Development of Car Carrier Maritime Transportation Planning System for Effective Car Carrier Maritime Transportation Planning

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2. Introduction
The automotive industry occupies the first place in Korean export goods, and Korea is has the second position in the world. Korea International Trade Association has announced that automobile export rates will increase drastically after free trade agreement (FTA) between Korea and the United States. Although automotive industry has such significant impact on Korean economy, it is facing several problems including the high proportion of logistics costs over the total revenues. In order to solve these problems the supply of automobile transport vessels must be handled smoothly. On the other hand, the total amount of automobile transport vessels fall behind the rapid increase in the automobile export, thus problems related to vessel capacity shortcomings are likely to occur in the near future.

Lately, transport planning tasks at automobile shipping companies is carried out manually based on the experience of responsible employees. Operational planning based on the experience of the employees generally focuses on merely throughput handling and it cannot be claimed to be the optimum solution. In order to carry out marine transport planning of automobiles in a more systematic and effective way, an automobile transport system is needed to express and adjust the information required for transport planning in a real-time manner, and timely supply the end user with the changing information.

However, in the web environment where the planning operations in the current automobile transport systems take place, visual expressibility of the user interface decreases and optimum usage of data cannot be realized, due to simplicity of page composition and limitations in component usage. Also due to limitations of HTML based user interfaces cannot satisfy the requirements about multi-level, multiple option tasks, or interoperability.
This research aims to develop an efficient user interface for automobile transport system using RIA (Rich Internet Application), a technology that is gaining grounds lately. For this purpose the general characteristics of automobile transport system was seized and, RIA based user interface development guidelines were proposed. On the basis of these guidelines, a user interface for automobile transport system was developed based on RIA, and a questionnaire survey was carried out in order to evaluate the user satisfaction of the developed interface.

3. Marine Transport Planning of the Automobile Shipping Companies

In the second chapter, the planning tasks of automobile shipping companies were analyzed and the problems related to planning of automobile transport and direction of improvement was proposed.

2.1 Composition and Process of Automobile Transport Planning Tasks

The transport planning tasks of automobile shipping companies compose of four parts, i.e. Tonnage Planning, Voyage Planning, Vessel Allocation Planning, Stowage Planning, and the task process is given in <Fig. 1>.

![Figure 1] Automobile Transport Planning Process

First, Tonnage Planning is the planning of annual amount of automobiles to be transported on the basis of the contracts done with the car shippers and the outcomes of the previous years. Through Tonnage Planning, the company determines the distribution of the cargo on its own vessels and chartered vessels. Vessel Allocation Planning is the determination of number and type of cars to be loaded on each vessel to assure that maximum amount of cars are loaded in each vessel, on the basis of general cargo and vessel information determined in Tonnage Planning.

Finally, Stowage Planning is the determination of position and loading order of each car cargo on the vessel on the basis of the results of Vessel Allocation Planning. Since it is carried out separately by an exclusive team, Stowage Planning was not included in this research.
2.2 Characteristics of Automobile Transport Planning Tasks

If the planning activities in automobile transport and container transport are compared, general processes are similar, but in the case of car transport, cargo information and destinations must be included for each item, and the range of change in cargo and vessel navigation information is wide. For this reason, different from container vessel operations in which vessel allocation and container scheduling is based on monthly determined trips; in car transport vessel allocation is done by correct matching of vessel type with cargo’s size, type and amount. Also, loading plan and vessel destinations must be determined according to the cargo destinations. Such characteristics of car transport planning certainly require real-time information and planning in order to reflect dynamic environment changes.

2.3 Problems and Direction of Improvement for Automobile Transport Planning

The planning activities in car shipping company basically depend on the middle and long term cargo information obtained from the shipper and allocating the company’s car vessels to the given cargo information. The general problems of such planning activities are analyzed and a direction of improvement was proposed.

First of all, real-time monitoring for the changes in the basic information is required, since the range of information change of such basic information is wide. Various factors, such as cargo information obtained from the shipper, port handling costs, port operational fees, tariffs, etc. must be considered. Also the changes in cargo information must be monitored in a real-time manner due to occurrence of various exceptions, such as labor-management dispute, change in prices, vessels and cargo. On the other hand, an information system to assist automobile shipping companies’ planning tasks actually do not exist, and the planning tasks are carried out manually, relying on the personal experience of the employees, using software like MS Excel. Thus the real-time monitoring of changes in critical information cannot be realized.

Secondly, a system to systematize and standardize the planning tasks for automobile shipping companies is necessary. Since the planning operations generally depend on the experience of the employees, it is not possible to neither verify the reliability of the outcome, nor make a comparative analysis between alternative plans. Thus the planning tasks consume more time than needed, and have serious economic demerits.

