ORIGINAL ARTICLES

FRESH FISH TRADING SUPPORT SYSTEM DEVELOPMENT
A KANSEI ENGINEERING APPROACH

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Abstract: A Web-based retailing system for fresh fish trading has been instituted on experimental basis in Kesennuma city public fish market, with the assistance of Miyagi University. Buyers and Sellers can trade time-constraint fresh tuna meat through virtual supply market created over a database transaction system. The system is designed using the most recent software design methodology, framework, components and agents. The researchers investigate various aspects of this project, e.g., how to bring the merit of digital convergence of existing retailing companies, what is strategic scenario for price formation process, and how the future management of electronic commerce technology applied to this local industry should be. By taking a Kansei engineering approach for the development of this system, we study the possibility of incorporating sophistication in the trading process.

Keywords: Kansei-based business management, Agent, Digital convergence, Framework, Components, Retailing, Tuna meat

1. INTRODUCTION

Our research group has been working on BPR (Business Process Re-engineering) and B-to-B (business-to-business) transaction system development and administration for fresh tuna trading with wholesalers in Kesennuma city in Miyagi Prefecture. The Kansei engineering approach is considered to be effective for this research project because the trading mechanism is formed in complicated custom, and many human factors are involved in real-world trading. The price does not vary as much as expected in auctioning at bidding market. The sellers and buyers tend to put the priority over a credible relationship between them, rather than having cut-throat competition over the prices so that the price and trading lot tend to become stable. Perhaps everyday dealing would become routine work. At least, if one pays attention to the relationship between the broker and the business shop.

If we see this situation carefully, each agent (sellers and buyers) behaves very differently, depending on the particular situation. Some would care more for price than the quality of products or vice versa. Others may try to get discounts by purchasing larger amounts of goods. Each agent has different desires in trading. We apply the Kansei engineering approach in order to understand patterns of those agents who exhibit a variety of behaviors in trading activities.

This study should provide deep insight into human behavior in trading. It may not be easily explained in the logical format of computers, rather an analog or fuzzy kind of approach is suitable.

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experienced significant scale revolutions, from management style to the price formation process.

The driving force of such a trend is IT. Computer technology, the network environment and database technology allow us to convert existing business processes, such as ordering, warehouse management, price formation, and customer relationship. There are several success stories of digital convergence trials in marketing.

In this paper, a digital convergence trial to the existing fish trading mechanism is explained from a system-design perspective. Fresh fish and related processed products trading are one of the important industries in Miyagi Prefecture in Japan. In our research, we focus on fresh tuna trading.

In general, the distribution channel of primary industry products such as tuna, is composed of a series of dealing relationships required to deliver the goods from the producer to the end consumer.

If a company in the distribution channel plays a dominating role in terms of the price and amount of dealings, the stability of the whole supply chain depends greatly on the company’s position in the channel.

2.2. Current situation on tuna trading

The digital convergence scheme that we are adopting in this research project is not limited to fresh fish, but it can be commonly applied to other agricultural products, such as vegetables and processed food products. Japan is rich in processed foods and there are many small producers as well as retailers. By focusing on tuna trading, we are searching for generalized solutions of digital convergence in the situation where the number of traded items is very large in a certain marketing channel.

The initial price formation process of tuna and other fresh fish consists of bidding in a producers’ auction at the starting point of distribution. This process is well organized and practiced so that computerizing such an environment is not a simple task. In any case, this industry will experience vast business process re-engineering in the near future. However, we are not going to convert everything in this established procedure now. The system we design is aimed at providing the so-called B-to-B (business-to-business) transaction mechanism over the Internet. The system is placed in between retailers of producer side. We do not consider the electronic retailing system in which the end consumer purchases goods from an Internet web site.

Once the wholesaler at the producer side finishes bidding, they possess products to sell in the short-periods, in rather large-scale lots.

Miyagi University plays a role in leading this digital convergence project in Kesennuma fish trading market by developing a B-to-B Internet trading environment.

Kesennuma city in Miyagi prefecture is the tenth largest fishing port per income basis in Japan. Its major trading item is tuna, especially fresh tuna, due to the relatively short distance to the rich producing sea from the port.

Although the fishermen’s community may be considered distant from recent computer technology, gradually the importance of IT is being recognized by business.

Our digital convergence project is planned and pursued in such circumstances.

