MARIDES

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MARItime DEcision Support

WP10

D26 Final Project Report

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REPORT SUMMARY SHEET

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Short Description:

In this deliverable we provide the final report for the MARIDES project. The report contains a summary of the project, presents its main results and concluding remarks. In addition there is an assessment of the project's overall impact regarding benefits to partners, dissemination and exploitation issues as well as required future steps.

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1 Executive Summary

The shipping industry has been traditionally negative towards computer support. By now, there exists a huge selection of software packages to automate some of the activities engaged in by shipping companies. There is still very much missing from this corpus, however. Existing systems are in fact very much alike each other. In practice, they almost always provide little more than office automation tools. This does not mean these programmes are trivial. Analysing and modelling the data structures and flows behind the operation of shipping companies requires sophisticated handling, due to the complexity of these operations. Moreover, the existence of these tools is required by international regulations and codes ruling the maritime transportation sector. Though the result in the best cases may be complex, sophisticated and efficient software, from the point of view of the user the functionality is still limited to the automation of basic office procedures. The quality of this software is seen as the efficiency of the automation.

To offer truly better software support to the shipping industry is no easy undertaking. What sets our project apart from others in this area is that it sought an understanding of which tools can really add intelligence to shipping software in order to complement the typical office automation functionality. The MARIDES project thus possesses a broad vision for the shipping industry, considering ways in which new business processes in the vessel chartering domain could be taken advantage of by offering them the necessary support.

The MARIDES project focuses on the improvement of the decision-making process in the chartering departments of the shipping companies. It is a data management, communications automation and decision optimisation software tool. The system's goal is to assist people working both on-board and ashore in the shipping industry to deal with the mass of data and to provide an accurate, fast and on-line consultation.

Nowadays, commercial software applied in the shipping industry can belong to the aforementioned class of basic office automation applications (which lack any significant machine intelligence capabilities) or also to an alternative, emerging category, that of Internet applications with functions similar to those of a broker – including functions such as sites hosting auctions or cargo-order lists – which, once more automates a set of existing procedures, in this case related to communications related to the shipping industry. There is no innovation in terms of actual processes. That is to say, even though a potentially huge variety of options is offered to the user, current software products fail to provide the means to assess these business possibilities.

In contrast, MARIDES aims to revolutionise the way chartering departments function by improving and innovatively integrating a number of state-of-the-art technologies into one unified tool. Instead of competing with existing software, the MARIDES tool complements it. The MARIDES system is based on the combination of an enhanced communication intranet, modern, web-enabled information accessing technology, an intelligent decision support tool and a powerful knowledge base.

The MARIDES system achieves:

- The provision of advanced data management and data presentation capabilities
- Components to partly automate the users' electronic communication and data acquisition needs, applicable to cases where machine-readable formats are involved
- The combination of decision support and financial optimisation tools with its data-handling

The services for chartering offered by MARIDES can be summarised as follows:

- Sophisticated decision support for maritime chartering including forecasting and quantification
- Telematics and networking infrastructure and development of a chartering network service
- Semi-automatic data manipulation procedure for the chartering process

The adoption of the MARIDES application and services enhances the chartering business strategy in terms of:

a. Speed and accuracy in the acquisition of information
b. Fast and efficient reaction during chartering negotiations
c. Accuracy in estimations and decision making and through the consideration of stochastic factors which play an essential role in the feasibility and profitability of chartering contracts
d. Enforcement of fleet control and its exploitation in a more systematic and orchestrated manner due to transactional information exchange between the vessels and shipping company premises
e. Delivering appropriate information to the appropriate actors
f. Well designed control of office-level operation, with organised workflow and information flow between executives and support personnel within a chartering department
g. Expansion of business perspectives by allowing automated decision making by the system when a large market presented in machine readable format is available. Though the decision support tool of course does not compete with the expert's decisions, the expert can allow the system to assess possibilities which he would otherwise simply not have time to examine thoroughly enough and then concentrate personally only on those which are determined to be promising by the system. This opens to exploitation previously inaccessible markets where good options do exist, but are hidden amongst an oversupply of business possibilities – for instance, broad-scope on-line marketplaces.

2 Motivation

Waterborne transport efficiency is dependent on various factors such as the operating costs of the vessels, the charter selection, port time, route followed, costs of cargo handling, communications reliability and efficiency. The trading-chain involves numerous inter-linked, intricate stages and also a large number of mediators (sellers, buyers, charterers, ship-managers, ship-owners along with their corresponding brokers, services providers, etc). All these factors heavily influence the efficiency and cost in Shipping. Current policies in shipping procedures are rather simplistic and static, although the business processes, especially the ones concerning chartering, have a very dynamic nature. Decisions are usually taken on the spot and they are based, mainly on experience and intuition. However it is possible to facilitate decision support, by introducing active, "knowledge based" systems, which will be using continuous incoming information gathering and will utilize historical and statistical data stored in databases.

Decision taking for chartering is heavily based on information that it is available through different means of communication (phone, fax, Internet, e-mail or verbally). The collection, organization and presentation of all this information have to be improved and automated. The company should no longer rely solely on the ability of the human resources to exhaustively inquire and process all the relevant information.

The need for automation in chartering has not been ignored by the market. The products that have appeared so far in the shipping market can be divided into the *Standalone*

Systems, the *Online Information Sources,* the *Electronic market places* and the *Hybrid* systems. The *Standalone Systems* such as [10], [13] are usually used for voyage estimation and time charter analysis without any particular intelligence. The *Online Information Sources* such as [8], [18], [20], [15] provide to subscribers a lot of market related time-variant information such as indices, fixtures, vessel positions, bunker prices etc. The amount of the information that is provided is huge and it requires a big amount of experience to evaluate. The *Electronic Marketplaces* like [23] [22] [16] [9] [12] [14] [11] host online auctions for members and matching of cargoes with orders. However they are not widely accepted yet because many ship owners or charterers are reluctant to expose their actual needs. The *Hybrid* systems are combinations of the above systems and such systems can be found at [17], [21].

The most important failing of past attempts to create intelligent shipping software is that they placed artificial intelligence techniques in direct competition with human experts. It is appealing to formulate many of the decision-making problems faced by experts as mathematical problems, and reasonable to attempt to apply AI techniques to discover optimal solutions. Some problems may indeed be possible to solve deterministically and optimally – for example, when a known fleet is intended to execute a known set of cargo transportation orders and the objective is to distribute the cargo in a way which minimises distance travelled. However, in any case where uncertainty enters the equation, especially in the case of business-level unknowns such as future market conditions, software is doomed to fail dismally when *competing* with the capable human decision maker. Although it is complicated to explain why human intuition is so much better than computational power at making business choices, a more than sufficient reason behind experts' prevalence is their knowledge of an endless multitude of critically important facts which are never encoded electronically for software to assess.

There remain two very important ways in which software can assist the human expert, if only its designer is wise enough to shun pointless competition with human intelligence, which remain, the first largely, and the second totally, unexploited:

Firstly, a software system can assist the human decision maker by concentrating on specific components of the decision process which are amenable to combinatorial or statistical processing. This requires a careful modelling of the human's decision process, with emphasis given to the objective of creating a semi-automatic decision tool. The software suggests solutions, but the user can easily impose his or her own judgement, which the software accepts and uses as a hint to improve those decision components which are left to it to make.

In the second case, software indeed replaces human decisions, but in a very special case, that is, when decision making is easy. This concept suddenly becomes meaningful when there is a large quantity of data to be processed. Traditionally, the expert considers a handful of alternatives and chooses the best one, a process in which software cannot easily help. If there are thousands of choices, however, most of which are clearly bad ones, the human expert will be very hard pressed for time to plough through the endless list of obviously pointless options in order to locate those which are worth at least considering. Here, the software can perform an initial sorting step. It still cannot offer a final choice, but it can draw the human's attention to the handful of potentially good ones, for him or her to make an intelligent final assessment. Vast numbers of options are indeed open to the decision makers in the shipping industry today and, to take the reverse viewpoint from that chosen above, the reason they remain unexploited is the lack of effective computer tools to take advantage of them. Chartering managers with cargo

vessels could access gigantic online marketplaces, but human resources simply cannot cope with the increased workload, which today's typical software does little to alleviate.

The MARIDES system built components to connect the chartering department of shipping companies and the ships of the fleet of the company, which enhances bi-directional information exchange. It also provides new application-level motivation to create highly integrated business communications networks in the future. Although building such communications as artificial-intelligence- or natural-language-processing-enabled information mining tools was not within the project's scope, business-level cross-organisational information which *is* directly machine readable is used to new advantage. This motivates either the building of tools to access similar information expressed in less usable formats, or the convergence of the formats themselves.

As far as the chartering procedures are concerned, there is an essential need for a vast amount of diverse information to be collected and processed from various and remotely located sources. The MARIDES system offers a widely relevant knowledge base to the user, supplies automated information acquisition of well-structured data, enhances understanding through the provision of decision support, and of course offers all this within the context of a user-friendly working environment.

Thus, the MARIDES system, by contributing to the state-of-the-art in the domain of vessel chartering, supports efficient and friendly administration of related processes, effective reactivity during negotiations and enhances organisational schemes to enable businesses, organisations and individuals to take advantage of their new environment.

