Development of an RIA-based User Interface for Promotion of Effectiveness in Marine Transportation

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Abstract: This study aims to develop and evaluate an RIA-based user interface which can effectively support marine vehicle transportation planning. Currently, it is emphasized that user interface not only plays a role to show the results processed in systems but that it also has to take a role to support users' operations, promote usability and so forth. Also, it is necessary to modify information system so that it can effectively express and adapt to information changing on a real-time basis and provide the information in a timely manner. Thus, this study develops an RIA-based user interface and proves with evaluation that it contributes to operation support and enhancement of usability.

Key-Words: Rich Internet Application, User Interface, Maritime Transportation Planning

1 Introduction

Recent studies in relation to user interface put emphasis on interactions between users and systems such as usability and users' awareness. In other words, there is a stress upon development oriented to users and operations for creation of perfect user interface. This affected studies into principles in design of web interface. Jakob Nielson attached great importance to usability evaluation in principles of web interface design [4] while Alison J. Head defined the manipulation behavior of users when performing operations as interaction between users and systems and put emphasis on this [1].

This study aims to overcome the limits found in user interface with Web Application and embody user interface which can deliver information closer to and based on human communications by embodying a marine vehicle transportation planning user interface based on RIA (Rich Internet Application) technologies recently taken notice of. This is aimed at improving operation support such as supplementation to work functions and problem solving, helping smooth interaction between users and systems, and enhancing usability.

RIA can be defined as "a new technological paradigm that enables a process of simple and two-dimensional expressions and sequential operations based on the existing Web Application technologies to handle all processes on a single user interface through inter-working of dynamic user interface and database."[2] The RIA-applied Web Application can improve usability as user interface that used to express over many pages turns to one that is enabled to express all in one page. It processes various information and mass data on a real-time basis. Also, dynamic user interface which can express user experiences just like those in the real world helps transformation into Web Application such as intelligent clients (Rich Client, Smart Client, Intelligence Client).

2 Marine Vehicle Transportation Planning

Marine vehicle transportation planning of a shipping company specialized in automobile transportation is composed of Tonnage Planning, Voyage Planning, Vessel Allocation Planning, and Stowage Planning and the flow of operation is as shown in Fig.1.

Fig.1 Marine Automobile Transportation Planning Process

In Tonnage Planning, the first operation, owned and chartered ships are secured and allocated based...
on information of annual transportation volume. Annual transportation volume is estimated based on information of vehicle volume made available through contracts with shippers (automobile manufacturers) and the existing transportation performance. The quantity of pure car carriers is generally smaller than that of vehicle freights and the cost for shipping services is high. Thus, more quantities shall be shipped to one ship and Vessel Allocation Planning and Voyage Planning are carried out to minimize the shipping cost.

Vessel Allocation Planning determines the types and quantities to be shipped to each ship based on overall freights and ship information established by Tonnage Planning and aims to plan to ship the maximum quantities of vehicle freights.

Voyage Planning determines ports of call and the order of calling according to the size, form, and quantity of freights for each ship transportation. Information of destination of each vehicle freight is stored inside and it is necessary that the plan shall be established after consideration of individual freight information as there is a great variety of size and form of vehicle freight unlike container freights.

Stowage Planning determines the location and order of loading of freights to be shipped based on volume information of each ship established in Vessel Allocation Planning. However, as Stowage Planning is separately operated by a separate team when planning for marine vehicle transportation, this study does not cover this.

Marine automobile transportation planning is similar with marine transportation planning of general container freights and overall work process but it implicates individual and destination information of each freight and has a wide range of fluctuation of information of shipping volume and services. Thus it is necessary to put ships appropriate for size, type, and volume of each freight according to the types of ships, which is different from container ships allocating ships based on monthly routes and forecasting the next operation based on schedules only. Also determination of shipping and a port of call in consideration of destination information of freights is required. As can be seen from this, the real-time information and changes to plans based on the information after consideration of characteristics of automobiles and dynamic changes of environment shall be available in marine automobile transportation planning.

