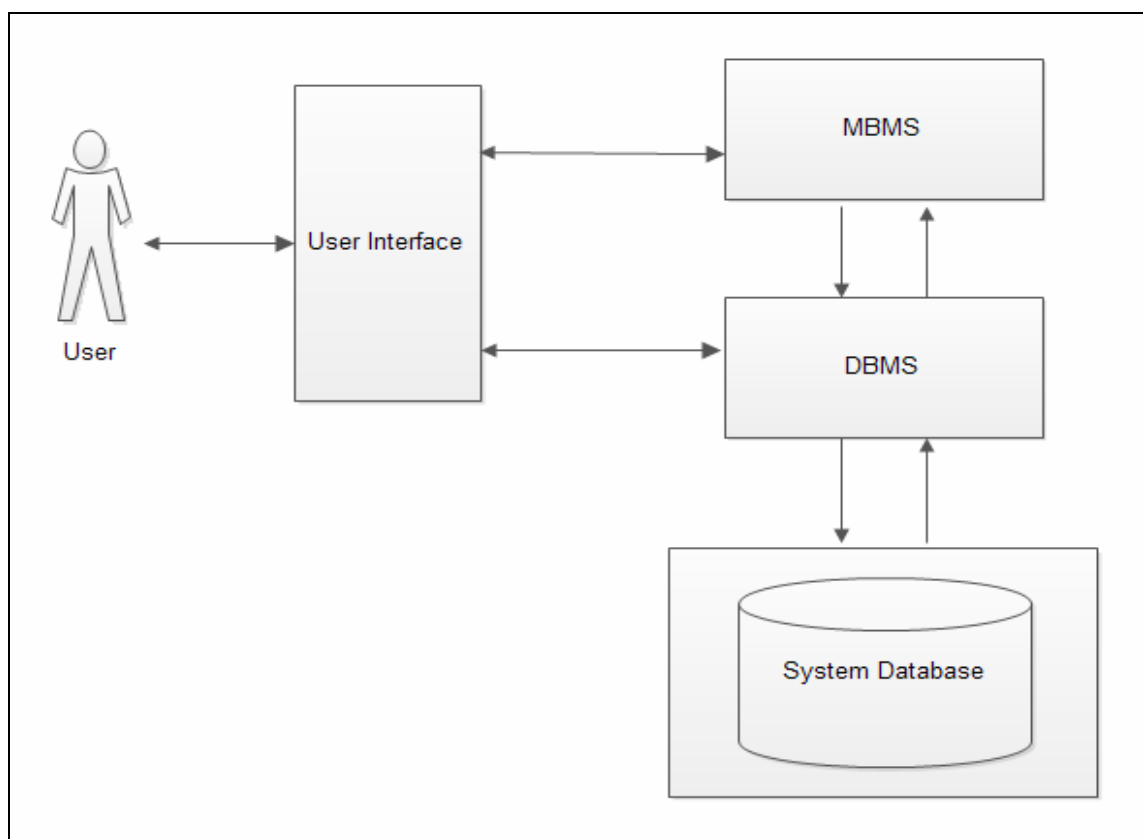
Figure 4.1: DSSSPM Structure

4.2 The DSSSPM System Components

In this section we will explain, in some details, the components of DSSSPM system (in figure 4.1). The first component is the User Interface that is used to interact with other system component. The second component is the Model Based Management system **(MBMS)** that represents the core of the system and it implemented in the system by many procedures and functions. The last component is the Database Management system **(DBMS)** which is designed and implemented using relational database, it contains the tables that are needed to build the DSSSPM system database. It is used to store all important information and knowledge that will be used by the system to take the decision and supports the user with useful information.

Figure 4.2: DSSSPM System User Interface

As shown in Figure 4.2, the User Interface consists of many modules each of them is represented as a command button in the information menu, these modules are, Agents, Ports, Berths, Stores, Equipments, Vessels, Travels, and Query & Reports. Most of these modules are auxiliary and are used to entering information about the port, berth inside each port, store inside each berth, equipment that are used in the system, vessels that are usually coming to the port and so on. When the system is newly installed, the database tables are empty in figure 4.3; therefore the user must fill these tables with required information. Each module is representing the user interface for these tables. As we mentioned before, these modules will be used to support the main module (Travels module). The user interfaces for these modules are shown in the Appendix (page 64-79). The travels module records the manifest information to enables the system to take useful decisions, as well as, to generate accurate queries and reports to help the managers of seaport. In figure 4.3 we present the Travel module User Interface, and the next section, we will describe in detail all processes of the travel module.

Figure 4.3 Travel module user interface

4.3   Travel Module

The Travel module essentially takes its information from the manifest, which contains information about the vessels. The system's user must fill the fields of the Travel module by the required information using the received manifest. As we show in Figure 4.3 the travel module consists of three parts, each of them contains many controls, and will be represented as text box, combo box, list box, clack box, or command button. Each part has a group of related controls and we will describe them in the next paragraphs.

Part1:

This part contains many fields used by the user to enter information about the travel number and vessel name or number. The user can select the vessel name (and number) and the system will retrieve automatically all information about the selected vessel from the vessel table that is stored previously by the user. If the required vessel is not found in the vessel table, the user must click the "vessel information" button which is linked to the vessel information form to enter information about the new vessel.

Part 2:

In this part, the user must enter the expected arrived date and time, and select the shipment type based on the vessel's load. If the shipment type is not available in the list, the user can click the "shipment information" button which is linked to the shipment type form to enter the required information about the shipment type. In case of the shipment type is container, and then the system will show a new field to allow the user to enter the number of container on deck that will be stored in the container Yard. Also, the user must enter the shipment capacity.