3. SCENARIO OF DIGITAL CONVERGENCE

3.1. Supply chain management classification and location of our work

In supply chain management (SMC), different business entities related to the distribution channel share information. Thus, efficiency in the trading relation, including the physical distribution of goods, is achieved.

Up to now, we have used the term "trading relation", where we mean the settlement relationship, i.e., the relation between bills and payments. Sometimes, the actual goods circulation does not follow the same route as the settlement relation. For example, although the settlement relation is from A-> B-> C, the actual goods flow may occur only from A-> C. This case, where the settlement relation and the actual distribution relation differ, is frequently seen in Japan, especially in food distribution. The price formation process and the distribution channel have a strong influence on each other. Thus, the circulation of goods is dominated by the wholesaler, who has the initiative in determining price.

We can classify the SCM into the following three types: a) the producer initiates the channel and dominates up to the customer-side, b) the producer and the general merchandise store (GMS) cooperate so that the retailer and the factory are directly connected and c) the GMS approaches to the producer-side of the channel.

If we see the distribution channel as a river, we can refer to the traders at the producer-side of the channel as "up-stream ", to the traders at the customer-side of the channel as "down-stream ", and to the wholesalers as "middle-stream ".

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The "up-stream" and the "down-stream" have experienced changes this decade. As a result, the wholesalers in the "middle-stream" will have a major influence over the whole river or circulation route.

By observing these types, we can devise a new type in which a horizontal expansion is formed through cooperation among the wholesalers, with either a geographic expansion of the market or an increase in the number of trading goods, with the benefits of wide-area delivery functions.

We will refer to this new type as "horizontal tie-up" and to the existing traditional types as "vertical tie-up".

For instance, in the case of fresh fish, there is a vertical flow in the distribution as follows: fishing --> auction at production-site market --> wholesaler --> auction/purchasing at consumer site --> retail store user/consumer.

In the vertical type, improvement of the efficiency in supply chain management will be achieved by tying-up in vertical form.

In contrast, in the horizontal type, the dealers in a specific region or in a specific product exchange information, so that they can commit, for example, to a joint delivery in order to improve the distribution efficiency.

According to the above explanation, our research project is characterized in both vertical and horizontal tie-ups.

First of all, we can see a vertical tie-up because our project aims to omit the "middle-stream" of the distribution channel, i.e., to bypass the distribution channel up to the "down-stream" (consumption side). This is done in order to give higher priority to the producers regarding the benefits of distribution process. If we assume the future advancement of electronic commerce, we can predict that shortening this circulation route becomes usual.

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Once a virtual mall is formed, the constituent members of this mall try to cooperate in determining such factors as the goods to be traded, the minimum trading amount and the reference price.

In the process of forming a virtual mall, a type of negotiation process is built, that can be seen as a "coalition" of the horizontal tie-up type.

In order to understand the details of the business, there are several technical issues associated specifically into fresh tuna trading. However, we will not provide the details here.

The constituent members of the malls do not have the knowledge or information technology. In the fish trading community, the application of information technology is not widely realized yet. Through this research project, Miyagi University plays this role of the so-called "technology broker", who tries to lead the digital convergence process [1].

By undertaking this role, we provide knowledge and technology equally to the members of the virtual mall developed for electronic transactions. The constituent members are treated equally so that there is no difference in the degree of application.

However, if we observe the progress of introducing technology, it might be the case that other technology brokers would offer some advanced technology to a specific member, resulting in differences in skills and behavior of that member. Thus, the profit from the mall might differ.

In this context, it can be predicted that a certain mall with good features achieve a definite position in the industry concerned. Thus, regarding the horizontal tie-up in the electronic transaction system, there is a unique aspect in formation of such a community [2].

### 3.2. The scenario of digital convergence

In our experiments into digital convergence, we placed some conditions as follows: a) the existing rights of merchants regarding the channels and the customers in their commercial sector should be respected and b) the system designed should tend to position price benefits on the supplier's side of the distribution channel.

The digital convergence is an unavoidable trend in merchandizing. From this perspective, our system attempts to look for benefits on the production side rather than on the consumer side. Thus, our experiment consider the producers' aspects of the supply chain.

Perhaps, in general, in order to accomplish the digital convergence for a certain commercial sector, there are several stages to go through. In the following, we assume one sequence or pattern of such developing stages.

(I) The composition of a virtual shop: sharing of information, which can convert the settlement relation into a smooth settlement relation. Only limited information is shared, and confrontation of interests is not obvious. For example, sharing the goods' code, goods' data base, and Web pages for customer information.