Functions required for efficient automobile transportation planning most of which is based on manual labor currently are as following. First, the real-time based monitoring of basic information is necessary as there is a wide fluctuation of basic information necessary when planning marine vehicle transportation. Diverse factors such as volume information provided by shippers, cargo-working and operation cost at ports, customs duties and so forth shall be considered. Also as there may arise various exceptional events such as labor unrest, fluctuation of oil prices, changes in freight space and volume and so forth, any changes to volumes shall be monitored on a real-time basis. Second, functions systemizing and standardizing marine vehicle transportation planning are necessary. Currently, reliability of alternatives to plans is not being verified as marine transportation planning is based on experiences of individuals and there occurs much waste of time and trials and errors as comparison and analysis of modified alternatives are absent. Third, functions that can establish Voyage Planning in consideration of each freight information is necessary. Currently, Voyage Planning is carried out based on routes of each service area only rather than volume information of each freight. This creates problems failing optimization in selection of ports of call and cost estimation.

3 Development of an RIA-based user interface

3.1 Structure of user interface

User interface of marine vehicle transportation planning system can be divided into a screen of basic information necessary for marine vehicle transportation planning and the other screen performing marine vehicle transportation planning.

Basic information is composed of three kinds of information of volume, ship, and shipping charge. Basic information screen is composed of monitoring screen which monitors and analyzes basic information on a real-time basis and information management screen which works on input, modification, deletion and so forth of basic information.

The screen of marine vehicle transportation planning contains an alternative screen for marine vehicle transportation planning, a monitoring screen for vehicle freights changing on a real-time basis, volume information processed by marine vehicle transportation planning, and the next month Tonnage Planning screen which shows volume
un-met in the relevant month and transferred to the next, freight space available for the next month, and volume of ships for service contract after calculation of insufficient freight space for the volume of the next month. Also it provides a detailed information screen of marine vehicle transportation that does not need to be always provided when planning but shall be on the request of users. The detailed information screen provides detailed information of volume and route on alternatives to marine vehicle transportation plans. The Help screen which provides advice on overall use of the RIA-based marine vehicle transportation planning system has been additionally established. Diagram of the structure of user interface of marine vehicle transportation planning system is as shown in Fig. 2.

\[ \text{Fig. 2 Navigation Flow} \]

Components and detailed information constituting the user interface of marine vehicle transportation planning system is as presented in Table 1.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
\textbf{Division} & \textbf{Component Screen} & \textbf{Sub-components} & \textbf{Contents of component screen} \\
\hline
\textbf{Basic information management screen} & Volume information monitoring & Provide basic information necessary for marine vehicle transportation (volume, ship, charge) in one screen & \\
& Ship information monitoring & & \\
& Shipping charge information monitoring & & \\
\hline
\textbf{Basic information management screen} & Volume information monitoring & Input, modification and deletion made possible on the same screen of the basic information monitoring screen & \\
& Ship information monitoring & & \\
& Shipping charge information monitoring & & \\
\hline
\textbf{Automatic marine transportation planning screen} & Screen of alternative marine vehicle transportation & Provide an alternative established through utilization of IP module of marine automobile transportation planning & \\
& Screen for information of changed volume & Provide information of volume changed after IP planning module operation & \\
\hline
\end{tabular}
\end{table}

3.2 Characteristics of the RIA-based user interface

Points and characteristics that the RIA-based user interface outperforms HTML-based user interface are as following. First, in the embodiment of the existing HTML-based user interface, the movement from basic information monitoring screen to basic information management screen needs a movement to a separate page or a new window. The RIA-based user interface can provide both basic information monitoring and basic information management screens in one page, enable movement from one to the other, and help users against confusion in the current operation and location by not opening many new windows.

Second, the RIA-based user interface can provide more user manipulation functions than the existing HTML-based user interface. For example, one can directly input or modify texts within the basic information table which falls under output with consideration of user experiences with spreadsheet and OS, application mainly used for the existing marine vehicle transportation planning in the basic information management screen. Also it provides date data input using Date Chooser and Help which uses Tooltip and pop-up in pop-up input area. The RIA-based user interface like this can provide more diverse functions for user manipulation than the existing HTML-based user interface.