After entering the required fields, the user must click the "Execute" button to calculate the expected departure date and time, and calculate number of needed tracks.

The final process in this part is to select the needed equipment type that is required to unload the vessel's load depending on shipment type, the system support with a button "Add equipment" to add the required equipments. In some cases the vessels may be supported with required equipments for unloading its shipment load.

As shown in figure 4.3, the "Execute" button (in part 2), will be used to compute the expected departure date and time and is done by applying the following pseudo-code:

1- Begin

2- **Input:** A. Expected Arrived date and time.

        B. Shipment capacity.

3- **Output:** Expected departure date and time.

4- TULS= ATULSU x SC.

5- EDDT= TULS+EADT.

6- End.

Also we need to computes the number of required tracks that are done by applying the following pseudo-code:

1- Begin

2- **Input**: A. shipment Type.

        B. shipment capacity.

3- **Output**: Number of required trucks

4- NNT= SC/NUPT.

5- End.

Part 3:

In this part the user must enter the actual arrived date and time, and click the "Execute" button (as shown in figure 4.3, part 3) in order to check the available berths that are suitable to the vessel and compute the departure date and time. This is done by applying the following pseudo-code.

1- Begin

2- **Input:**   A. vessel name.

B. shipment type.

C. arrives date and time.

3- **Output:** A. available berths.

B. departure date and time.

4- Check if there is available and suitable berth:

A. If available then select the berth name from the list of available berths and set travel status to "Arrived".

B. otherwise add the vessel to the waiting list and set the travel status to "waiting".

5- End.

The vessel status has three cases, when the user enters new travel the vessels status sets to "new", when the system is assigned to a suitable berth for the vessel then the vessel status will sets to "Arrived", otherwise the vessel status will set to "waiting".

In case of vessel status is "waiting", the system support with button "check available berth" to check if there is some berth become available to the waiting vessel.

Finally, the system support with a "waiting list" button, which is used to show all vessels in the waiting list.

4.3.1   Check Available Berth

The check available berth button is used to check the available berth and suitable for the vessel that are waiting in the waiting list. If any berth is become free and suitable for any vessel in the waiting list the system will assign this berth to this vessel and change its status to "Arrived", and remove it form the waiting list. The system is queues the vessels that are waiting to the specific berth which is suitable to the vessel specification.

The vessel in waiting list is put into a queue data structure as first in first serve. The system automatically informs the user if there are any berths become available.

4.3.2 Travel Report

The system has the ability to print the travel information as a report. It contains all information about the travel, as shown in Figure 4.4 (sample of the travel report).

Figure 4.4: Travel Report

Also we have more examples are shown in the Appendix (page 80-81).

4.3.3 Travel Queries and Reports Module

The system has the ability to generate various desired queries and reports. There are many criteria for the query such as specifying vessel name, berth name, vessel status, shipment type, arrives date and time. Also the use can make any combinations of there criteria's. If all criteria fields is empty and the user clicks the "query" button. The system will display all the travels in the database. Also, if select the desired vessel name, the system will display all travel for the select vessel name, and so on, for all other criteria fields and its combination.

Figure 4.5 Show the travel query and report user interface.

Figure 4.5: Queries and Reports user interface

Figure 4.6 show a sample report for a generated query.

Date: 16/12/2011

Travel No.	Vessel Name	ShipmentTypesName	Shipment Capacity	No of needed trucks	Berth Name	Arrived Date	Departure Date
1	Vessel A	Container 20	2	1	Container Berth 1	03/12/2011	03/12/2011
2	Vessel B	Container 20	100	50	Container Berth 1	10/12/2011	10/12/2011
3	Vessel A	Cars	36	3	Cars Berth	10/12/2011	17/12/2011
4	Vessel B	Cars	36	3			
5	Vessel A	Cars	36	3			
6	Vessel A	Cars	36	3			
7	Vessel A	Cars	30	3			

Figure 4.6: Queries and Reports Report

Chapter 5

Conclusions and Future Work

5.1.   Conclusions.

5.2.   Future Work.

Chapter 5

Conclusions and Future Works

5.1 Conclusions

In this section we summarize the conclusions that are established from our developed system, these are:

1. The DSSSPM system is developing to help the decision makers in the seaport to take the accurate decisions, and to support him in managing the arrived vessels and schedule the equipments and yards.

2. The main characteristics of the DSSSPM system are, the simplicity of use, high efficiency, quick response in the critical situations, generating dynamic query and reports.

3. The DSSSPM system is portable and can easily configure to work with DBMS, such as Ms-SQL server, My SOL, My SQL and oracle.

4. The system helps the seaport manager to know the situation of all travels, vessel and berth in the seaport.

5. Our system can easily arrange and schedule the vessels to there actual status (new, available and waiting).

6. Our developed system can be installed and run on any IBM compatible computer with windows XP or newer version operating system.

7. During running and testing the system, we observe its fast response to any required task.

8. The validation rule is implemented in all system parts, therefore, all data that is stored in the system database is accurate.

9. The system capable of deal with all types of vessels and shipment capacities like huge number of containers.

5.2   Future Work

In this section we will suggest several recommendations for the future work to extend the DSSSPM system, these are:

1.   Adding a new component called KBMS, which is used in advanced DSS 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.

2.   Integrating the system with other systems in the seaport like the yard management system and the vessel traffic system.

3.   Develop our system to be able to working with intranet or internet and communicate with other seaports.

4.   Add a part to the system for the urgent vessels, which loaded by perishable goods.

5.   Develop the system farther to be an expert system.

6.   We can add the Geographical Information System (GIS) to improve our system.

7.   We can integrate between vessel traffic system (VTS) with Geographical Information System (GIS).

References

Bourner, T (1996), the research process: four steps to success, in research methods: guidance for postgraduates, Arnold, T.G (ed.), London, pp.7-11.