3 Main Results Achieved

MARIDES is an ambitious project, whose main goal is the development of a unified system that will provide and represent to the end user not only all the crucial data about a given order but will also aid the user to make a decision considering the order itself, the possible alternatives and information about the environment which will influence the decision. The user is able to access, through a homogeneous environment, all the data that are crucial for the given order, and also to have access to any additional general information (such as vessel particulars etc.). According to the above classification it belongs to the hybrid systems.

From the decision support point of view, given a certain chartering order, the system estimates all the possible solutions (all vessels that can serve the given order) and presents them to the user sorted, according to the estimated profit - optionally modified to cater for other factors such as the future market potential. The evaluation is based not only on deterministic data but also on stochastic data. As will be explained in section 3.3 the stochastic data used concern the possibility of the vessel to be chartered from the destination port and the route that the vessel should follow to load the next cargo.

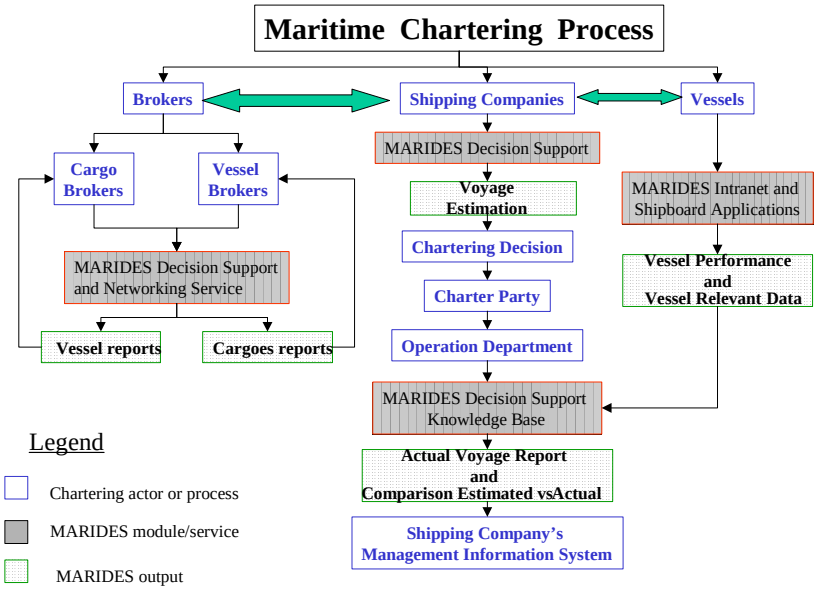

Figure 1 MARIDES incorporation in the maritime chartering chain.

The project addresses the chartering departments of shipping companies, by providing them a system that will create an efficient way of work for the whole range of the companies staff, from company's top management to fleet crew. Processing and availability of information in a unified representation form helps all the key players in the chartering process, to find new opportunities of trade, improve the contractual conditions and reduce transaction costs. The combination of an enhanced communication intranet, a decision support tool and a knowledge base is a strategy that could lead a company to more effective decisions based on well weighed up criteria and not only on the expert's intuition. A diagram illustrating the way MARIDES can be integrated in the chain of chartering actors and processes is presented in Figure 1.

3.1 MARIDES Architecture Overview

An overview of the MARIDES system is illustrated in Figure 2. The office system is the core of MARIDES and it comprises the Data Management System - DMS, which includes the central database, the Decision Support System – DSS and the GUI. The mobile MARIDES system is a minimal version of the office system, for users that are not in the office. Its database is updated from the central database.

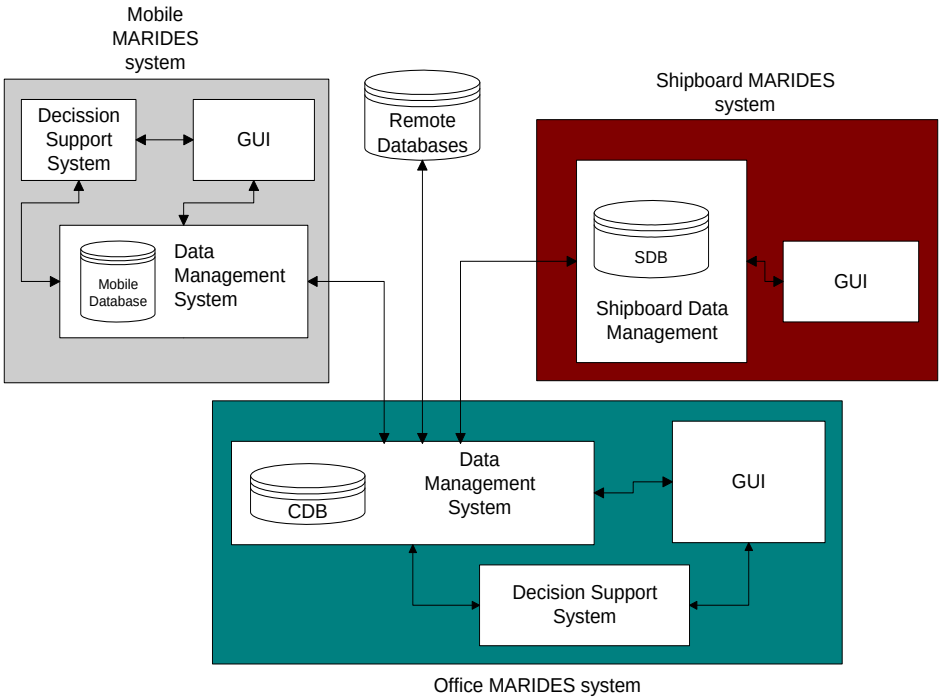

Figure 2 MARIDES Architecture Overview

The Data Management System – DMS collects, manipulates and stores data in order to make them usable by the algorithms and formulas of the Decision-Support System. It includes the central database of the MARIDES system where all important data retrieved during the data manipulation process are stored. The specific data manipulation rules are stored in the knowledge base and the DMS automatically performs periodical accesses to remotely located data sites, in order to pro-actively seek and update the content of it. It also receives via e-mail incoming orders and reports from brokers in a predefined format. Finally, it can directly acquire data from internet locations for which an appropriate interface exits. This interface is just a wrapper, a set of rules, which describes how various data fields can be filled in by using appropriate bits of information offered by the content provider. Constructing these wrappers is a labour-intensive manual operation, but is not an intellectually challenging process, as it simply maps data from one format to another.

The Shipboard MARIDES System is the MARIDES module that is installed on-board and facilitates the transactional information exchange between the vessels and shipping company premises. Thus the chartering manager has a good overview of the chartering procedures regarding the whole fleet. The shipboard users are able to prepare and send their reports by using the Shipboard MARIDES system. All the reports from the office to the vessel and vice versa are stored in the Shipboard Database - SDB.

3.2 Decision Support System-DSS

This subsection presents the most important aspects of the design of the DSS subsystem. The DSS functionality consists of three separate modules, the third of which is presented in most detail:

- Voyage estimation[1] calculations, performed according to standardised formulas used in the shipping industry
- Market monitoring module, which performs data handling and - where the MARIDES Data Managements System reaches its most advanced level - automatic input from both standard communication media such as emails, and the World Wide Web in general; this module involves informing the user of market data, which should affect his decision but is not normally considered by voyage estimation, such as the movements of competing vessels.
- The "Investigation and assessment of proposed charter business and main terms" module; this module has a considerable machine intelligence basis, relying primarily on modelling and statistics, and is presented in detail in the following.

Figure 3 presents a schematic architecture of the "Investigation and assessment of proposed charter business and main terms" module.

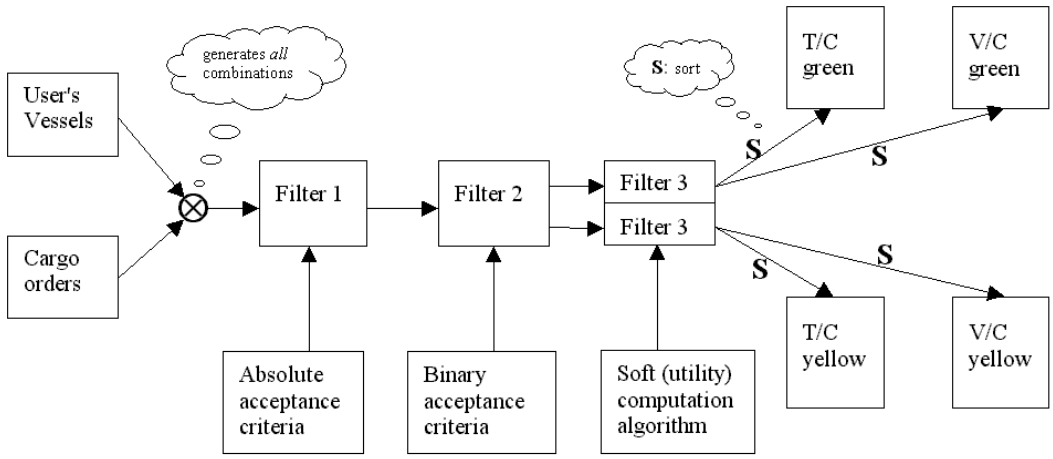

Figure 3 Flow chart for the DSS sub-component which assesses cargo orders.