Thirdly, a voyage planning considering throughput information for each piece of cargo is needed. Currently, voyage planning in car shipping companies is limited to determining voyages for each service region rather than considering tonnage of each cargo. Thus, optimization of port selection and cost estimation could not be reached.
Finally, it is necessary to manage the final result and charter base. The amount of car vessels and supplementary facilities may not be sufficient for the given amount of cargo, and it is difficult to consider profitability maximization according to the amount of cargo.

In this research, an automobile transport system is to be developed by using RIA technology in order to solve the problems described above.

4. RIA-based User Interface

In a web based environment, the one that supports users with maximum information and convenience, enables efficient interoperability between the user and the web application is called the web application’s user interface. In this chapter the characteristics of a RIA-based user interface is examined and a guideline is proposed for developing it.

3.1 Feature of RIA-based User Interface
RIA-based user interfaces overcome the limitations of the previous HTML-based user interfaces, such as interconnectivity, data containment, rich media support, and evolving user guide.[4][5]

1) Interconnectivity
Since the previous web applications consist of hierarchical structure and operate in units of pages, it is very difficult to look up another information related to the information that is actually been observed or to seen the different forms of the information, the user must shift to another page or open a new browser. Such structure of HTML-based user interfaces requires re-education of the users about the new page and generates differences between the levels of the pages. On the other hand, since RIA has independent structure for each element and interconnection between the sub-screens, the difference between usage level of the pages and user education can be minimized. With such interconnectivity, RIA has various advantages such as responsiveness, productivity and user experience.

2) Data Containment
Currently a huge amount of data is been exchanged through the web, and that information is shared between the web applications. Web applications have to keep their own data, in order to prevent server overloads and decrease user waiting time. Thus a lot of information can be supplied efficiently by using various components.
3) **Rich Media Support**
When web applications are used, the users prefer web application environments that unite real working environment and operational functions. The compatibility of RIA with images, sounds, videos and various types of multimedia is high, and offers various operational functions such as Drag and Drop, Slider, and Double-click.

4) **Evolving User Guide**
The existing web applications offer user guide through user manuals and libraries. On the other hand, RIA can offer guidelines in various forms through multimedia.

RIA supports the users to train themselves while using the web application by enabling the tasks that were carried out on separate pages to be done in a single screen. For example, it expresses the real-time changes in stocks market in tables and charts instead of simple text messages, thus the users can recognize the information in one sight. By using such components, the trainability of the users can be enhanced.

3.2 **RIA-based User Interface Development Guideline**
Donald A. Norman(1998), Jeff Johnson(2000), Jakob Nielson(1994), Alison J. Head(1999) has stated user interface design principles as user-oriented interface, simplification of task structure, a systematic structure for information transfer, visibility and direct expression, error messages, standardization, feedback, and trainability (being easy-to learn).[6][7][8][9]

On the basis of these principles, the elements of user interface development guideline is given in three categories, namely Level Of Task Support, which indicates the purpose of the user to use the system, User Interface Structure which composes the web application, and finally User Usefulness for using the web application more efficiently. A detailed content of each category is given in <Table 1>. 

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of Tasks Support</td>
<td>Overcoming the Problems of Previous System</td>
<td>Seize the problems of previous interface, modify and solve</td>
</tr>
<tr>
<td></td>
<td>Tasks Function Containment</td>
<td>Offer all necessary functions to the user for task completion</td>
</tr>
<tr>
<td>User Interface Structure</td>
<td>Application Function Structure</td>
<td>Align the applications in a hierarchical structure for visibility, accuracy and ease of use.</td>
</tr>
<tr>
<td></td>
<td>Connection between Functions</td>
<td>Establish relevant relations between different functions through menu composition and navigation</td>
</tr>
<tr>
<td></td>
<td>Interface Component Entities for Each Function</td>
<td>Offer all entities necessary for each function</td>
</tr>
<tr>
<td></td>
<td>Order of Tasks</td>
<td>Offer clear steps for tasks in order to prevent confusion</td>
</tr>
<tr>
<td></td>
<td>Simplicity</td>
<td>Offer a simple structured interface for the user to approach easily and conveniently.</td>
</tr>
<tr>
<td></td>
<td>Integrity</td>
<td>Offer a stable and integrate interface.</td>
</tr>
<tr>
<td></td>
<td>Trainability</td>
<td>Minimize the training time of the users by indicating and leading with integrity.</td>
</tr>
<tr>
<td></td>
<td>Task Process Time</td>
<td>Minimize the time to complete each tasks.</td>
</tr>
<tr>
<td></td>
<td>Self-Construction</td>
<td>Enable the user to modify controls and functions for ease of use.</td>
</tr>
<tr>
<td></td>
<td>Feedback</td>
<td>Give necessary information to the user using an easy and understandable language</td>
</tr>
<tr>
<td></td>
<td>Error Prevention</td>
<td>Prevent the possible errors and consider their solution methods in advance.</td>
</tr>
<tr>
<td></td>
<td>Satisfaction</td>
<td>Maximize the sense of satisfaction of the user when using the system</td>
</tr>
</tbody>
</table>
5. RIA-based Automobile Transport Planning Support System

4.1. System Design
1) Design Process System

The detailed process of car transport planning, which is carried manually by car carriers, is given in <Figure 2(left)>.