Brian Mennecke (2006). Decision Support, Knowledge Management and Expert Systems, IOWA State University.

Chien-Chang Chou (2007), "A fuzzy MCDM method for solving marine transshipment container port selection problems**", Applied Mathematics and Computation**, 186, 435–444.

CAO Jinxin, SHI Qixin and Der-Horng Lee (2008)," A Decision Support Method for Truck Scheduling and Storage Allocation Problem at Container": **Tsinghua Science and Technology**, Volume 13, Number S1 October 2008, pp211-216.

Dan Power. "Types of Decision Support Systems (DSS)". Documents and reports, Retrieved December, 23, 2011 from: http://www.gdrc.org/decision/dss-types.html.

Dr.Saeed Shiry. "Decision Support Systems", access 13, 12, 2011 from: http://ceit.aut.ac.ir/~shiry/lecture/DSS/Introduction.ppt.

George Luger, (2002). Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 4Th edition, Addison Wesley.

Goodall, A. (1985), the guide to expert systems, New York, oxford and New Jersey: Learned information. Published 30/11/1985, publisher (information today), ISBN: 9780904933499

Hyung, R.C, Hyun, S.K, and Byung, J.P (2003)."An ERP approach for container terminal operating systems", MARIT. POL. MGMT., **JULY–SEPTEMBER**, VOL. 30, NO. 3, pp. 197–210.

Katta G. Murty, Jiyin Liu, Yat-Wah Wan, Chuqian Zhang, Maria C. L. Tsang, and Richard Linn 2000, (DSS) Decision Support Systems for Operations in a Container Shipping Terminal. http://www-personal.umich.edu/~murty/kuwait4.pdf
Access in 2/5/2011 at 14:34:23

Kap Hwan Kim, and Kyung Chan Moon, (2003), "Berth scheduling by simulated annealing", **Transportation Research Part B** 37, 541–560.

Kjetil Fagerholt, (2004), "A computer-based decision support system for vessel fleet scheduling—experience and future research", **journal of Decision Support Systems**, 37, 35 – 47.

Klein, M. and L. Methlie (1995)," Knowledge-based Decision Support Systems with Applications in Business", Chi Chester, UK: John Wiley & Sons.

Korea Logistics Network Corp, "Introduction of Port Management Information System in Korea". Retrieved March, 16, 2011 from:
http://www.aplf.net/files/down/B1m.pdf

Marvin Minsky, (1974), "A framework for representing knowledge", Technical report , memo No.306, Massachusetts Institute of Technology, Artificial Intelligence Laboratory, Cambridge, MA, USA.

Martin, M & Nigel , B (2002), " Proceedings of IFIP 17th World Computer Congress", Montreal, Canada, 25-30, Kluwer Academic Publishers, p133-148.

Michael, N (2005), Artificial intelligent: A Guide to Intelligent Systems/ (2nd ed.), Wesley, A, London.

Notteboom, T & Winklemans, W (2002), Stakeholder Relations Management in Ports: dealing with the interplay of forces among stakeholders in a changing competitive environment, IAME 2002, Panama City Panama, pp.1-20.

Owaied, H.H. & Abu- Arr'a, M (2007), "Functional model of human System as knowledge Base System", **Proceedings of the 2007 International Conference on information & Knowledge Engineering**, PP.158-161.

Tran, T, Harris, C. J. and Wilson, P. A. (2002)."A vessel Management Expert System": the Maritime Environment Engineers, Part M: **Journal of Engineering for Proceedings of the Institution of Mechanical**, Vol.216, pp.161-177.

Tom T.H & Huosheng Hu, (2002),"Distributed Agent Architecture for Port Automation", **Proceedings of 26th International Computer Software and Applications Conference (COMPSAC 2002)**, Oxford, UK. PP.81-90.

Tsung-Yuan Tseng, Yeou-Ren Shiue, Ke-Chih Ning, Shih-Wei Lin, and Wei-Ming Cheng (2009),"Using new attribute construction to incorporate the expertise of human experts into a smuggling vessels classification system", **Expert Systems with Applications**,36,7773–7777.

UNCTAD secretariat, 2004, Assessment of a seaport land interface: an analytical framework Retrieved April, 02, 2011 from:

http://www.unctad.org/en/docs//sdtetlbmisc20043_en.pdf.

Winklemans, W (Eds.) (2002), Port Competitiveness. De Boeck Ltd, Antwerp, Belgium.p.4.

Walczak, S (2006), "Knowledge Acquisition and Knowledge Representation with Class: the Object Oriented Paradigm", International Journal of Expert Systems with Applications, Vol. 15, No. 3/4, Oct./Nov., PP. 235-244.

Wikipedia, Available at:

< (http://en.wikipedia.org/wiki/Decision_support_system#Benefits) >

 [Access in 23/12/2011 at 18:12:44].

Wikipedia, Available at: < http://en.wikipedia.org/wiki/Observation > [Access in 12/11/2011 at 12:21:10].