(II) Integration of virtual shops: the information becomes more advanced, and the sharing of substantial workflow
is accomplished. Then, one or more enterprises, which are members of the virtual mall, need an organization that specializes in the digitalized form of transaction.

(III) Total integration: digital convergence in the vertical direction may occur. This is, the virtual shop explained previously in (II) aims at the vertical type integration. However, for this stage, a drastic review of the business process is necessary, and the good use of information technology is strongly required. In order to secure the success, it is necessary to have constant innovation and to always revolutionize, along with the advancement and progress of information technology.

In our experiment, the wholesalers played the role of (I), and a research consortia played the role of this digital convergence promotion. In order to progress according to the standard scenario of digital convergence, an organization with a higher ability is needed. It might be, for instance, the local governments, specialized companies or the operation company.

There are unsuccessful cases reported which introduce the level of (III) immediately without considering such a scenario and the human and social factors. Such a case was observed when the attention was beginning to be paid to the Intranet. The reason for failure was that they were merely technology-oriented and did not consider existing customers and merchants.

For digital convergence to be successful, it is necessary to have systematic advancement. Thus, in this project, we have carefully selected the appropriate features.

4. OVERVIEW OF THE SYSTEM STRUCTURE

4.1. System overview

In this section, we describe the wide-area distributed trading support prototype system we have implemented.

An Intranet server is installed at Miyagi University, in which web-based virtual stores are developed. This server, with UNIX as the operating system, has the following functions: a relational database function, a Java interface function, electronic trading oriented package software, and a framework interface.

Our business partner - a major software and hardware vendor - is responsible for the requirement analysis, the system design and the development of the components.

The sellers and buyers involved in the fresh fish distribution process build a virtual marketplace on this server.

Regarding the network structure, we adopt the so-called virtual private network, which is based on a general Internet service provider.

4.2. Technological advantages

4.2.1. Development based on frameworks

We adopt a component-oriented development methodology based on a decentralized, object-oriented technology and framework [3], aiming the rapid prototyping and low-cost system development. In the prototype, a standard software package for constructing virtual shops is used, along with framework-based components provided by a major software vendor.

Framework means a set of hierarchical class libraries for building an application system. Framework-based development involves building such an application using these libraries, with commonly defined procedures over a standardized framework.

The framework includes a dynamic aspect that is absent in class libraries. In traditional class libraries, the function that each class executes is defined by static relationships. In addition, framework contains some application logic that ties the various classes together, exhibiting a dynamic behavior.

For example, a general ledger framework can provide a BankAccount class that can be used to represent the bank accounts with which a given business works. In this case, the framework already includes the logic required to transform a bank account transaction into the appropriate entries in the general ledger journals.

The reuse of software is an important issue in software engineering. The concept of framework is settling in business. It provides software components that are independent from vendors. These components can be used for system configuration, as well as for the execution environment based on a common framework. Also, these components can be customized for an individual concrete application, and can be operated on multiple platforms.

Systems built based on frameworks are easy to expand and modify. In this research project, we will assess the feasibility of this concept by applying it to the development of our system.

4.2.2. Object-oriented language and distributed object technology

In recent years, due to the spread of the Java language and surrounding technologies, platform-independent execution environments are becoming available. Object-oriented technology is infiltrating from the research laboratories of companies and universities to real world business activities.
In comparison with traditional system development methods, the major advantage of introducing object-oriented technologies is the platform-independence.

Considering these points, Java is selected as the development language for the components to be added to the existing ones.

4.2.3. Design patterns

When the framework is adopted, the inheritance structure between objects in the framework and their relation becomes complex. It is thus necessary to reduce the expert's load in designing the business process. This is done by adopting design patterns [4].

In order to construct an effective business system, it is necessary to adopt a method based on concrete real cases. Through the construction of our system, we aim to accumulate knowledge concerning the design patterns and their use in the framework.

In this research, we examine the problem of application of the design pattern, including the current state of the fresh fish trade business.

4.2.4. Requirements analysis and component development

Regarding the business analysis required for the prototype design, the trading process is modeled by the object-oriented analysis technique. The modeled business process group is embodied as a business procedure (workflow) of the trunk system. The procedure is realized as a component with the decentralized object technology.

In the component constructed in our research, the following functions are included: i) interface function to accumulate static image of trading products in database, ii) function to support both sales and purchase credit, and iii) an expert system function to optimize many transactions and combination of purchased goods in a short period.

