MARINE WEB-BASED SYSTEM FOR ELECTRONIC ORDERS OF CONSUMED RESOURCES

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ABSTRACT
The paper represents a system for electronic orders of spare parts and consumed materials. The system was designed for marine applications and implemented by several small shipping companies. The system was integrated with ships onboard information systems from one side and with coast warehouses information systems from another side.
Keywords: e-business, electronic orders systems, resource management.

1. INTRODUCTION
The paper is devoted to the designing of ship virtual systems for electronic orders of spare parts and other consumed materials. The research was initially intended for Russian shipping companies.

The following specifies the actuality of the research. From one hand, the procedure of orders of consumed materials became complicated for Russian ships as a result of crisis in Russia. Large-scale shipping companies have disintegrated into small independent companies. These companies are not supplied with consumed materials in a centralized order, as it was before. Figures of items in warehouses are insufficient, and prices of the same spare parts vary for different warehouses. So it is necessary to search for the required items in several warehouses. But if a ship is in the sea, it is difficult to search for every required spare part in different warehouses and to order them by means of traditional radio communication.

From another hand, Internet offers wide opportunities for the designing and application of information searching and electronic orders systems. Also the possibility of wireless communication for mobile objects is very important for marine application. Therefore the designing of marine virtual system for electronic orders of spare parts is a promising trend. This problem determined the aim and tasks of the research. To design marine electronic orders system the following tasks have been set:
1. Analysis of procedures of consumed materials orders as an interaction between ships, shipping companies and warehouses.
2. Analysis of information structures and information flows.
3. Analysis of existing commercial systems of electronic orders: main ideas and principles, applied hardware and software.
4. Designing of databases, algorithmic and software components of marine electronic orders system, choosing hardware components.

Let's look how these tasks were solved.

![Figure 1. Marine electronic orders system. Hardware components](image)

2. REQUIREMENTS FOR THE SYSTEM
The list of required spare parts and consumed materials is determined at every ship according to the present and predictable state of technical systems. The organization structure and routines of ship maintenance processes as well as circulation of documents concerning orders of consumed materials are presented in [1,2].

No information about marine electronic orders systems was available [3,4]. But the analysis of earth-based Internet systems such as virtual shops and systems of electronic orders as well as analysis of ship maintenance routines let to pose the requirements for marine electronic orders systems:

System must provide:
1. Grouped and ranked listing of consumed materials and spare parts with all necessary attributes available at a warehouse.
2. Generating and transmission of queries from ships to coast warehouses according to the standard marine documents and routines.
3. Processing of queries at coast warehouses and return the result to the ship.
4. Convenient user interface.

3. ORGANIZATION OF THE SYSTEM
Marine electronic orders system is based on the client-server architecture. Client computers are installed as ships. They contain the internal ship databases on spare parts, consumed materials and plans of maintenance actions. Also client computers let to browse information about available materials at coast warehouses and order required spare parts and materials using Internet browsers. Servers are situated at coast warehouses. Their databases contain information about available consumed materials, material-keeping journals and data about orders. Also they contain special software for order making.

Communication session is realized between client and server. Interaction between client and server takes place under the control of standard protocols. The figures 1 and 2 illustrates hardware and software components used in the system.

The marine electronic orders system includes:
1. Onboard computer-client with Windows NT operation system and Internet Explorer or Netscape Navigator browsers;
2. Onboard satellite antenna for Internet communication;
3. Server of the shipping company Internet provider supporting Internet satellite communication.

Coast warehouses' servers containing interactive databases and service applications.
The analysis of information circulation and data dependencies relating to orders of consumed materials led to design the database structure. The database is of relation type and corresponds to the 3rd normal form requirements. It consists of two parts: client and server part.