Tonnage Planning assigns the car transport vessels for each major voyage by calculating the required number of vessels on the basis of monthly transport throughput. Voyage Planning/ Vessel Allocation Planning combines the cargo that have destinations on the same voyage by taking the produced car information into consideration and assigns vessels to cargo. By doing so, the ports of call for each vessel are determined.

Currently, the limitations to car transport planning process are as follows. First of all, it is impossible to determine whether the outcome is the optimum solution, since the tasks are carried out manually. Second, information about the amount of cargo changes frequently, thus it is difficult to reflect the changes on the plan in a real-time manner. Third, there are certain limitations to voyage planning, since the vessels are allocated to major transport routes.

![Diagram](image)

*Figure 2* Previous Car Transport Planning Process and the Planning Process Applied to the Developed System

In order to overcome these limitations, the processes of car transport planning support system are modified as shown in <Figure 2(right)>. First, the part of tonnage planning related to route information for each transport service region was deleted. Instead, required amount of vessels according to amount of
car cargo to be transported monthly is calculated directly. Second, the routes for transport service regions were deleted, and optimum alternatives for Voyage Planning/Vessel Allocation Planning are derived by appropriate algorithms. And the changing amount of cargo is provided on a real-time basis and reflected to car transport planning. If the cargo information changes or any exceptional cases occur, the plan is revised.

2) Navigation Flow & Content Structure
The structure of car transport planning support system is given in <Figure 3>. It can be considered as Basic Information Screen necessary for car transport planning tasks, and the screen to make car transport planning through IP modules.

The basic information can be classified into three categories, namely cargo information, vessel information and payment information. The basic information screen is composed of monitoring screen, which monitors and analyzes the basic information in a real-time manner, and information management screen for modifying the basic information, such as input, correct and delete. Car Transport Planning Screen is composed of Car Transport Alternative Planning Screen that uses IP modules, Monitoring Screen that keeps track of changing cargo information in a real-time basis, and Next Month’s Tonnage Planning Screen. And, it includes a screen that displays detailed cargo and route information. This information may not be necessary every time when transport planning is made, but it should be available to the users upon demand.

<Figure 3> System Structure
As the structure of the user interface gets deeper and/or broader, it would be more difficult and confusing for the user to actually use the system, thus the structure is kept as simple as possible.

3) Design Grid System

The system is composed of 2 phase structure, there is an Application Bar in the upper part and a Contents part where actual tasks are done resides at the lower part. In Application Bar, the elements that must always be displayed on the screen, namely system name and navigation, are expressed together.

The system name is displayed at the left-upper part of the screen in the main visual part. In order to emphasize “Identity” and maintain integrity, the main contents part and Application Bar part that includes menu navigation, are distinctly separated. Considering the general movements of the user’s line of sight, main contents part is placed just below the system name. By doing so, the contents part is always kept noticeable.

<Figure 4> Design Grid System

4.2. System Development

1) Basic Information Monitoring Screen

As it is given in < Figure 5>, Basic Information Monitoring Screen is divided into three sub-screens for each of the basic information types required for car transport planning, namely cargo information, vessel information and payment information, respectively.

The left-hand side panel is the title of the three basic information groups, and it also offers Tab Bar function for switching to basic Information Management screen which enables connectivity between the basic information groups.
The cargo information can be displayed in both table and chart forms (Column Chart, LineChart, PieChart) for each shipper, thus enabling comparison among each other and the distribution of the cargo among the shippers. It also generates information related to the car carrier’s own ships and payment information for each vessel at each port.

2) Basic Information Management System
As it is seen in <Figure 6> the screen for Basic Information Management is given in the same layout with the monitoring screen to maintain integrity. The screen is divided into two, namely the part where the information is entered and the part where the entered information is displayed in a table. The monthly amount of cargo over a year is also given at the bottom of the screen for Tonnage Planning.
It is possible to enter, modify and delete the basic information. The modification of the data can be directly done on the table to be consistent with general spreadsheet applications that the employees are accustomed to use for planning tasks. Shifting from one cell to another can be done similarly with keyboard functions. When entering date data, i.e. departure and arrival information can be assisted by “DateChooser” function for easy inputting. Also, help function is provided through “Tooltip” and pop-up messages for new users.