Appendix

User Interfaces for the DSSSPM System

1. **Introduction.**

2. **User Interfaces**

    2.1   Login Form

    2.2   Travel Module User Interface

    2.3   Users Permissions

    2.4   Travel Report

3. **Examples for DSSSPM system**

Appendix

User Interfaces for the DSSSPM System

1. Introduction
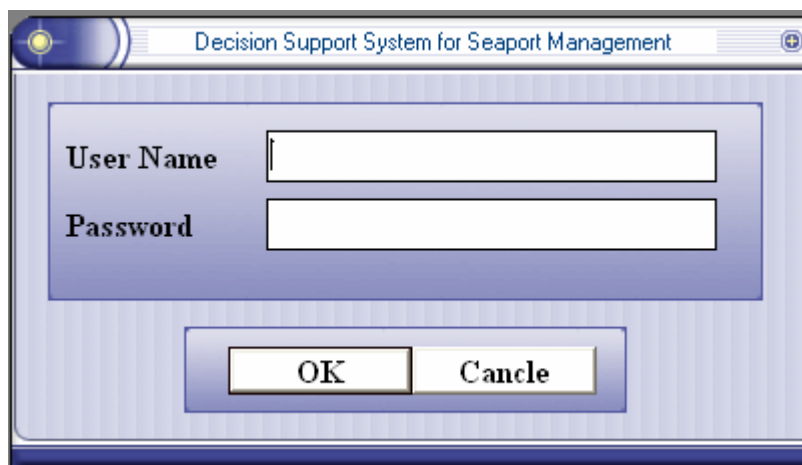
In this Appendix we will describe all user interfaces for the DSSSPM system, by using its main components in order to show its capabilities and functionalities.

2. Main User Interfaces

In this section we will describe all user interfaces for the system, which are the login form, the Travel module user interface, and the information menu.

2.1 Login Form

This form will ask the user to enter the name and password to login into the system.

Figure A.1: Login Form

If the user not has a permission to use the system, the following massage will appear (figure A.2).

Figure A.2: Invalid user name or password error message

2.2 Travel Module User Interface

Figure A.3: Travel module user interface

This form allows the user to add, edit or delete a travel after receiving the travel manifest, and it contains the following fields:

Travel Number: contains all travel numbers that are added in the system.

Vessel Name: contains all vessel names defined in the system.

Vessel No: contains all vessel numbers defined in the system.

Displacement, Draft, Length, Width: when the user select the vessel (name or number) all these fields will be filled automatically by values related to the selected vessel (stored previously).

Expected Arrived Date and Time: This field will be filled based on the manifest which represents the expected arrived date and time for the vessel.

Shipment Type: Shows the shipment type for the vessel based on the manifest.

Shipment Capacity: Its value will be filled depending on the manifest; it represents the expected shipment capacity for the vessel.

Execute: *compute the Expected Date and Time and compute Number of the needed trucks:* This button used to calculate the expected departure date and time and fill the "Expected Departure Date and Time" field. The calculation depends on the type of shipment and it capacity, as well as it calculates the number of needed trucks and fills the "Needed Trucks" field.
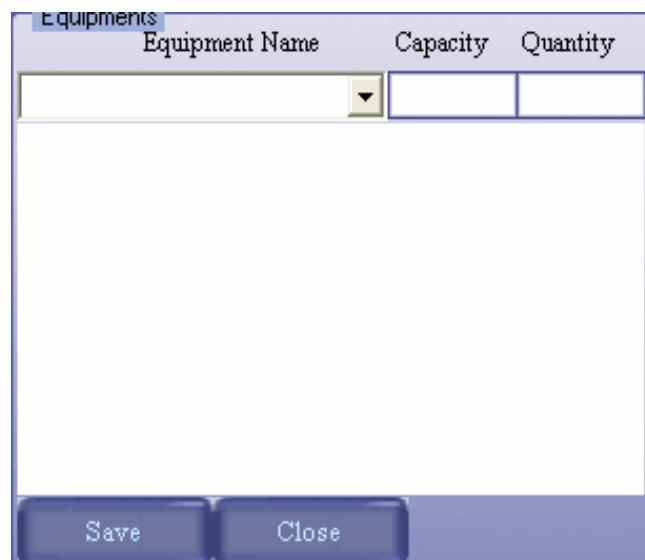
Expected Departure Date & Time and needed trucks: filled automatically when the Execute button clicked, it presents the expected departure date and time for the vessel, and also the number of needed trucks respectively.

No. of containers need to be stored in the yard: This field will be shown only if the shipment type is "containers", it will be filled by the number of containers that need to be stored in the yard, this field will effect on the "Needed Trucks" field value by

decreasing the number of needed trucks or make it zero if all containers need to be stored in the yard.

Need Equipment: This check box will be checked if the selected vessel needs equipment to unload the cargo. The error message "Please save the travel before adding equipments." appears if the user selects the checkbox before saving the travel.

Add Equipment: This button allows the user to add the needed equipment for this travel; the user can add the desired equipments as shown in Figure A.4.

Figure A.4: Add Equipment form

Actual Arrived Date and Time: This will be filled by the user after receiving the confirmation of the arrived date and time for the vessel.

Execute: *Check Available Berths and Calculate the Departure Date and Time:* This button will be clicked after filling the Arrived Date and Time field in order to calculate the Departure Date and Time and filling its fields, also to check the available berths that are suitable for the vessel by checking the dimensions of vessel and shipment type with suitable available berth.

Figure A.5, shows the message that will displayed if there is no available berth proper for the selected vessel to inform the user that the vessel will be added to the waiting list.
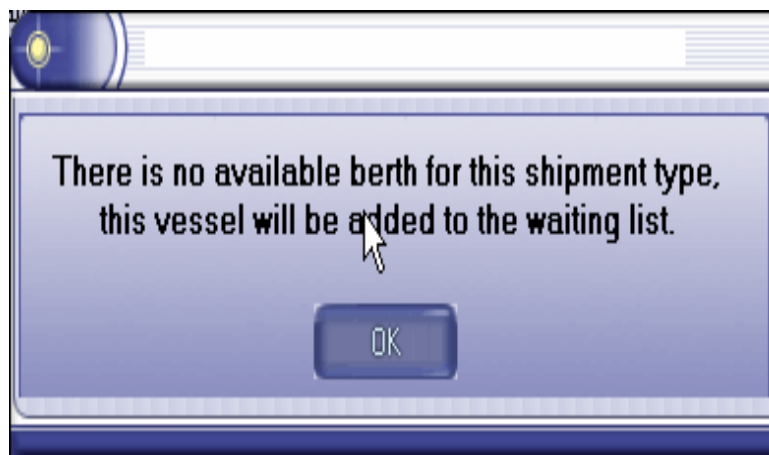
Figure A.5: Adding the vessel to waiting list message

Actual Departure Date and Time: This will be filled automatically after clicking the "Execute" button; it represents the departure date and time for the vessel.