The system's input consists of all possible combinations of 1) the set of incoming cargo orders and 2) the set of ships and their status. These combinations are then fed through the three Filters.

The system's outputs are ship-cargo matches organised according to the fashion in which they should be displayed to user: 1) in separate windows according to a general type and desirability classification and 2) sorted from best to worst according to the evaluated utility functions. Four windows are used, separating combinations which cannot be compared to each other except by a human expert: 1) Time-Charter and Voyage-Charter[2]

[1] The term Voyage Estimation refers to standard calculations performed by Chartering managers, either by hand or with some simple form of automation, in order to make a basic prediction of the cost of a voyage based on known parameters (such as the current fuel prices) and well-understood mechanisms in shipping (generally simple ones; for example, "total fuel consumption" is "daily fuel consumption" times "days at sea"). Some more complicated parameters are generally simplified based on experience: "daily operating costs" is a constant derived from experience operating the vessel under consideration and includes all costs which might be considered "miscellaneous", such as acquiring provisions for the crew, fixing chance damages of a general nature, and so on.

[2] Voyage Charter (V/C) refers to a contract where a vessel undertakes a single voyage under hire based on the quantity of cargo carried, while Time Charter (T/C) refers to a contract where a vessel is hired for a period of time independently of what voyages might be undertaken. Except for the basic difference that V/C is a contract of substantially smaller duration that T/C, it is also very important that

options are separated, since they offer a ship-owner essentially two different strategies of employment for his fleet, and 2) "problematic" options[3] (of each charter type) are also shown separately for the user to judge whether the appearance of a high rate might offer an unexpected opportunity.

As a black box, the module is a system which finds feasible matches of cargo orders with vessels and presents them to the user sorted according to their assessed desirability; matches which cannot be compared to each other but should be considered separately by the user are provided through separate output views.

3.2.1 Filters 1 and 2

Filter 1 chooses all feasible matches of cargo orders with vessels. Filter 2 separates fully acceptable cargo orders from others, which have some qualitative problem (dangerous materials, not trusted charterer, dangerous country etc) related to them. Normally a chartering manager would ignore the options in the worse set, unless a very expensive rate were offered. Since it is not possible for a computer system to analyse how unusually high a fee would make such options worth consideration, they are separated from the rest, so that a single glance of the user at the top of their list will show whether any "dangerous" but profitable opportunities are available.

Filters 1 and 2 are an issue of Data Management (modelling and processing the appropriate data types). Main Filter 1 criteria:

1. Ship can carry this type of cargo
2. Ship is allowed to travel (from origin) to destination (or within specified Trading Areas for T/C) (e.g. Australia does not accept old ships)
3. Ship is capable to travel (from origin) to destination (or within specified Trading Areas for T/C) (not the same as above, e.g. target port may be too shallow, use Loadport and Disport characteristics)
4. Ship is capable of travel for the desired duration (e.g. no need for dry-dock before end of Charter)
5. Ship is open for charter during the period required by the cargo order (from ship records and first Laytime and last Cancelling date)

Main Filter 2 criteria:

1. Cargo type is to be avoided (re: cargo exclusions)
2. Voyage passes through regions which are to be avoided by user choice
3. Voyage passes through conditionally undesirable regions
4. Voyage passes through regions suffering from extremely bad weather
5. Charterer is not trusted
6. Broker is not trusted

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under V/C the ship-owner faces any unexpected risks, since the fee is a constant for the voyage as planned in advance, while under T/C the ship-owner receives a constant fee for the duration of the charter and is not in danger from risks which might cause the voyages actually performed to deviate from the initial plan agreed upon. However, since T/C is a low-risk option for a ship-owner, the fees agreed upon are typically lower than what might be expected from a consideration of V/C fees.

[3] see description of Filter 2 in the next section

7. Market is very low and duration of charter is long
8. Market is very high and duration of charter is short
9. Very high level of competition detected at and/or near destination port
10. User has specified preferences for voyage parameters which are not satisfied

3.2.2 Filter 3

The purpose of filter 3 is not to supplant the user's judgement, but rather to make as powerful an estimation as possible, and then to offer this estimation as an aid to the user. Filter 3 *augments* the normal Voyage Estimation procedure by including a prediction of the duration or distance of the Ballast Voyage[4] which will *follow* the voyage being considered. This is an indirect measure of the desirability of travelling to the destination port of the current voyage. Average expected ballast size is predicted based on location, season, type and size of ship, and the detection of patterns present in historical data.Estimations are possible due to feasibility to predict:

- reasonable quantities of commonly available data required (for example [8] [18] [20] [15] provide good databases for this purpose)
- reasonable prediction accuracy possible (as reasoned above)

The suggested feature is a useful indication for decision making:

- depends on ship type and size and on location and seasonal considerations, easily expandable to more features
- strongly measures a basic desirability connected with voyages, that is, basic patterns in the length/duration of (future) ballast voyages, due to geography, trading patterns, and so on (a clear example is that a tanker delivering to Japan is condemned to a longer ballast voyage that another delivering to the USA, since there is no hope of reloading in Japan).
- in addition. the measure is not a simple cost-related feature taken from historical data; it is correlated with many factors (market fluctuations, bunkering, anything which will influence a charterer's decision-making) and so offers at least a partial measurement of all relevant information. Whereas such parameters could not be estimated directly, the correlated feature used is in fact summarising some of the *most important* results of their influence: the cost of a vessel travelling without cargo, as predicted based on real data, i.e., based on the way real chartering decisions were taken in the past.

The process of Ballast Voyage estimation involves the following steps:

1. Draw upon data for estimation (*pre-processing step*) – build a database with records of past ballast voyage distances from historical data, extracting information on ballast

[4] Vessels do not always travel loaded with cargo. It often passes that the loading port for one voyage is not the same as the discharge port of the previous one. The vessel must then travel without cargo, in other words "in *Ballast*", between these ports. The costs of a Ballast Voyage are normally considered together with the costs of the normal voyage which commences from a port which is located away from the vessel's current location. The fact that traveling to a given port implies predictable probabilities of Ballast to possible next loading ports is not normally used for calculations (although humans may of course intuitively include such facts in their considerations).

voyages from consecutive entries in fixture lists[5], excluding problematic data (missing values or outliers which are likely to be due to incorrect reports or other errors)

Similarity matching – find the degree of similarity between available historical records and input; we use a utility-theory-inspired similarity metric [23] to find records which are useful for using as samples for a prediction for the unknown quantity.

Data selection – choose which records should be used as a basis for prediction; the most similar results from the previous step will be used, but the number of records which are significant for the prediction must be determined. We use statistical significance and goodness-of-fit criteria [1] [4] [5] [6] to make this decision.

2. Smoothing – estimate ballast distribution; the final prediction is based either by fitting a probability distribution to the data, or by taking the data itself to represent the probability density of the result, but in this latter case explicit smoothing must be used to reduce the effect of noise, outliers etc. in the historical data. Our first work involves fitting the data to the distribution chosen from the step above, using standard maximum-likelihood techniques [7].

3. Utility calculation (*post-processing step*) – find utility of voyage having estimated ballast probability distribution. The utility of the voyage under consideration is calculated by a numerical integration based on:

$$U(voyage) = \int_0^{oo} u(TCE \mid nBal)\, p(nBal)\, dnBal \qquad (3)$$

where: nBal is the next-voyage ballast duration, estimated as described, u(x) = √(x+A), as studied by Cullinane [2] [3], p(x) is the probability of x and TCE is the Time-Charter Equivalent[6]. The TCE is evaluated by a standard Voyage Estimation where the price charged is either that quoted by the cargo order, or, if there exists no quotation, the highest possible (*realistically* possible) derived from the last-done value[7] and perhaps additional fixture information from fixture lists (last-last-done value etc). The default setting for a Voyage Estimation is a break-even rate computation, that is, what TCE must be charged in order for profit to be 0. Here, we require a TCE profit given that we charge the highest rate feasible. Last done values show the rates, which are currently agreed upon in the market, this of course being just an indication of what Charterers will accept to pay.

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[5] fixture lists are lists which are made public and contain information on chartering contracts agreed upon for all vessels in the market

[6] The Time Charter Equivalent is a standard way to describe a fee for a voyage charter by simply dividing the net fee by the estimated duration of the voyage. It is a simple normalisation and the chartering manager needs to intuitively understand the arising incongruences due to the differences between Time and Voyage charters (for example, the differences in risks explained above).