Such a RIA-based user interface can display Basic Information Monitoring Screen and Basic Information Management Screen in a single web page, shifting from one to other without opening a new browser is convenient. Thus user’s confusion about the task and its position can be prevented. It also supports various settings done by the user.

3) Car Transport Planning Screen
As it is shown in Figure <Figure 7> Car Transport Planning Screen is composed of Car Transport Alternatives Screen, Changed Cargo Information Screen, Next Month’s Tonnage Planning Screen, and Car Transport Planning Details Screen.

The transport plan alternatives made by using IP modules, and the changes in cargo information after the IP module has been executed are shown in a table form. Also, Next Month’s Tonnage Planning Screen provides the amount of cargo to be handled in the actual month, the amount left from the last month, the amount to be handled in the next month, number of vessels assigned for
next month, and additional vessels needed in label form, and the information
details of the vessels assigned for next month are given in table form.

Since the system is developed based on RIA, it is possible to display all the
necessary information for transport planning in a single browser, as it is seen
in <Figure 7>. Also, by using Title Window function that can modify window sizes, the amount of data displayed in a single screen can be increased.

![<Figure 7> Planning Screen](image)

If the users need to look up the details of the transport alternatives, they can
click the Details button, or double click on a particular alternative. Details of
cargo information are given as a table, whereas the route information is given
on a map. The XML-based map is handled by mashing up Flash-based Ya-
ahooMaps.

The map provided by the RIA-based user interface can be linked to other applications, and it can move freely within the browser. Moreover the usability
of the map by the user is enhanced with Zoom In/Out function.

4.3. Evaluation of the System

In order to evaluate the system developed in this research, a questionnaire targeting car carrier employees who are responsible for transport planning and transport planning experts was performed. The respondents were asked to compare the RIA-based interface with previous interfaces based on HTML, on the basis of the guideline given in Chapter 2. Each factor of the guideline, namely Level of
Task Support, User Interface Structure, and User Usefulness were evaluated on a 5-point scale.

According to the results, RIA-based user interface was indicated to be better than HTML-based interface in all items except for error messages, as it can be seen in Figure 8.

![Figure 8] Results of User Interface Evaluation

The detailed results of the questionnaire for each factor are as follows. In Level of Task Support aspect, RIA-based user interface can overcome the problems of the previous systems by 2.4, which means it can support transport planning more efficiently by providing the changes in the information in a real-time manner using various components. On the other hand, task function containment got 1.6 points, which means that previous HTML-based interfaces can also include the necessary functions for transport planning and the respondents could not figure out big difference between the two systems.

In structural point of view, HTML-based interfaces have the limitation of having layered structure and displaying only one screen in one browser. On the other hand, RIA-based interfaces turned out to be superior to HTML-based interfaces in all items of User Interface Structure, namely application function structure, connectivity between the functions, interface component entities for each function, order of tasks execution, and use continuity of use. Especially the function that enables to perform tasks independently without any additional pages or changes to the layout got high points from the respondents.

In Usability aspect, RIA-based user interfaces got higher points in all of the items, such as simplicity (2.4 pts), integrity (2.8 pts), trainability (2.2 pts), self-construction (3.2 pts), feedback (2.6 pts), and satisfaction (3.2 pts). The reason for that was providing various self-construction functions to user, such as Click,
DoubleClick, and Drag & drop etc., and offering a dynamic interface through integration with various applications, such as YahooMap and VideoPlayer. Also, overall unity and integrity of the system was maintained by using CSS technique in the same layout without any need to shift to other pages.

On the other hand, although the system offers functions like Tooltip and Data-format for error prevention, previous HTML-based interfaces appeared to be 2.2 times better in error prevention. It is due to insufficient testing of the developed system before evaluation. Also there were some limitations to obtain real data to be utilized in the test, thus detailed data that are actually used in field operations could not be included in the test.

6. **Conclusion**

The automotive industry has deep impact on export of Korea, but the industry is faced with some structural problems such as high share of logistics cost when compare to the revenues. In order to solve such problems, sufficient amount of car transport vessels must be supplied, but the actual supply cannot reach the increase in the export automotive cargo. The car carriers need an efficient system for transport planning to decrease logistics costs, but the support for planning tasks are not realized to achieve these goals.

In this research, a RIA-based user interface was developed for car transport planning system in order to enhance tasks support, user interface structure and usability of the system. The developed interface was compared with previous HTML-based interfaces to evaluate, and the results show that the developed interface is superior to previous HTML-based systems on every evaluation item, except for error prevention. Especially, the system got higher points in Usefulness parts due to providing various components such as YahooMap and VideoPlayer, and enabling user self-construction of functions such as Double-click and DragAndDrop. And finally, the respondents were very satisfied with the developed system since the system enables them to perform various tasks in a single browser, without any need to change the web page or open an new window for a new task.

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7. References