Berth Name: This field will be filled automatically to enable the user to select on which berth will unload the vessel.

Need Store: This check box will be checked if the shipment needed to be stored in the berth store; clicking the "Add stores" button allows selecting the needed store(s) to be used by the selected berth, as shown in figure A.6.

Figure A.6: Add Stores form

Vessel Status: This field will show the status of the vessel, it will be filled automatically by one of the following values "New, Arrived, or Waiting".

Check Available Berths: This option inform the user if there is an available berth to use it by any vessel in the waiting list and display a message to inform the user to berthing the vessel to the berth for specific travel number as shown in Figure A.7.
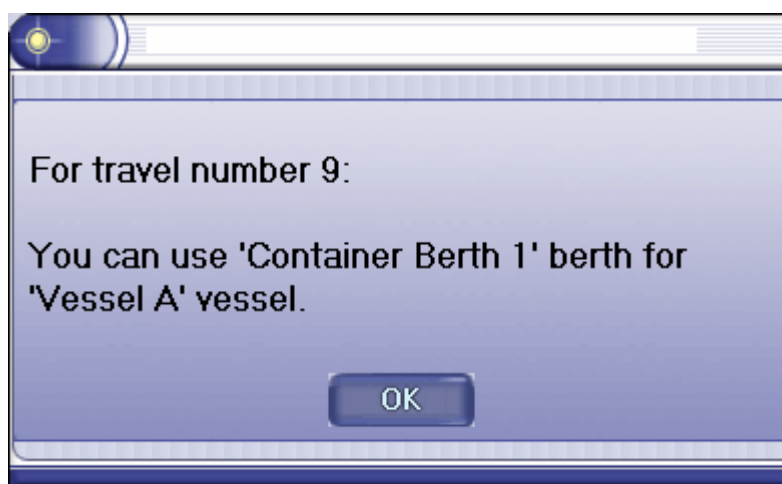
Figure A.7: Notification Message

Waiting List: This option will be enabled if there is an existing vessels in the waiting list, it will show all vessels in the waiting list.

The following buttons allows to manipulating the travel:

    New: This button allows adding a new travel. And travel number will be generated automatically by the system.

    Edit: Allows editing the travel fields for the selected travel.

    Save: Allows saving all information for the displayed travel.

    Delete: Allows deleting all information for the displayed travel.

    Print: Allows printing the displayed travel.

Queries and Reports: Allows opening the Queries and Reports form.

Information Menu: This button allows opening the information menu.

Exit: Used to exit from the system.

As mentioned above, the travel module user interface contains all information about the travel. The following forms are used to collect information about, shipping types, Agent information, port information, berth information, berth types, store information, store types, equipment information, vessel information and vessel types, as shown in the following figures:

Figure A.8 Information Menu

Figure A.9 Shipping Types form
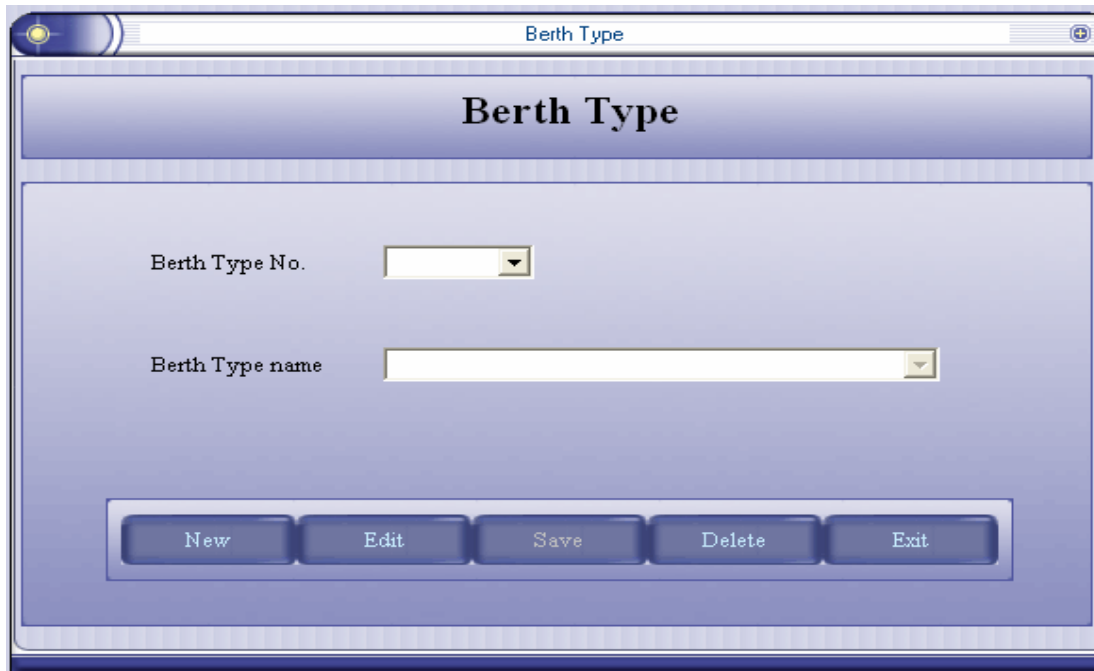
Figure A.10: Agents Information

Figure A.11: Ports Information

Figure A.12: Berths Information

.