[7] the last-done value is in turn derived from fixture lists (this is an issue of basic data input)

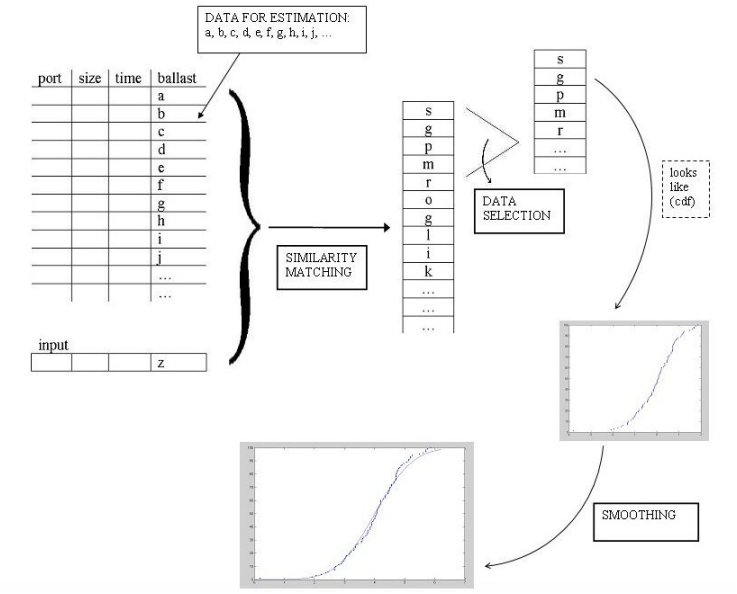


Figure 4 Data flow chart for Filter 3.

The data flow described here is depicted in Figure 4. In the figure, it is shown how an input voyage for consideration is compared to other voyages. Data available for comparison is in the first three columns, port, size and time.

3.3 Data Management System

Collection, manipulation and storage of data are essential to the functionality of the overall MARIDES system. Without a management system for the vast volumes of data, information will not be meaningful, reliable and exploitable for decision making by the chartering departments of the shipping companies.

The role of the Data Management System (DMS) is intended to organize, filter and store all the data necessary for the MARIDES system to function optimally. The DMS is fully integrated into the overall MARIDES system in order to provide reliable and consistent data to the other MARIDES subsystems. Moreover, DMS is able to collect and provide on user demand some critical maritime information (ex. news) in a way fully understandable and worthy to the user. The software is developed with a view of providing an open, modular architecture that is expandable for future requirements.

The Data Management System's primary responsibility is to provide efficient data manipulation and supply in a formal manner all the stored data to the User Interface in order to be presented to the system's user. It includes the knowledge database of the MARIDES system where all important data required is stored.. In addition, the Data Management System can accesses external content providers, translates data collected from these various sources in order to update or enrich the content of the knowledge base and make the data usable to the other MARIDES modules and especially to the algorithms and formulas of the Decision-Support System.

The Data Management System (DMS) can be modularised in 3 sub-systems:

a) The Core Database Access Module (CDAM) – the business logic tier.

b) The Data Interface Module (DIM)-the module interface tier.

c) The Knowledge Base Module (KBM) - the data store and exchange tier.

3.3.1 Core Database Access Module

The CDAM is the only system module that communicates directly with the database to retrieve and/or store information. CDAM stores all the data received by the DIM and and/or other MARIDES modules into the appropriate tables in the database. The other MARIDES modules requests to the CDAM can be either for data acquisition or for data modification. CDAM processes each request and performs the desired action. CDAM can receive a request to provide specific data to the User Interface, Decision Support System or the Service & Dataflow Control System. These MARIDES modules have also the ability to request from the CDAM to modify the state of the data in order for the database to reflect the present status. The main operations this module serves include information storage, selection and retrieval, deletion, update and transformation.

3.3.2 Data Interface Module

Data Interface will act as the entry point of the data module system. There are two options for information feed in the Data module of MARIDES.

a) The Automatic External Data Interface (AEDI). The AEDI's task is to collect required information such as fixtures of vessels, cargo availability and fuel rates from external content providers.

b) The Manual Data Interface (MDI). This module acts like an alternative way to import data to the MARIDES knowledge base. MDI is necessary for the external information that is not organized in electronic form, thus cannot be entered into MARIDES through the AEDI.

3.3.3 Knowledge Base Module

The Knowledge Base Module is the MARIDES system Database on a RDBMS environment. It includes all the necessary tables, relations, indexes, stored procedures for the optimal support of the MARIDES system.

3.4 Shipboard Application

The Shipboard MARIDES System is the MARIDES module installed on-board vessel and aids at controlling the fleet and exploiting the information recorded in a systematic and orchestrated manner, due to transactional information exchange between the vessels and shipping company premises.

The Shipboard MARIDES Application module consists of the Onboard Data Manipulator (ODM) and Vessel's Database (Shipboard Database - SDB). The ODM enables the report preparation by onboard personnel and the SDB is the module that stores (the SDB is a limited version of the KBM).

The Shipboard MARIDES System component of MARIDES supports the preparation and submission of daily performance reports and actual voyage reports. The information of interest includes the estimated time of arrival (ETA) to the next port, steaming hours, consumptions, the position of the vessel the remaining miles the average speed etc. There is also the ability to view vessel details and browse ports and passages information. Moreover the Shipboard Application support the recording of Time Sheet information. The time sheet is an analytical report of data regarding cargo charging or discharging operations. More analytically, the Time Sheet contains information such as the time of arrival at the port, the quantity of the fuel at arrival at the port the total operation time and so on. All data recoreded by the on-board personel is stored in the vessel's database.

3.5 Implementation

The MARIDES system is implemented on Windows 2000. The databases of the system are based on Microsoft SQL Server technology. The internal communication with the database is performed through ADO recordsets. The GUI is implemented as Active X documents implemented using Visual Basic. The Decision Support utilizes SQL to access the database and the various algorithms.

The communication within the system components concerns mainly files or data recordsets and it is implemented through TCP. The communication with the vessels is performed through the internet over a dial-up connection via satellite.

3.6 Pilot Chartering Networking Service

In this sections we provide the goals, benefits and design issues of the Pilot MARIDES Chartering Networking Services which is implemented through a web enabled work flow system and as Web Services.

3.6.1 Goals and benefits from a Chartering Network Service

The Chartering Network Service (CNS) augments chartering applications with WEB integration or web based specialised solutions in order to provide chartering managers with timely information required to do their job efficiently and effectively. The service exploits emerging web technologies, and provide the following advantages:

a) Enhanced mobility allowing the chartering manager to access specialised services through the Internet ;

b) Increased flexibility enabling the chartering manager to interchange information with dynamically assigned internal or external collaborators;

c) Improved access to automatically updated information from various Internet information sources;

d) Elimination of any requirements for in house IT infrastructure and acquisition of expensive software tools.

We can view the core part of the chartering process as consisting of three main activities:

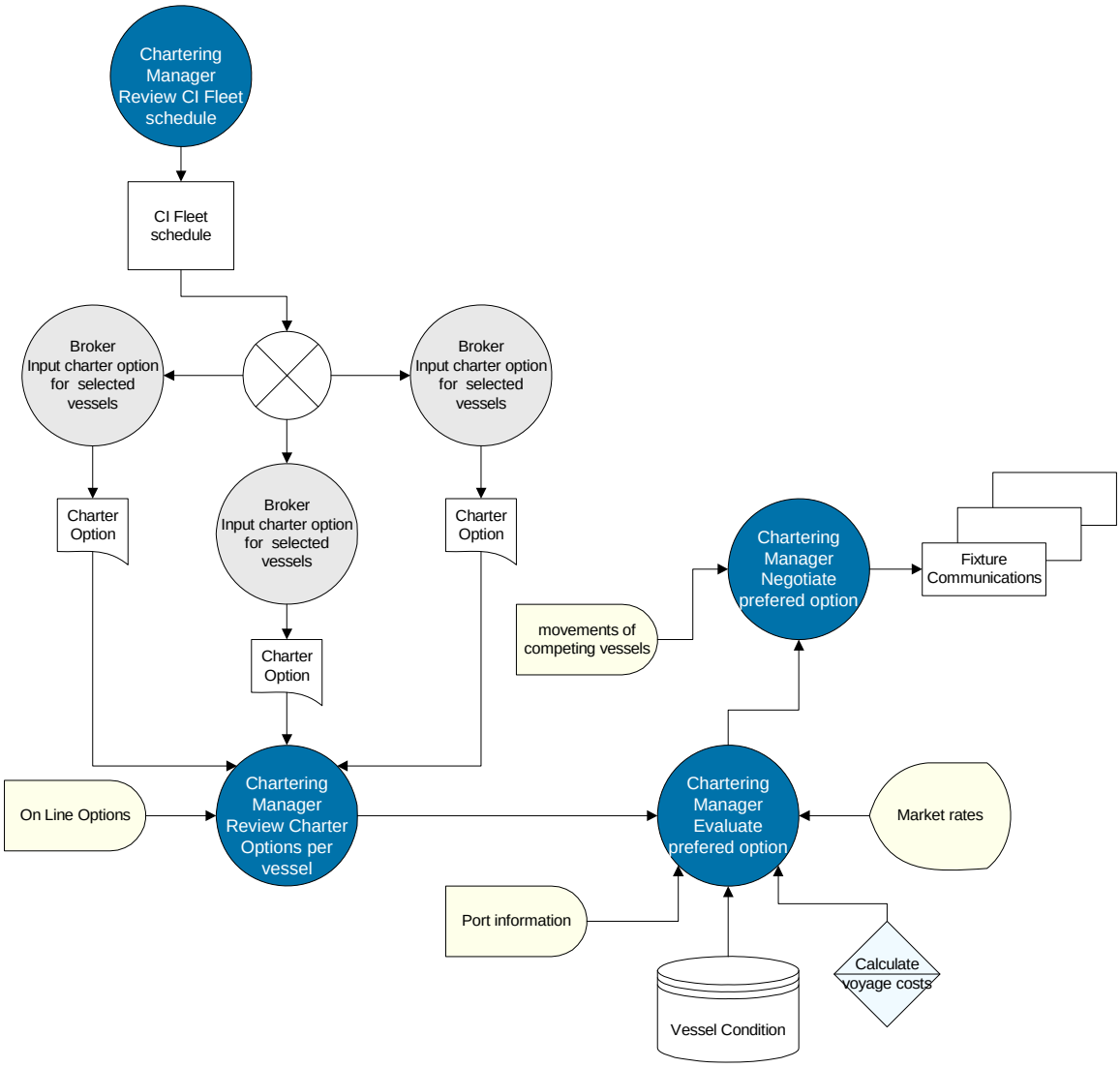
- Options generation (identification of charter options for the company's vessels);
- Options evaluation (assessment of market factors and internal parameters associated with cost and vessel condition);
- Negotiation (definition of maximum rates that will be reasonably achieved for a particular option);

Standard voyage estimation calculations are required to establish the cost of an intended voyage and therefore the break even charter rate required. Such calculations rely on confidential company data and therefore should not be considered as part of the web based solution. Market intelligence can be handled efficiently through portal services and therefore market monitoring could be addressed equally well by chartering in-house application or by a web based service. The forecasting modules of the decision support system rely on advanced modelling and statistical techniques and can be extended with artificial intelligence tools associated with neural networks and fuzzy logic. Such modules rely heavily on access to large amounts of data and therefore would be best organised as components that are maintained in a Web service facility. In such a case the potential use of these components from many shipping companies will create the feasibility of sharing the necessary computer and software maintenance costs. The use of such components from the chartering network service are therefore investigated within the project.

3.6.2 CNS Conceptual model

This Chartering Network Services conceptual model is defined in the following diagram. CNS automates a set of tasks normally performed by the chartering manager and internal and external collaborators with whom the chartering manager interchanges information. This service can be customised in terms of the chartering manager roles and tasks and those of his collaborating partners.

This type of service performs information consolidation. It selects information from various sources, publishes it to various roles and updates it according to user definable rules.



This conceptual model covers two roles, the chartering manager and the chartering broker. The main tasks of the chartering manager are listed below:

- Review chartering relevant fleet schedule;
- Review charter options per vessel;
- Evaluate preferred option;
- Negotiate preferred option.

The main business documents which are interchanged are:

- Fleet schedule reviewed and circulated by the chartering manager;

- Charter options identified by charter brokers and evaluated by the chartering manager ;
- Fixture communications.

3.7 Intranet Infrastructure Design Guidelines

This section provides a design guide for Intranets addressing benefits and drawbacks in the contact of the shipping industry, as well as the design process and the future outlook of web based services that should be considered by a shipping company considering an intranet solution.

The Intranet Infrastructure issues addressing the appropriate interconnections between the chartering departments of shipping companies, the co-operating parties and the fleet are addressed particularly in relation to future developments.

The integration of chartering applications with Web services or web based specialised solutions is also a key issue in considering shipping corporate intranets. From a chartering perspective the intranet design should provide chartering managers with timely information required to do their job efficiently and effectively. We provide a guide for developing Intranets in the shipping industry acknowledging the fact it is likely to take some time before such solutions become widely adopted by shipping companies.

3.7.1 Proposed Intranet design process

For shipping companies that wish to develop an Intranet the following steps are recommended:

- Define Intranet goals
- Identify key users
- Undertake user task analysis
- Specify usability criteria
- Identify content resources and management strategy
- Define integration strategy and plan
- Address information architecture needs
- Review and rewrite key content
- Create an Intranet style guide
- Migrate content from other existing sources
- Define dissemination and training strategy

3.7.1.1 Define Intranet goals

The important issue for shipping companies is to identify specific goals in relation to the business activities in which the company is engaged such as the Improvement of information that will prevent the occurrence of risks in ship operation, the improvement of the knowledge flow within the fleet and the assurance that the latest chartering information is made easily available to chartering personnel.

3.7.1.2 Identify key users

An Intranet design should identify the employee types that take part in the operations defined as the Intranet's goals in the previous step and their physical location (captains are mostly onboard vessels, chartering managers may be travelling a lot) in order to

distinguish appropriate point of access and methods for secure and cost-effective access to the Intranet.

3.7.1.3 Undertake user task analysis

The Intranet, as other information systems, must be designed for the user and not for the department or a business function. It is therefore important to learn about the day to day tasks of the specific roles used on board ships and in the office. A process model and in particular the specific tasks undertaken by the crew and shipping company employees ashore create the central point for linking the necessary information to the job in hand.

3.7.1.4 Specify usability criteria

It is important to produce at an early stage a pilot demonstrator of the intended solution that will be evaluated by the intended users. Conclusion have to be taken into consideration during the design and development of the final integrated solution.

3.7.1.5 Identify content resources and management strategy

The main issues are to identify and validate the initial content to be included in the Intranet and then to define how content will be generated and how will be managed.

The basis for an effective publishing approach includes the:

- Knowledge of the information dissemination objectives and user needs
- Provision of available information on demand
- Measurement and improvement of the provided information's value

3.7.1.6 Define integration strategy and plan

The Intranet benefits are maximized by deep integration with the entire business process. A shipping company can establish a core system LAN or INTRANET based on existence infrastructure which will be extended gradually to replace existing legacy applications. The Intranet should by integrated to all business process by defining and implementing efficient workflow business units (user, roles, tasks etc.) and the relations between them.

3.7.1.7 Address information architecture needs

In order to achieve easy and simple tracking and access of information by employees the intranet should be organised according to:

- task, activity or process
- subject

3.7.1.8 Review and rewrite key content

Information should invariably be rewritten and restructured, to deliver the best business benefits and increase to possibility that users will read the company manuals and instructions. The intranet pages must be easy to read, concise, written to match the online medium, comprehensive and up-to-date, well structured and extensively hypertext linked.

3.7.1.9 Create an Intranet style guide

To ensure that the intranet does not slide into a state of disrepair, develop an intranet style guide for authors, covering usage of the standard page templates, tips for good writing style, guidelines for structuring pages, linking conventions, other support style guidelines and the benefits for users of the consistent style.

3.7.1.10 Migrate content from other existing sources

Effective reactivity during business negotiations heavily depends on the information in hand. The Intranet development should focus in the collaboration with external data providers for frequent acquisition of the maximum possible consistent information on the shipping market.

3.7.1.11 Define dissemination and training strategy

Experience from the maritime business and other business environments shows that employees find it quite difficult to adapt new ways of working even if the new infrastructure guarantees an enhancement in the efficiency of operations. In order to maximize the benefits of an Intranet development in the context of a shipping company, a strategic approach should be designed an executed as far as familiarization of the employees with the developed technologies and training on the new tools is concerned. The objective should be to take advantage of the developed Intranet infrastructure by proving to the employees that it can significantly assist them in performing their work in a more efficient, fast, simple and secure way. Then, training by specialized personnel should teach the employees how to be productive and collaborative by using the novel company Intranet. Training should also focus in optimization of existing operations utilizing the new capabilities offered.

4 Overall impact

4.1 Benefits

The MARIDES project provided a deep insight into the computerized management of decision support process in chartering operations for the shipping companies involved. The end-users have benefit from the enhanced IT infrastructure that has increased interoperability and operational effectiveness. The system provides improved data manipulation and novel decision support functionality to aid the process of evaluating alternative situations. The importance of these operations is amplified by the fact that the maritime market has a huge turnover (e.g. ships running costs amount a few thousand U.S. dollars per day) and there is a large margin for increasing profitability by effectively assessing the available business options. In parallel, the MARIDES platform can assist in the establishment of closer business relations and partnerships in the maritime industry. The developed prototype enhances cooperation and information exchange procedures with affiliated actors and partners, thus maximising the performance of the related business practises for the involved business entities.

The involvement of the technical partners in the project has primarily given them a complete view of the business models and practices ruling the maritime transportation industry. The project has broadened their fields of expertise and created new market opportunities (commercial exploitation of the project results will increase expected revenue). In addition, the development of state of the art software systems allowed the preparation of research publications and strengthen the prestige and market impact of

the involved parties. Moreover, the accumulated experience has also improved the consulting and task administration abilities of the partners in the related business domain of the shipping industry.

4.2 Organizational Impact

The MARIDES system is a tool for enhancing chartering operations especially in cases of vessels fixing and management of the huge amount of related information. From this point of view the MARIDES system does not obligatorily affects or requires changes into the organizational structure of the company that owns the system. Nevertheless it can provide significant increase of the quality of service in terms of accuracy and quick response times when considering internal and external communication. The MARIDES system allows the user to increase efficient reaction during negotiations by:

- efficiently manage information about available cargo orders
- perform on-the-fly voyage estimations
- accessing current market rates
- accessing position list of vessels
- accessing port and passages information
- accessing vessel particulars and surveys

In cases of internal communications, the user does not have to leave his desk for retrieving information related to the chartering of vessels. Utilization of the MARIDES system provides easy and quick access and provision of critical information about available cargo orders, voyage estimation figures, fixtures, vessels, ports and so on.