Third, there are problems with the existing HTML-based user interface. As the size adjustment
of overall application screen is possible, a separate page needs to be embodied when providing much data, or when providing together, one needs to see partial pages using scroll as the size of screen is big. However, the RIA-based user interface enables to provide components necessary for marine vehicle transportation planning in one page altogether as presented in Fig.3. And utilization of TitleWindow in which adjustment of window size is possible enables to enlarge and see large quantities of data at one look. For example, by constructing with TitleWindow in which adjustment of window size is possible on the screen of marine vehicle transportation planning, it can provide large quantities of information including vehicle freight of large shippers, pure car carriers of shipping companies, and the corresponding shipping charges.

Fig.3 Screen of marine vehicle transportation planning

Fourth, the map provided by the existing HTML-based user interface was a static and fixed image but the map provided by the RIA-based user interface is available for inter-work with other applications so users can move to a desired location while Zoom In/Out provided by this interface helps more effective application to operations. For example, when users wish to see detailed information of the alternative automatic marine vehicle transportation planning, detailed volume information is made available as a table at the bottom of user interface as shown in Fig.4 with clicking Click buttons, Click event and DoubleClick for each alternative on the alternative screen of marine vehicle transportation as well as route information expressed in a map. Maps are processed based on the XML-form and can provide dynamic user interface by mashing up with Flash-based YahooMap.

Fig.4 Screen of marine vehicle transportation planning (Detailed information screen)

Fifth, while the Help to the existing HTML-based user interface is provided mainly in the form of texts like product description with Tooltip and pop-up, the RIA-based user interface can provide diverse multi-media like animations based on standard development technologies so that users can directly follow after illustrations as Fig.5. For example, it provides overall process performing marine vehicle transportation planning in a video-player and as animations are provided as FVL files and played in a Flash Player, it is usable without separate installation.

Fig.5 Other screens – Help

4 Evaluation of the RIA-based user interface

In order to prove that the RIA-based user interface for marine vehicle transportation planning can enhance work efficiency, user satisfaction revolving around function structure and work flow was compared against HTML-based user interface. Main evaluation areas were divided into the level of operation support, structure of user interface, and usability. Mainly, it evaluated whether it provided easy and convenient user interface so that users effectively use this for marine vehicle transportation planning. If evaluating the RIA-based user interface only to the experts on the site, there may arise unnecessary influence of factors such as a rejection to a new screen. Thus, a group of persons
responsible for marine vehicle transportation planning of marine companies specialized in automobile transportation in the country and the other group of experts familiar with RIA and new user interface took part in evaluation in this study.

4.1 Evaluation of the RIA-based user interface for marine transportation planning

Results of evaluation of the RIA-based user interface for marine vehicle transportation planning conducted by persons responsible for marine vehicle transportation planning of marine companies specialized in automobile transportation and others with experiences of marine transportation related projects or study in the area as major are as shown in Table 2. Over all, evaluation was higher than 4 and the variation of evaluation was even with 1 and less. However, satisfaction was low with 2.875 of feedback and 2.5 of errors.