Figure A.13: Berth Type

Figure A.14: Stores Information
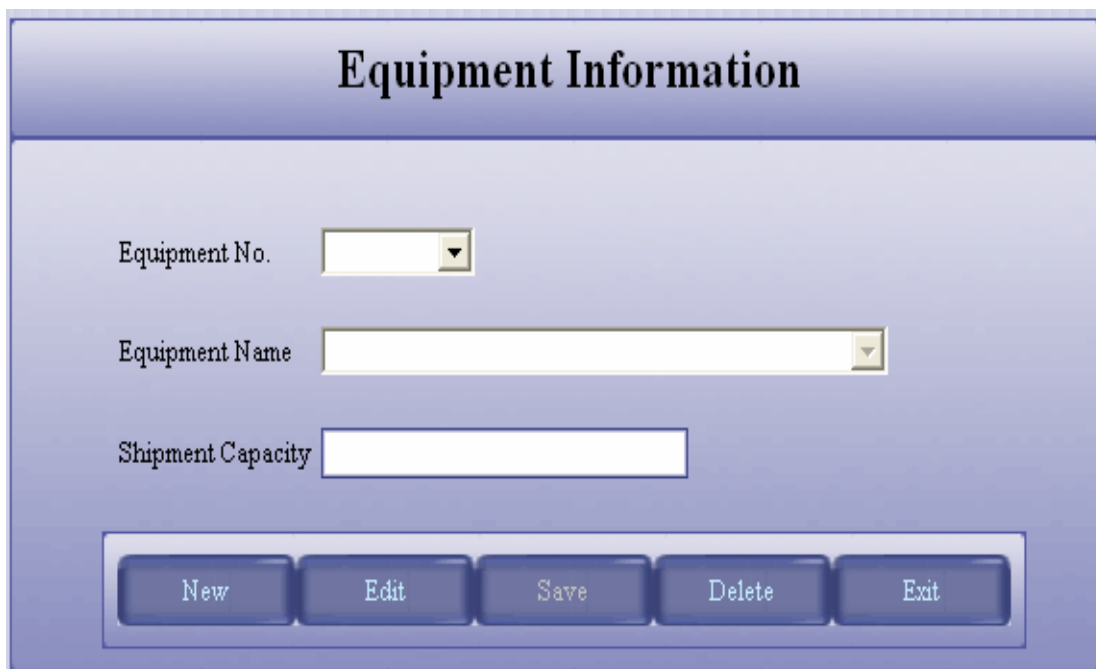
Figure A.15: Store Type
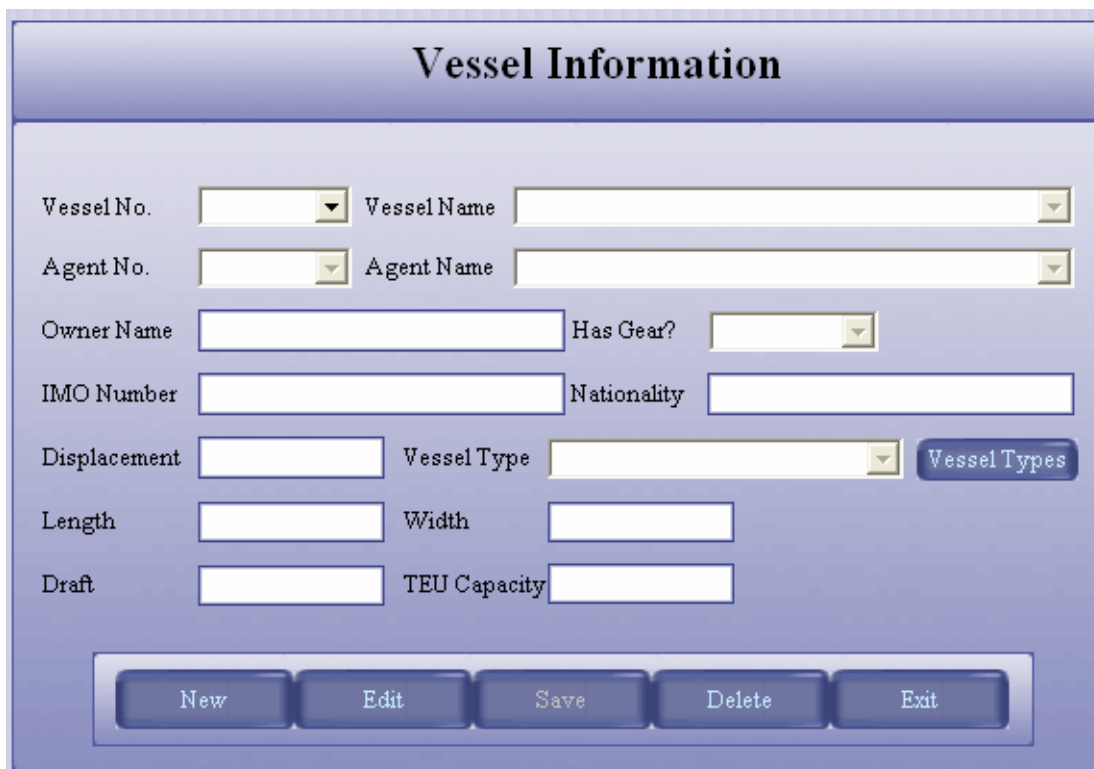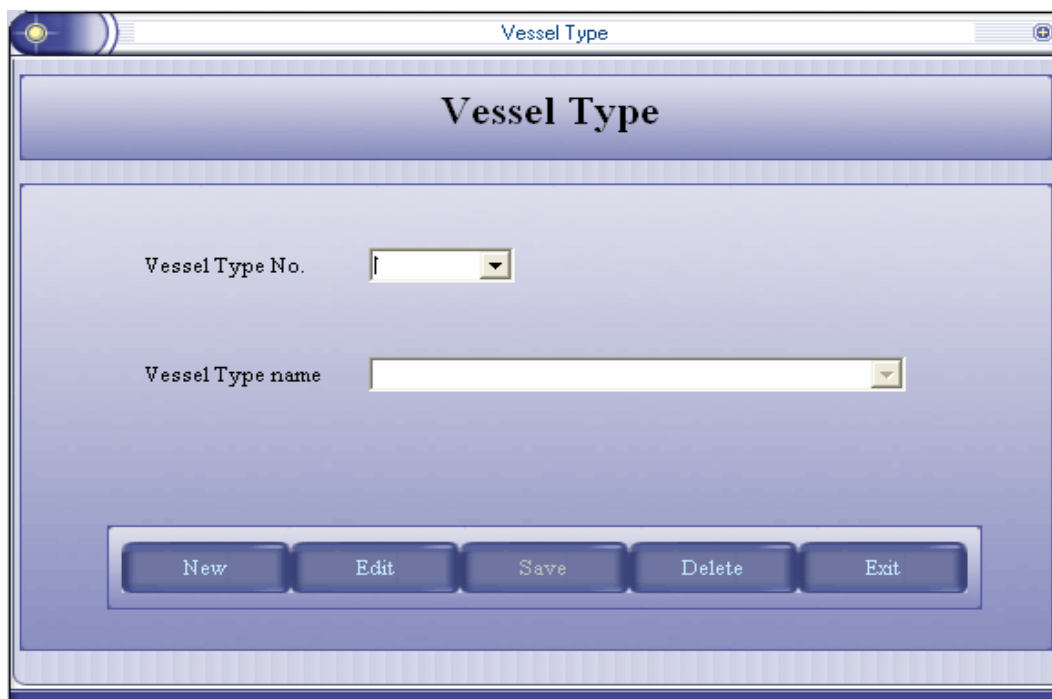
Figure A.16: Equipment Information