In addition, adoption of the MARIDES system to every day operation in the chartering department can significantly decrease the usage of paper. A big percentage of the information in and out of a chartering department is in hard copies and driving the user to realize the important functionality provided by the system can lead to increased utilization of the MARIDES system for gathering and efficiently retrieving the required information.

4.3 Dissemination

All the partners of the consortium have work together but also in a complementary way individually, to disseminate and make the MARIDES system public to the international maritime business society. The dissemination activities have addressed both business and technical issues of the resulting system. These activities comprise of:

- A web site (www.marides.com or www.telecom.ntua.gr/MARIDES). This site provides information on the project and helps to the internal communication between MARIDES partners, provides information about documents that are circulated among the consortium, news, agendas and notes, decisions and actions taken etc.
- Presentation of the MARIDES project to meetings of European research projects (MISTIC, SWAN)
- Dissemination of the MARIDES results through European research projects (SWAN - Deliverable D2.3: Interconnection and Decision Support Systems - State of the art and proposed functionality).

- Creation of a brochure and a poster for MARIDES system and distribution at meeting and through postal services.
- Creation of research publications with the project results.
- Development of a MARIDES Business Plan which contains a lot of information about the MARIDES product, its characteristics and a comparison of it with the key competitive systems. Also, a list of milestones that has been set for MARIDES development and exploitation are discussed.
- Presentation of the project to relevant user groups including authorities, SMEs customers and selected representatives.
- Participation to exhibitions, congresses and conferences. Emphasis was given to the integration and application of the current know-how to relevant domains.

4.4 Exploitation

Project results can be exploited individual by each partner or by forming a new partnership as proposed by the MARIDES business plan. Individually, the technical partners have expanded their expertise in the promising maritime industry. The co-operation between the technical partners can possibly improve in the future the quality of the services each partner already provides to its customers by incorporating dynamic Decision Support, Forecasting, and in general Intelligent Data Management tools. The technical partners intent to use the project results to:

- Exploit state of the art the Decision Support and Forecasting methodologies and technologies, possibly through continuous collaboration with the other partners, in its present fields of activity, such as Product Data Management, Manufacturer-supplier procurement etc.
- Expand to the maritime market through the synergy with the partners involved in the project.
- Exploit them in software product lines related to integrated solutions for management of shipping operations.
- Providing related internet services such as the deployment of a shipping news or market information service

Each of the end-users with well-trained staff on information technologies and on modern ways and methods of work can fully incorporate and be familiarised with the MARIDES system aiming to improve the efficiency of its cargo trading practices. The basic exploitation activity consists of using the MARIDES platform to automate frequent information exchange between the company and affiliated ship owners, charterers and cargo owners. In case of development and adoption of a commercial product based on the MARIDES system all business collaborators will be contacted in order to inform them on the advantages of the MARIDES platform and discuss possible application of the platform in the context of inter-company transactions and collaborations.

In general, all the partners can be involved directly or indirectly in the provision of corporate services to domains relevant to the maritime chartering process. These services include:

- software and networking products particularly in the area of logistics
- marketing and/or consulting services and feasibility studies;

- seminars on the application of innovative software tools and technologies for SME.

4.4.1 Business Plan

The MARIDES business plan contains a lot of information about a possible commercial MARIDES product, its characteristics and a comparison of it with the key competitive systems. Also, a list of milestones that has been set for production of a commercial product and exploitation are discussed. In order to commercialize the developed prototype a brief summary of the market and the segmentation policy that it should be followed is presented. The segmentation policy proposed, involves customisation of a single overall product platform to the individual needs and requirements of each customer. The MARIDES target segment is identified according to some criteria like the number of vessels for chartering the user owns/ manages, the capital the user commands, the number of human recourses a user/ shipping company employs, the type/ size of a shipping company's fleet, the type/ frequency of the vessels' itinerary, the type of shipping company's customers, the general company's lifestyle and finally the general company's purchasing. Moreover, the MARIDES sales strategy is analysed as regards the promotion of the product (e.g. its advertising), the distribution channels that should be used (e.g third-party retail businesses, outside agents wholesales, direct mail, internet etc) and finally the MARIDES pricing policy (customised pricing, personalised pricing, group pricing etc). Finally, tables regarding sales forecasting and financial previews are submitted.

The plan is to create a partnership that will allow commercial exploitation of the project results. The objective is to competently disseminate enterprise-wide opportunities in order to completely foster excellent content. The possible partnership intends to make enough profit to generate a significant return for investors and to finance continued growth and continued development in a quality product. In addition, effort will be made to maintain a friendly, fair, and creative work environment that respects diversity, new ideas, and hard work.

More specifically, the partnership will try to agree on the development of an innovative and intelligent product based on the MARIDES to provide users with support which will go far beyond the accustomed database handling and standardised calculations provided by established products. Rather, MARIDES will offer the user an intelligent system, seamlessly integrated with its environment, capable of automatically inputting and dispatching information from and to the user's business partners, and also of providing decision-support tools capable of filtering large quantities of input data at the user's request in order to offer him or her the time to thoroughly assess only the best opportunities available.

4.5 Future Steps

Assessment of the project results has identified the key areas that need attention and enhancement when considering the development of a corporate business infrastructure to support consistent and efficient management of the chartering process based on the MARIDES results.

4.5.1 Chartering Networking Services

There are two areas already identified as potential extensions:

- Automated integration between CNS Services and chartering applications/ products.
- On-line sessions management with a high degree of confidentiality.

4.5.2 Enhanced Automated data input

There are two kinds of data input tasks which can be automated: information extraction from any user communications and information acquisition from the internet. Future work could make both processes robust, capable or accessing information from texts composed as communications between humans and not designed to be readily readable in an automated fashion by a computer.

User communications are via email, fax, telex and telephone, of which it is easiest to process emails. It would be useful to integrate third-party OCR (optical character recognition) systems for automated fax or telex reading, which would result in text files which could then be processed as the emails are. Unless the author of these texts is aware of a need to make them amenable to automated parsing, they are very often quite chaotically written. To start with, they are almost entirely composed of application-related abbreviations. However, since the texts are written by humans, different abbreviations can appear for the same word, even in the same email (or fax, telex, etc.). Also, the tabular format of the information exists for readability and is not of guaranteed structure in informal messages. Sometimes the structure changes, especially when it comes from different sources. Natural language occasionally appears to comment on some fact, or the order of the abbreviations can occasionally be somewhat unpredictable. In order to be able to access these hard-to-read texts, a system must be designed to apply something like a template-based pattern-matching model of the communications structure to extract valuable information from incoming texts. The system's databases can then be automatically enriched with all information which is successfully extracted – this information can be used by Decision Support components or viewed by the end-user as naturally as local data, without the need to browse lengthy communications. Note that the system we envision must be tolerant to the appearence of unreadable texts or parts thereof. What cannot be processed is simply ignored as far as the input system is concerned and the user is optionally prompted to complete the task manually.

The current view is that automatic acquisition of information from the internet is also a hard task, but in terms of work necessary rather than in the design of the system. For each source (internet site) to be used, a wrapper must be written. This allows information to be extracted from pages which have been structured for presentation to human readers. As it was not within the scope of this project to deal with mining of weakly structured web content, this is the point of view we followed. Wrappers were designed for a number of important internet sites, allowing MARIDES to automatically learn fixture results, fuel prices, etc. However, there exists a research momentum to develop automatic wrapping techniques, and these could allow automated access of the MARIDES system even to poorly structured content.

4.5.3 Innovative Provision of Services for the Shipping Market

4.5.3.1 New Web services for shipping

Recently there has been an explosion in automated Web services primarily in B2B and e-commerce applications. Generally, however such interoperation is realized through APIs that incorporate hand-coded information-extraction code to locate and extract content

from the HTML syntax of a Web page presentation layout. Unfortunately, when a Web page changes its presentation layout, the API must be modified to prevent failure.

WSDL is an XML format for describing network services as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information.