The client part of electronic orders system is a part of general ship onboard information system. The most important tables are presented below. Hidden tables and system fields are not shown to save space. Keys are bolded and underlined. The client part includes the following tables:

**Table 1/c. Onboard consumed materials directory**

<table>
<thead>
<tr>
<th>type</th>
<th>name</th>
<th>code</th>
<th>group</th>
<th>unit of measure</th>
</tr>
</thead>
</table>

**Table 2/c. Availability of onboard consumed materials**

<table>
<thead>
<tr>
<th>code</th>
<th>place of storage</th>
<th>quantity</th>
</tr>
</thead>
</table>

**Table 3/c. Requests for consumed materials**

<table>
<thead>
<tr>
<th>N of request</th>
<th>code of material</th>
<th>quantity</th>
<th>crew subdivision</th>
</tr>
</thead>
</table>

**Table 4/c. Procurement directory**

<table>
<thead>
<tr>
<th>N of request</th>
<th>code of material</th>
<th>date of procurement</th>
<th>actual quantity</th>
<th>price</th>
</tr>
</thead>
</table>

The server part includes the following tables:

**Table 1/s. Consumed materials directory**

<table>
<thead>
<tr>
<th>type</th>
<th>name</th>
<th>code</th>
<th>group</th>
<th>unit of measure</th>
<th>price</th>
</tr>
</thead>
</table>

**Table 2/s. Procurement directory**

<table>
<thead>
<tr>
<th>code of material</th>
<th>date of procurement</th>
<th>quantity</th>
<th>code of supplier</th>
<th>price</th>
</tr>
</thead>
</table>

**Table 3/s. Directory of suppliers**

<table>
<thead>
<tr>
<th>code of supplier</th>
<th>name of country</th>
<th>address</th>
<th>city</th>
<th>phone, fax numbers</th>
</tr>
</thead>
</table>

The software of the designed marine electronic orders system consists of three main parts: database management program (onboard and coast components), user interface for order procedure and CGI-module.

The database management onboard and coast subsystems provides browsing, searching, editing, inserting and deleting data about consumed materials in ship and warehouse databases respectively. In general their algorithms are similar. Of course all the information in databases can be browsed and changed according to the access right of operator. That is, for example, a crew member can change nothing in a warehouse database except for sending an order application. The generalized flowchart of their algorithm is shown in figure 3.

**Figure 3. The generalized algorithm of database management part**

The user interface supports interactive process of order making by a crew member. It provides browsing, searching and order of consumed materials and also provides adjustment possibilities for concrete user. The interface program is loaded to client computers from warehouse server everytime they begin to communicate. The generalized flowchart of the interface part is shown in figure 4.
CGI module is located in server computers and manages the information flows between client and server computers. CGI module is based on common gateway interface—the set of specifications for the organizing of data exchange between client browser, server and CGI application. Figure 5 shows the process of information exchange according to CGI specifications.

The process consists of the following steps:
1. Client computer sends a query to a server.
2. Server passes the query to CGI application.
3. CGI application returns the result to the server.
4. Server transmits data to the client.

The generalized algorithm of CGI-module is shown in Figure 6.

In general, the designed marine system for electronic orders operates in the following way. When a computer-client connects to a warehouse server, it gets on the screen the warehouse homepage. After the activation of "Entry" button, the database interface program is loaded to the client from the server. A user (a crew member) browses information about spare parts and consumed materials available at the warehouse and forms the basket of order. After the activation of the "Complete order" button, the standard filled order form appears on the screen. User can print out the form and transmit the data about the order to the warehouse.

Figure 6. The generalized algorithm of CGI-module

4. IMPLEMENTATION AND CONCLUSIONS

Database management part was based on Oracle PL/SQL. The interface part was designed as Java applets. CGI module was realized in C++ language. In fig. 7 one of the possible modes of system functioning is presented. Here the procedure of order forming is shown (a screen of client computer). The system is realized in Russian language, but here is the explanation of the screen in English. A user can choose a group and subgroup of needed consumed resources. A user can choose the required subgroup with different level of specification. In this example the “spare parts” subgroup is chosen. In the first window all the spare parts available at the contacted warehouse are shown in an ordered way. In the table user can see names, types, prices and other data of spare parts. A user can search the required items and order them in different ways. The second window represents the basket of chosen items. Users can select/delete items to/from the basket and make an order.

The designed marine electronic orders system is implemented on several ships of Russian shipping companies and several coast warehouses. Using of this system has shown that it satisfies to the modern requirements. The system lets to:
- decrease labor expenditures spent for making orders onboard a ship.
Another important merit of this system is the fact that the system is integrated with general ship onboard information system from one side and with warehouses information systems from another side.

The future research is supposed to be dedicated to the designing of agent-oriented marine system of electronic orders. Intelligent agents will search for the required spare parts and consumed materials in warehouses sites and offer to crew members their solutions.

REFERENCES