Figure A.17: Vessel Information
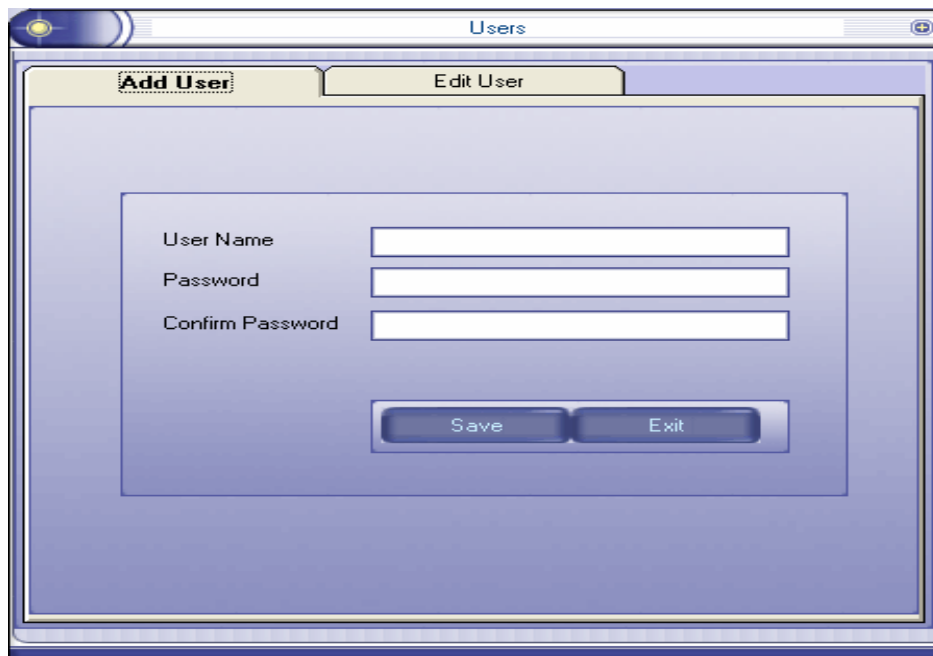
Figure A.18: Vessel Type
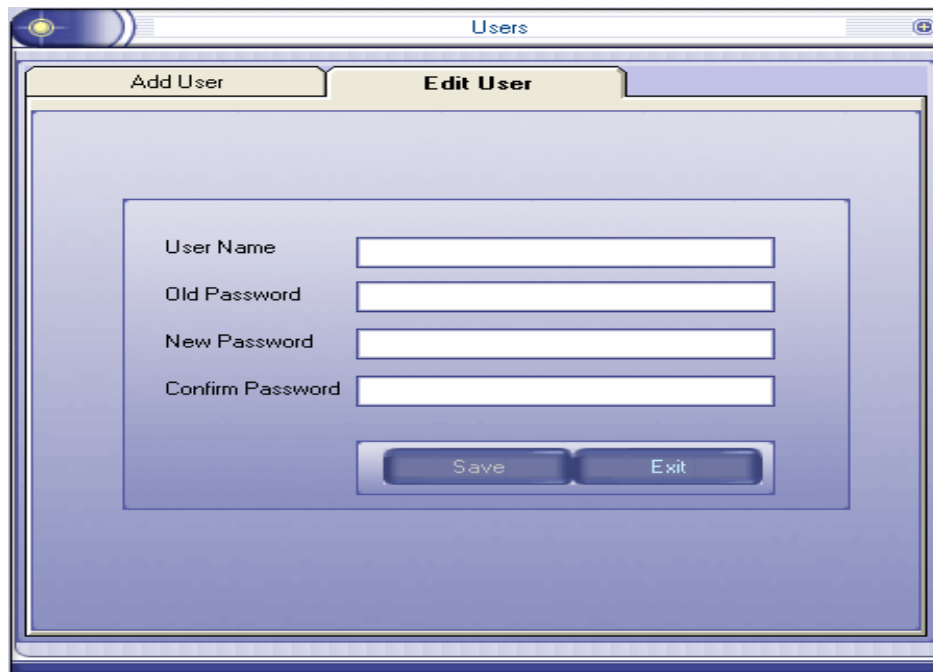
2.3 Users Permissions:

The system has the ability to add new users, as well as, modify existing uses as show in the following figuires:

Figure A.19 add Users

Figure A.20: Edit User

2.4 Travel Report:

The user can print the reports for the selected travel; we can take as an example four cases as follows:

1- Travel that contains Equipment and Stores.

Figure A.21: Travel Case 1 Report

2- Travel that does not contain Equipment and Stores.

Report For Travel Number: 2   Date: 16/12/2011

Vessel Information:

Vessel No. 2   Vessel Name: Vessel B

Displaceme 10   Draft 10   Length 10   Width 10

Shipment Information:

Expected Arrived Date 06/12/201 03:00:31   Expected Departure Date 06/12/201 04:40:00

Shipment Type Name Container 20   Shipment Capacity 100

Needed trucks 50   No. of containers need to be stored in Yard 0

Travel Information

Arrived Date 10/12/201   Arrived Time 03:31:54   Departure Date 10/12/201   Departure Time 03:50:00

Berth Name Container Berth 1

Figure A.22: Travel Case 2 Report

3- Travel that contains Equipment and does not contain Stores.

Report For Travel Number: 3   Date: 13/02/2012

Vessel Information:

Vessel No. 1   Vessel Name: Vessel A

Displaceme 10   Draft 10   Length 10   Width 10

Shipment Information:

Expected Arrived Date 07/12/201 03:23:29 م   Expected Departure Date 07/12/201 05:03:00 م

Shipment Type Name Cars   Shipment Capacity 36

Needed trucks 3   No. of containers need to be stored in Yard 0

Needed Equipments

Equipment Name	Capacity	Quantity
Lorry	120	10

Travel Information

Arrived Date 10/12/201   Arrived Time 01:07:01 م   Departure Date 17/12/201   Departure Time 02:22:00

Berth Name Cars Berth

Figure A.23: Travel Case 3 Report

4- Travel that contains Stores and does not contain Equipment.

Report For Travel Number: 4   Date: 13/02/2012

Vessel Information:

Vessel No. 2	**Vessel Name:** Vessel B		
Displaceme 10	**Draft** 10	**Length** 10	**Width** 10

Shipment Information:

Expected Arrived Date 07/12/201 03:58:57 م   **Expected Departure Date** 07/12/201 05:38:00 م

Shipment Type Name Cars   **Shipment Capacity** 36

Needed trucks 3   **No. of containers need to be stored in Yard** 0

Needed Stores

Store Name	Capacity
Cars Store	1000

Travel Information

Arrived Date 17/12/201	**Arrived Time** 02:31:37	**Departure Date** 17/12/201	**Departure Time** 02:37:00
Berth Name Cars Berth			

Figure A.24: Travel Case 4 Report

3. Examples of using the DSSSPM System

The following is an example of a manifest for a new vessel that is not defined in the system and contains 200 cars, this mean that the user has to define it by clicking on the Vessel Information control to open the vessel information module as shown in Figure A.25, then fill the vessel information as in the manifest then save it and back again to the travel module by clicking Exit control.

Figure A.25: Add a New Vessel

Select the added vessel in the Travel module and observe that the vessel information in **Part 1** will be populated automatically, now fill in the Expected Arrived Date & Time with (13/2/2012, 1:21) and select (Car) in the shipment type control and fill in the shipment capacity with (200) based on the manifest information in **Part 2**, then click the Execute control. The system will fill in the Expected Departure Date & Time with (14/2/2012, 10:41) and the Needed Trucks with 17 to transfer it out of the berth; since every 12 cars will be loaded on one truck as shown in Figure A.26.

Figure A.26: Cars Cargo Travel module

We will show the report, of the above travel in Figure A.27

Figure A.27: Cars Cargo Report

Also if we received another manifest for Vessel C and the vessel was defined in the system and contains 400 ton of soya bean, then select a vessel from the vessel name control in **Part 1**, and in **Part 2** fill in the Expected Arrived Date & Time with (13/2/2012, 1:21) and select (Soya Bean) in the shipment type control and fill in the shipment capacity with (400) based on the manifest information, then click the Execute control. The system will fill in the Expected Departure Date & Time with (25/2/2012, 1:21) and the Needed Trucks with 12 to transfer it out of the berth; since every 36 ton will be loaded on one truck as shown in Figure A.28.

Figure A.28: Soya Bean Cargo Travel module

We will show the report, of the above travel in Figure A.29

Report For Travel Number: 11   Date: 20/02/2012

Vessel Information:

Vessel No.   3   Vessel Name: Vessel C

Displaceme 150   Draft   25   Length   150   Width   25

Shipment Information:

Expected Arrived Date   13/02/201 01:21:55   Expected Departure Date   25/02/201 01:21:00 م

Shipment Type Name Soya Been   Shipment Capacity   400

Needed trucks   12   No. of containers need to be stored in Yard   0

Travel Information

Arrived Date   20/02/201   Arrived Time   12:07:11   Departure Date   20/02/201   Departure Time   12:07:11

Berth Name

Figure A.29: Soya Bean Cargo Report