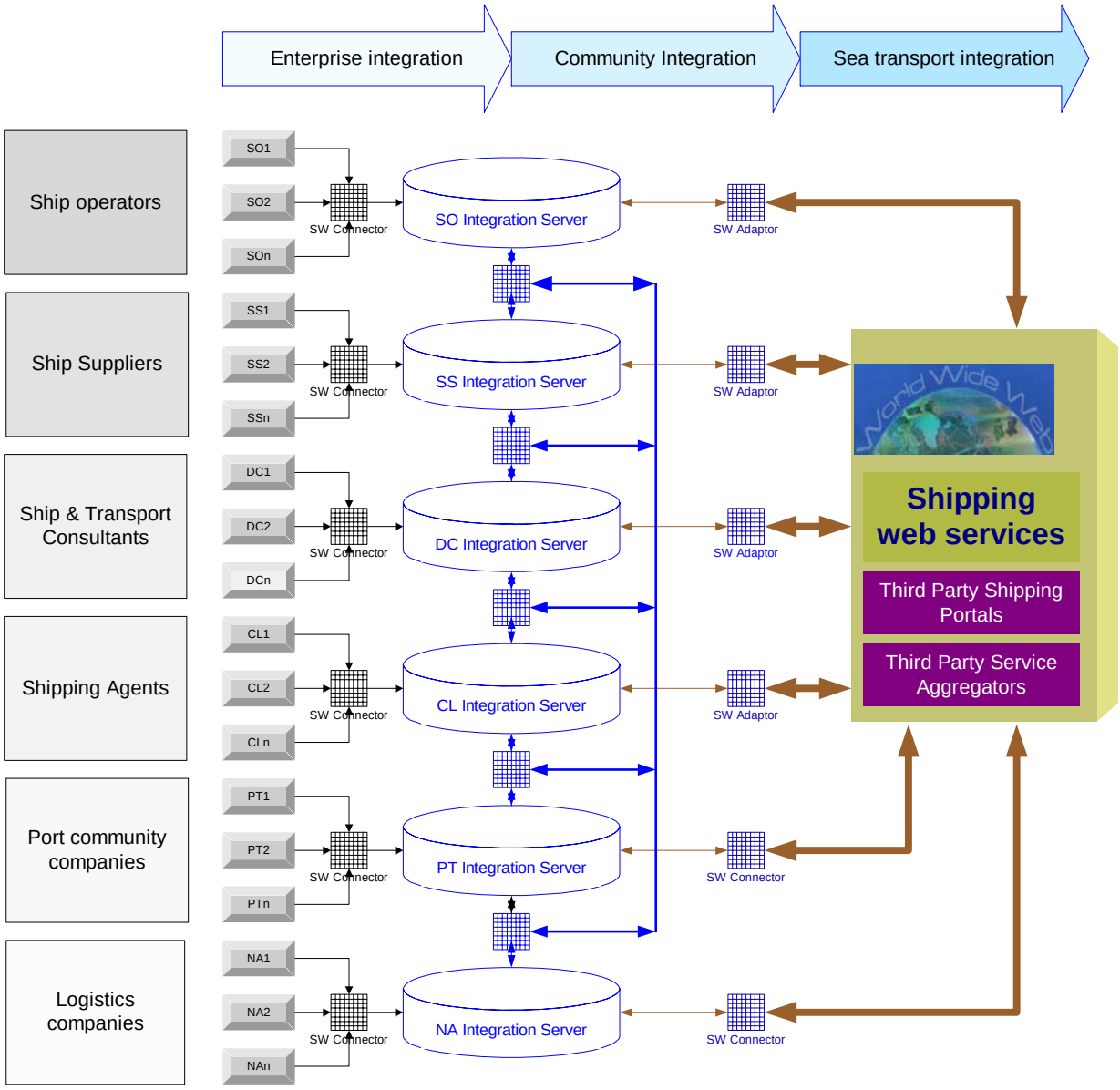
Web Interface Definition Language (WIDL) is a meta-language that implements a service-based architecture over the document-based resources of the World Wide Web. WIDL is an application of the eXtensible Markup Language (XML); it allows interactions with Web servers to be defined as functional interfaces that can be accessed by remote systems over standard Web protocols.

Wf-XML and XPDL are specifications that use XML as the mechanism for process definition interchange. XPDL forms a common interchange standard that enables workflow products to import/export function to map to/from the standard at the product boundary.

4.5.3.2 Peer to Peer Networks of Shipping Web Services

Future intranet and extranet architectures could utilize architectures which are a hybrid of the Client-Server and Peer to Peer approaches. Client-Server approaches are characterized by the existence of communication connections only between the server and each of the clients in the network while in Peer to Peer approaches every node of the network is connected with every one of the others. The main problems of those architectural models are the single point of failure in the Client-Server paradigm, where the service relies on the server being always available, and the scalability problem (performance and network traffic) in the Peer-to-Peer paradigm. In contrast, the hybrid architecture proposed ensures better process integrity (since there is not "Single Point of Failure" as in the Client-Server approach and faster response on Process execution, since the process is executed directly between the peers participating, without the intervention of a server.

The following scenario describes a three stage evolution approach in the use of intranets and web services in the shipping industry.



THREE STAGE EVOLUTION APPROACH

During the first stage, enterprises will link their legacy applications and databases to Web services using some connector tool. Ship operators or other types of shipping related companies can select what information they wish to extract from their existing applications, how they can make it available on the Web and to whom.

During the second stage of integration a community of shipping companies will be able to use the WEB infrastructure tools to set up Web services and establish an interaction network with the other members of the community. Full process integration would be feasible using reference models, customised and then maintained by the appointed community administrator.

Finally, in the third stage of integration, companies will be able to interact with shipping portals and services aggregators. WEB adaptors will facilitate such interaction, enabling companies to offer new services by combining, aggregating and specialising Web services to add value to existing services or to create internal benefits.

5 Conclusion

The ambition of the MARIDES project was to assist towards the integration of state-of-art technological approaches with business functional models and the development of innovative, comprehensive artificial intelligence solutions with user-friendly interfaces for chartering processes in the shipping industry. The MARIDES project relies on supporting and enhancing business processes and practices in maritime cargo transportation through the design and development of state-of-art decision support tools along with the required communications infrastructure and appropriate communications services for reliable and efficient local and remote process operation and administration.

We have achieved a change in focus for the artificial intelligence components of our decision support system, in order to make it viable for use in a real – and indeed very difficult – business environment. Unlike failed attempts at decision making which have been made in the past, which attempted to compete with human experts' decision making, we have found real needs for support which experts have within their powerful intuition-based decision making process. Thus, as described above, our system offers a quick and effective voyage estimation process based on estimation procedures known to be effective in the industry, it helps experts assess the future performance their vessels will be likely to achieve if they make the decision they are currently contemplating by relying on predictive statistical analyses, and it allows them to delegate assessment of large volumes of possible business options to the system in a way which allows easy stepping in of the expert to take over the analysis of any business order which appears to merit close human attention.

The decision support aspect of the system is firmly based at the heart of the MARIDES interface and communications architecture, which is based on a networking workflow management system. Users with various roles, such as manager, accountant, secretary with updating tasks, and so on, all access the system from arbitrary locations. They may, depending on arbitrary business processes, require access to each other's information at any time. Finally, the shipboard application seamlessly integrates into the whole, enabling effective coordination of official and ship-level operations.

The benefits that MARIDES brings to the shipping market have to do with the user friendly integrated environment, the estimation capabilities that consider the actually important current and historical market data, the distinguishing of the profitable offers and the utilization of the internet for constant and reliable monitoring of the chartering market.

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Annex I: List of Deliverables

D1-Users' Needs Report

In the specific deliverable the user needs for a Maritime Decision Support system concerning the chartering procedure result by employing a systematic, state of the art methodology for developing software. The market status is initially analysed and then an analytical business model of the current procedures is presented, illustrating the participating entities and the current business processes. From the detailed use case model that follows, the functional requirements are derived. The requirements list is completed with the non-functional requirements. The subsequent demonstration scenarios verify the user requirements and clarify what the system is going to do and how. Finally some initial implementation issues closely related with the user requirements are presented.

D2-Dissemination and Use Plan

This report is intended to summarise the dissemination and use activities that will be undertaken as part of the MARIDES project. It begins with an overview of the MARIDES expected results and the approach for dissemination and use

The report goes on to detail each of the dissemination processes that will be used for disseminating the project outputs comprising Exhibition, Conferences, Web presence, brochure, Promotional Literature, CD-ROM, the Provision of Information via the CORDIS/ECHO Database.

Then, the description of the Use Plan described the MARIDES result that can be potentially exploited, including its market characteristics.

This document will be complementary to the MARIDES Technology Implementation Plan (D24, due date: Month 24).

D3-Draft validation plan for the services to the users

This report presents the final validation plan, for the validation of the MARIDES system during the software development phases and also under some user cases.

It presents the general principles of the software validation, the questions to answer during this work phase, and also the structure of the validation work under the use cases.

The present final validation plan is based on the draft validation plan (D3) and has been completed after more information became available. The purpose is further to define a User Acceptance Test Plan for MARIDES. This plan will be the roadmap for the validation of the user requirements defined in D1 regarding the individual software components as well as the whole information system. The plan describes the activities that need to be performed by the executors of the plan and the procedures required for each test case

D4-System Architecture Report

This document presents detailed information on the environment in which the MARIDES system will operate. This environment is described in terms of business organisation, hardware facilities and communications facilities. The applications (Decision Support System, Data Management System, Shipboard MARIDES System, Services and Control Dataflow) that are to be integrated into the MARIDES system are also presented.

D5-Overall System Technical Verification Plan

Through this document the preparation of the framework and the guidelines which will be used for the verification of the various system's components as well as the overall system after the accomplishment of the integration task will be presented. This plan will be the roadmap for the verification for the design requirements defined in D4 regarding the individual software and hardware modules as well as the whole information system. The purpose of this document is to indicate the test cases, which are going to be further analysed and executed during the implementation phase.

Individual technical verification of each module will highly contribute to:

Unifying the way that all members of the consortium will approach system development.