**TABLE 2 Evaluation of the RIA-based user interface for marine vehicle transportation planning**

<table>
<thead>
<tr>
<th>Areas of evaluation</th>
<th>Items of evaluation</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of Operation support</strong></td>
<td>Supplementation of problems with the existing problems</td>
<td>4.125</td>
<td>0.331</td>
<td>0.109</td>
</tr>
<tr>
<td></td>
<td>Implication of operation function</td>
<td>4.125</td>
<td>0.331</td>
<td>0.109</td>
</tr>
<tr>
<td><strong>Structure of User interface</strong></td>
<td>Function structure</td>
<td>4.250</td>
<td>0.661</td>
<td>0.438</td>
</tr>
<tr>
<td></td>
<td>Corresponding relation by each function</td>
<td>4.125</td>
<td>0.781</td>
<td>0.609</td>
</tr>
<tr>
<td></td>
<td>Component object by function</td>
<td>4.125</td>
<td>0.331</td>
<td>0.109</td>
</tr>
<tr>
<td></td>
<td>Work order</td>
<td>4.375</td>
<td>0.484</td>
<td>0.234</td>
</tr>
<tr>
<td></td>
<td>Mutual continuity</td>
<td>4.500</td>
<td>0.500</td>
<td>0.250</td>
</tr>
<tr>
<td><strong>Usability</strong></td>
<td>Simplicity</td>
<td>4.375</td>
<td>0.484</td>
<td>0.234</td>
</tr>
<tr>
<td></td>
<td>Consistence</td>
<td>4.375</td>
<td>0.484</td>
<td>0.234</td>
</tr>
<tr>
<td></td>
<td>User learning</td>
<td>4.000</td>
<td>1.118</td>
<td>1.250</td>
</tr>
<tr>
<td></td>
<td>Direct manipulation</td>
<td>4.250</td>
<td>0.829</td>
<td>0.688</td>
</tr>
<tr>
<td></td>
<td>Feedback</td>
<td>2.875</td>
<td>0.927</td>
<td>0.859</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>2.500</td>
<td>0.707</td>
<td>0.500</td>
</tr>
<tr>
<td></td>
<td>Satisfaction</td>
<td>4.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Evaluation of objects constituting interface by functions, work order (behavior inducement), mutual continuity, direct manipulation, and user satisfaction was relatively high. The RIA-based user interface in which limits held by the existing HTML-based hierarchical structure and page unit processing form were supplemented provides basic information monitoring and basic information management screens on the basic information screen in one without a change of page or lay-out and its independent structure and mutual continuity were highly appreciated. Also evaluation of user satisfaction was found to have improved with support of diverse media such as video player (Help function) and so forth and inter-working with other applications (YahooMap).

4.2 Comparative evaluation against the HTML-based user interface

The RIA-based user interface was compared and evaluated against the HTML-based user interface with the existing marine vehicle transportation planning. The datum point for comparison and analysis between the RIA-based user interface and the HTML-based user interface is 0. Summing up results with the RIA-based user interface is as shown in Table 3.

**TABLE 3 Comparison and evaluation against the HTML-based user interface**

<table>
<thead>
<tr>
<th>Areas of evaluation</th>
<th>Items of evaluation</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of operation support</strong></td>
<td>Supplementation of problems with the existing problems</td>
<td>1.40</td>
<td>0.490</td>
<td>0.240</td>
</tr>
<tr>
<td></td>
<td>Implication of operation function</td>
<td>0.60</td>
<td>0.800</td>
<td>0.640</td>
</tr>
<tr>
<td></td>
<td>Function structure of application</td>
<td>1.60</td>
<td>0.800</td>
<td>0.640</td>
</tr>
<tr>
<td></td>
<td>Corresponding relation by function</td>
<td>0.80</td>
<td>0.748</td>
<td>0.560</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>Objects constituting interface by function</td>
<td>2.20</td>
<td>0.748</td>
<td>0.560</td>
</tr>
<tr>
<td></td>
<td>Work operation order (behavior inducement)</td>
<td>2.20</td>
<td>0.748</td>
<td>0.560</td>
</tr>
<tr>
<td><strong>Usability</strong></td>
<td>Mutual continuity</td>
<td>2.20</td>
<td>0.748</td>
<td>0.560</td>
</tr>
<tr>
<td></td>
<td>Simplicity</td>
<td>1.40</td>
<td>0.800</td>
<td>0.640</td>
</tr>
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<td></td>
<td>Consistence</td>
<td>1.80</td>
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<td>0.560</td>
</tr>
<tr>
<td></td>
<td>User learning</td>
<td>1.20</td>
<td>0.748</td>
<td>0.560</td>
</tr>
<tr>
<td></td>
<td>Direct manipulation</td>
<td>2.20</td>
<td>0.748</td>
<td>0.560</td>
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<tr>
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<td>Feedback</td>
<td>1.60</td>
<td>0.800</td>
<td>0.640</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>-1.20</td>
<td>0.748</td>
<td>0.560</td>
</tr>
<tr>
<td></td>
<td>Satisfaction</td>
<td>2.20</td>
<td>0.748</td>
<td>0.560</td>
</tr>
</tbody>
</table>