The first stage the system development involves the planning of requirement analysis from the technical point of view, which becomes the design specification of the system: a) examination of effective quality index data for fresh fish trading, b) planning of screen specification for input/output data, which contain image information on terminals, c) designing the specification of record format for the relational database, d) designing the specification of I/O screen for purchase business support functions, e) designing the specification of multivariate analysis function for dealings with data capable to support purchase business.

In the next stage, we concentrate on the development of components based on the object-oriented technology. Following the specifications, decentralized object technology is applied in order to build the components.

5. THE KANSEI ENGINEERING ASPECTS OF OUR EXPERIMENTAL OPERATION

We are currently performing the experimental operation and evaluation of our system, where the details can be found in [5]. Here, we will explain why the composition of a virtual market under our approach present a Kansei engineering flavour.

Wholesaling constitute a business-to-business relationship, because it is the dealings between the producer and the wholesaler. In case of fresh fish dealing in Japan, the business terms vary, even for the same item. For example, the price change depending on the type of customers, amount of items, units per case, the settlement conditions and the delivery dates. Thus, a interaction among traders is generated.

For such cases, the Kansei engineering approach contributes from the conceptual as well as the technological perspective, in order to develop a system which helps to have "smoother interactions" and to construct intelligent software agents which perform these interactions instead of the human customers. However, neither this conception nor the technology have been established yet.

It seems unavoidable the mutual influence of the development task and the establishment of such concepts and technologies over each other. This is more noticeable in the specific case of building virtual markets which we are dealing with.

It is not true that first the conception and technology is established in advance, and only after that, the construction task starts. Instead, this a repetitive cycle of gradual improvement. We are not focusing on whether it is possible to generalize each phase, which is left for future work.

In this paper, our focus from the Kansei engineering perspective resides in the tracing of the decision making during the dealing process, the re-organization of the interactions, and the guidance for finding new concepts and technologies. These new concepts and technologies are required for the development of a system which provides support for having "smoothness" in the trading as well as the in development of intelligent software agents which performs these interactions.

Emphasis is given to the large-scale dealings for business use, rather than the medium-to-small scale dealings between the general consumer and the shopless retailers on the Internet. Business use trading implies
that the price is not always specified beforehand. This is a "merchandize habit", so to speak.

For example, consider shopping in the Tukiji market in Tokyo, the largest market for fish and related products. The prices of goods there are not necessarily displayed and not necessarily specified in the dealing, which is a common practice for trading in Japan.

The price varies according to the level of trust to the buyer, the amount of purchasing lots and the alternatives of payment. The price formation process is accomplished through negotiation between the buyer and the seller. In some cases, the exhibited goods at the stores are just a sample. Very often, the transactions are completed without displaying the goods at all.

We believe that in the beginning of digital convergence for such a trading community, these kind of habitual dealing practices should be respected and reproduced in the electronic malls. Otherwise, convincing the traders to be part of this process will be difficult.

The prices displayed in the virtual shops are just reference prices, and this reference price would differ from the actual dealing price. In such cases, the business flow should be learned from the existing non-electronic transactions.

Here, the Kansei engineering aspect will play an important role. Agents who are able to solve such problems will appear to the scene, and at such time, this project will go towards real use. The industrial products are intended for improving the quality of life. Thus, engineering will be incomplete if the human factor is not taken into account.

One important aspect that Kansei engineering should address is measuring the human elements of sensibility and feeling. One possible application of systems reacting to the user sensibility is in the dealings of goods for which the prices are not displayed.

The electronic commerce supporting system should be designed so as to take into account various viewpoints, including human and social considerations. We believe this is a key for the advancement of electronic commerce.

More specifically, a computerized system should be sufficiently flexible so that every user can adjust the parameters in order to match his/her requirements. The electronic commerce system should not be an exception.

As we are going to continue this research in terms of primary products distribution, we will always try to consider the details of such human and social factors, namely the Kansei engineering approach.

6. CONCLUDING REMARKS

This research was supported by a TAO (Telecommunications Advancement Organization of Japan) Research Grant during the 1998 fiscal year, in the type for "Research and Development for Creation of New Business". We have conducted the business analysis of the community and the system design, and based on it, initiated experimental operation in March 1999. As a result of our research incubation, a new company, SRN has been established with a foundation of venture capital. We are looking at the potential of this business.

Our next research objective is the development of an agent-based marketplace on the Internet, which will be also funded by another TAO grant, starting in fiscal year 1999.

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