Guaranteeing the interoperability of the entire system and the ability to thoroughly test each component independently.

D6-Data Exchange and Interface models for standardisation purposes

In this deliverable XML schemas utilised by MARIDES will be described, in order to be available in an exploitable form by European and International Standardisation Forums

and organisations. Firstly the forms utilised by chartering companies will be described; then the corresponding XML schemas will be presented.

D7-Decision Support Tool Description

This document presents the design of the DSS subsystem. The functionality described consists of the fairly standard voyage estimation calculations, the market monitoring whose intelligence is mainly an issue of data handling and automatic input, and the Investigation and assessment of proposed charter business and main terms and Forecasting modules which have a considerably stronger machine intelligence basis, the former relying primarily on modelling and statistics, and the latter having an Artificial Intelligence focus, using neural networks and fuzzy logic.

Voyage estimation offers the user a calculation of the costs to be incurred when undertaking the voyage under examination. Market monitoring involves informing the user of market data which should affect his decision but is not normally considered by voyage estimation, such as the movements of competing vessels. The Investigation and assessment of proposed charter business introduces an intelligent heuristic to assess the effect of a voyage's destination on its desirability. Finally, the Forecasting modules explores the use of artificial intelligence to forecast straightforward, but normally very difficult to predict, values, such as the cost of fuel, as a final aid for the decision-making charterer.

D8-Decision Support Tool User's Manual

This deliverable constitutes a User's Manual for the Decision Support module of the MARIDES system. Its objective is to present the specific subsystem to the end user. DSS functionalities have been discussed in detail in D7 and include: standard voyage estimation offering calculation of the costs to be incurred, market monitoring involving supply of information about the market data (e.g. movements of competing vessels), and the Investigation and assessment of proposed charter business. Here we explain the mechanisms by which the user can access the functionality of each use case of the tool.

D9-Verification Report of the Decision Support Tool

The Verification Report of the Decision Support Tool has been written in order to achieve a systematic approach in testing the developed system. The report starts with a general review of important issues such as user needs and system architecture and then becomes more focused on specific use cases of the DSS application

D10-Data Management Tool Description

This document presents a complete description of the Data Management Tool of the MARIDES system. Primarily, the global MARIDES architecture is presented in order to identify the scope of the data management tools in the system's context. Subsequently, the tool's modules are described in terms of software design, implementation, offered functionality and inter-system interaction with the other MARIDES tools. A detailed description of the system's knowledge base is also presented.

D11-Data Management Tool User's Manual

This document constitutes a user's manual and its role is to present the Data Management Tool to MARIDES Users. The role of the data management tool in the system's context, the tool's modules in terms of software design, implementation, offered functionality and inter-system interaction with the other MARIDES tools have been described in detail in D10: Data Management Tool description. Here we explain the mechanisms by which the user can access the functionality of each use case of the tool.

D12-Verification Report of the Data Management Tool

This text presents the results of the verification process for the implementation of the Data Management module of the Marides system. It is shown that this module is indeed a helpful realisation of the intended functionality. The implemented use cases have passed through all possible tests, ensuring that no implementation errors found their way into the product tested. Inter-connectivity and cooperation of modules and sub-modules has been checked. The tests that have been carried out are described in steps in a clear and comprehensive way. The final results and conclusions are presented at the end of this document.

D13-Description of Shipboard Applications

The modules that constitute the shipboard application are described along with their interconnections. The shipboard database is also described and every entity of the database is further analysed. The current document is strictly related to deliverable D4 "System Architecture Report".

D14-Shipboard Applications User's Manual

This deliverable is devoted to the introduction of the Shipboard application to the user. The structure of the vessel database and the modules participating in Shipboard Application and their interconnections has been described in detail in D13: Description of Shipboard Applications.

D15-Verification Report of the Shipboard Applications

The Verification Report of the Shipboard Application has been written in order to achieve a systematic approach in testing the developed system. The report starts with a general review of important issues such as user needs and system architecture and then becomes more focused on specific use cases of the SA application. The tests were performed in a prototype BOS installation, installed for assisting development and testing of the Shipboard application. The outcome of these tests will support the integration of the shipboard application in the context of the MARIDES system.

D16-Intranet Infrastructure Design Guide

This deliverable provides a design guide for Intranets addressing benefits and drawbacks in the contact of the shipping industry, as well as the design process and the future outlook of web based services that should be considered by a shipping company considering an intranet solution.

D17-Pilot Chartering Networking Service Report

In this deliverable we provide the design and implementation of the MARIDES Chartering Networking Services which is implemented through a Web enabled work flow system and as Web Services utilising the INLECOM Web hosting infrastructure

D18-Integrated Software

D19-Installation Report

In this deliverable we provide the system requirements as well as the whole setup procedure for installing the MARIDES system on a Microsoft Windows 2000 ready personal computer.

D20-Overall System User's Manuals

In this deliverable we provide the overall MARIDES system user's manual. The manual includes the user's manual of the individual tools as well as the user manual of the MARIDES integration platform and the MARIDES Web enabled work flow system (Chartering Network Service).

D21-Validation Analysis Report

This report presents the results of the MARIDES system validation. The system validation has been performed for each use case regarding technical and user acceptance assessment. Assessment of the overall impact at the organizational level has also been performed as well as a quantified evaluation of the validation.

D22-Best practice models handbook on chartering processes

Model of best practices to adopt when acting in the chartering business domain.

D23-Project Assessment Report

This document provides a final assessment of the MARIDES project work in which the original vision is measured against the actual achievements. It is verified whether the work was carried out according to the commitments the partners submitted to. The project achievements are assessed in terms of: Operational/Functional Achievements, Technological Achievements, Business Goals of the End-Users and Project Impact in the Maritime Sector as well as regarding the EU Policy and the Community Social Objectives. The report is concluded with an outlook on the business prospect.

D24-Technological Implementation Plan

This document conveys an overview of the MARIDES project and its results. A description of each result is given as well as indications whether collaboration through

the Commission services is required. Moreover, it contains confidential data on the use and dissemination intentions by each partner.

D25-Quality Assurance Plan

The Quality Assurance Plan (QAP) defines the techniques, procedures, and methodologies that will be used to assure timely delivery of the software that meets specified requirements within project resources. The QAP establishes a process that will monitor and guarantee the quality of the deliverables that will be produced during the course of the MARIDES project life.

D26-Final Project Report

In this deliverable we provide the final report for the MARIDES project. The report contains a summary of the project, presents its main results and concluding remarks. In addition there is an assessment of the project's overall impact regarding benefits to partners, dissemination and exploitation issues as well as required future steps.

D27-Project Presentation

This deliverable presents the project goals, approach and expected results as well as the participants in the project.

MARIDES Business Plan

This document is a business plan for the establishment of a company which will aim at exploiting and extending MARIDES system further, in order to cover the needs of a variety of users like charteres, brokers, forwarders etc by doing the appropriate customization. After providing an analysis of the company, its ownership and the human resource plan, this Business Plan provides the reader with an exhausted analysis of the related industry and market, its segments and the characteristics of the target market segment. The next part of the business plan is devoted to competition analysis as regards its features, the competitive advantages, the weaknesses, their market share and their price. In the same chapter there is an exhausted analysis of the MARIDES system, its competitive advantages and a comparison of the MARIDES system with the competition according to selected criteria is provided. The chapter is completed with sales forecast for the next five year after setting up the company. The Market Plan follows where the sales policy as regards the product's price, promotion and place is analyzed. The last part of the Business plan is the financial plan which includes balance sheet, profit and loss statement (for normal case, for best case, worst case), cash flow calculation, calculation of the value of the business etc

Annex II: List of Research Papers

Giannopoulos A., Kosmopoulos D., Bouloudis Y., Varvarigou T., Hatziathanassiou C., Mourkousis G., Varvarigou V., Malamos A., Kalligeros I., *The MARIDES Project: Intelligent Chartering in the Maritime Industry,* 1st International Congress on Transportation Research In Greece, Athens, Greece, 21-22 February 2002.

Abstract: This paper presents the concept of the MARIDES project, which aims to improve the chartering process in shipping companies. MARIDES focuses on the development of the necessary decision support software tools and networking infrastructure along with the appropriate information exchange service provided to the actors of the chartering process under a unified environment. As far as the decision support is concerned, given a certain chartering order the system will estimate all the possible solutions (all vessels that can serve the given order) and it will present them to the end user in ascending or descending order according to the estimated profit or/and to other factors such as the future market potential. The filtering will be based not only in deterministic data but in stochastic data as well, that is, the system will make a forecast taking under consideration data that are not directly exploitable such as the future market conditions.

Mourkousis G., Giannopoulos A. and Varvarigou T., *A Decision Support Algorithm for the Maritime Spot Market* (under preparation).

Abstract: This paper presents a computerized support approach to the investigation and assessment of possible charters in the maritime transportation business. The actual problem is a complex real-life problem concerning the fixing of vessels for single voyages by chartering managers. The objective is to match available vessels with cargo orders so as to maximize the obtained profit. The proposed algorithm primarily filters the available resources, excluding unrealistic or impossible charters, and subsequently provides a quality measurement for potential charters based on statistical analysis of historical data.