* N=0: The RIA-based user interface and the HTML-based user interface are evaluated to be without difference.
* N>0: The RIA-based user interface is evaluated to be N higher than the HTML-based user interface.
* N<0: The RIA-based user interface is evaluated to be N lower than the HTML-based user interface.
Users evaluated the RIA-based user interface more highly than the HTML-based user interface in all evaluation areas. However, as there are areas that each user finds more critical, weights were given to 3 areas separately by identifying the level of importance in the areas. The weight given in each evaluation area is 0.467 for the level of operation support, 0.133 for structure of user interface, and 0.4 for usability. Analysis of each evaluation area based on the results from weighted evaluation is as below.

4.2.1 Level of operation support
Supplementation to problems with the existing operation was 6.538 and implication of work functions was 2.802. There is no great difference as the function of marine vehicle transportation planning is implicated in the existing HTML-based user interface, too. However, in terms of supplementation to problems with the existing operation, it was appreciated that more effective operation is supported by reflecting volume information changing on a real-time basis and assigning the optimum alternative for marine vehicle transportation planning in consideration of payability.

4.2.2 Structure of user interface
This area was the most highly evaluated before the weight was given but the weighted result was 2.128 for function structure of application, 1.064 for corresponding relation by each function, and 2.926 for objects constituting interface by function. The RIA-based user interface in which limits of the existing HTML-based hierarchical structure and page unit processing form were supplemented had its independent structure and mutual continuity highly appreciated just like both screens of basic information monitoring and basic information management are provided on the basic information screen without changes to page or lay-out.

4.2.3 Usability
Evaluation had 2.926 for work operation order (behavior inducement), 2.926 for mutual continuity, 5.6 for simplicity, 7.2 for consistence, 4.8 for user learning, 8.8 for direct manipulation, 6.4 for feedback, -4.8 for error, and 8.8 for satisfaction. Especially, users highly appreciated usability except for errors. Provision of diverse manipulation functions of Click, DoubleClick, Drag and drop and so forth for users and dynamic user interface inter-working with other applications such as YahooMap and VideoPlayer helped direct manipulation and user satisfaction highly appreciated. And identical lay-out provision and CCS technology utilization had overall unity and consistence kept high. However, user evaluation on errors was found to be rather low although there were supplementations by providing Tooltip, Dataformat and so forth for prevention of errors. This can be understood that although there were various functions provided to user interface, insufficiency of test of the embodied system and limits of provision of information necessary for establishment of marine vehicle transportation planning did not satisfy detailed operations.

5 Conclusion
This study developed the RIA-based user interface for marine vehicle transportation planning system to support marine vehicle transportation planning of shipping companies specialized in automobile transportation and compared and evaluated the developed user interface system against the system used at actual operations.

The RIA-based user interface was developed to enhance effectiveness of marine vehicle transportation planning and this improved the level of operation support, structure of user interface, and usability. The embodied RIA-based user interface was evaluated to be more excellent in all items except for error to the existing HTML-based user interface. Especially, provision of diverse components such as YahooMap and VideoPlayer as well as manipulation functions of DoubleClick, Drag and drop an so forth helped the area of usability highly evaluated. Also it was appreciated that work operation on one screen without changes of operation sites improved user satisfaction. In order to promote practicality and satisfaction of the user interface developed through this study, diverse exceptional cases that may arise in the future marine vehicle transportation planning shall be identified and functions that effectively support these identified issues shall be developed, too.

Also, through this study, it was emphasized that user interface is not only about showing processed results of information system but also needs to play a new role of user operation support and so forth.
References:


