Collaborative Commerce Model Using Shared Product Taxonomy

Sang Hyun Choi, Kwan Hee Han, Gun Hoon Lim

Abstract— In this paper, we present a similar product matching algorithm for the collaborative global sales and delivery model that share the product taxonomy table and have exchangeable products information. The collaborative companies can integrate their business processes for sales and delivery using the shared product taxonomy table. To implement the business model, a product matching algorithm is suggested to compose the shared product taxonomy table. Using the algorithm we can get specification values of two companies' products within a same category and find matching products with the similar utility values. The main idea of the proposed algorithm is to find the utility range of products in a product class of the companies and register them as exchangeable similar products. The collaborative global sales and delivery process is implemented by collectively classifying shared products of trading partners into similar product sub-classes based on their specification values. This model helps local companies to perform a collaborative strategy of performing vicarious delivery transaction for ordered goods at another area.

Keywords—Business model, Product matching, Product taxonomy, Recommendation, Utility, Electronic commerce

I. Introduction

INTERNET business can enable commercial exchanges that across physical, temporal, cultural, and legal boundary on a scale that was technically infeasible. Internet business can help companies strengthen the links between suppliers as well as customers and suppliers. Many companies have attempted to develop Internet business systems to create innovative virtual companies, markets, and trading communities. Successful players in the new electronic economy leverage Internet technologies in every aspect of their business operations [17].

But with electronic commerce, the business of getting goods from suppliers to customers is even more complicated than usual. That is because of the nature of e-commerce transactions. For starters or small and medium-sized companies, orders and shipments are much smaller because end users are the ones who are doing the ordering over the Internet and there are fewer middlemen buying in bulk. Order are not only smaller, they are more frequent. And they are also more time-sensitive. Under the circumstance, companies have to lay out a strategy to prepare their global supply chains for the future. This strategy involves integration of the three primary flows of commerce of goods, information, and funds [18, 24].

This paper is related with the flows of goods and information between collaborative companies. We present a collaborative global sales and delivery model enabling shared business processes between the collaborative companies. The companies integrate their business processes for sales and delivery using the product taxonomy table. The companies share the table that contains product matching lists at same classes. We also suggest an interactive algorithm for finding similar products. A company has its product map that registers similar products to ones being on sale by another collaborative company. They can be exchangeable between the companies. The main idea of the proposed algorithm is to find the utility range of products in a product class of the companies and register them as exchangeable similar products. The companies then allow consumer to shop and purchase the products at their own residence site and deliver them to another sites.

II. Previous Researches

Electronic commerce is an Internet application and it depends on key infrastructures such as information technology and telecommunications, social/cultural, commercial, and government/legal. In particular cultural elements such as language, education level, belief and value systems influence technological innovations and entrepreneurial spirit. An online survey conducted by IDC suggests that over 76 percent of Chinese respondents prefer to browse the Internet in their local language, and not in English. When viewed as a global distribution system, international social/cultural barriers remain. Just as many companies have made serious blunders when marketing in other countries, the lack of boundaries and the complexity of global consumer access magnify these complexities beyond anything previously encountered [12, 25]. Cultural factors inhibit the diffusion of electronic commerce. They comment that cultural values, including different traditions and habits of trading will impact the speed of e-commerce diffusion. Clearly, cultural issues including beliefs, languages, and value systems seem to present barriers to

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information sharing [22]. In order that companies targeting global consumers overcome the barriers, they allow the consumers to browse the Internet in their local language. Local companies need to have a collaborative strategy of performing vicarious delivery transaction for ordered goods at another area.

Grieger [7] suggested that there are different types of relationship within different internet-based electronic marketplaces (EM) categories. While there are myriad aspects within a relationship among trading partners in an EM, three broad categories have been identified: transactional, information-sharing, and collaborative relationships [2, 9, 14]. This paper is related with suggestion of a similar product finding algorithm based process to enable two trading partners to have an information-sharing relationship. Internet-based electronic product catalogs are one of the most important parts of EM. Schmid [19] and Slabeva and Schmid [21] suggested that the electronic product catalogs support product representation, search and classification and have interfaces to other market services as negotiation, ordering, and payment [10, 23].

Currently, two comprehensive approaches, Stanford and Q-technology-based approach, for providing a concept for intelligent integration of heterogeneous information sources can be identified. In the Stanford approach, objects and their relationships are represented according to the designed criteria for ontology defined by Gruber [21]. The Standard approach is comprehensive and allows a broad range of relationships that can be defined within an ontology. It requires the existence of common, generic ontology, which require the consensus of at least a particular branch world-wide. The Q-Technology approach limits the type of relationships that can be modeled and provides an intuitive and user friendly abstraction from the formalism. It provides semi-automatic procedures for ontology integration and the reconstruction of different information sources.

Both approaches are to provide a concept for intelligent integration of heterogeneous information sources of product categories, but use different methods to achieve this goal. After completing the intelligent integration of product categories among collaborative trading partners, the collaborative business process and product matching algorithm suggested in this paper can be preformed. This process can be applied to the products within same categories by these approaches and is to specifically classify products of trading partners into similar product sub-classes based on their specification values.

In this research we suggest a business process for collaboration between companies. This focuses on sales and delivery processes. Business opportunities are in managing the product information. It is important to register similar products among the collaborative companies. There are a little researches related to the similar product registration and the research of comparison shopping agent is similar to this research [6, 11, 26]. BargainFinder and Jango are the examples of first-stage comparison shoppers that specify the functions that agents must have in order to be applied to Electronic Commerce, and both employ the manual rule extraction method. Shopbot suggested an automatic rule extraction technique by analyzing and learning the shopping malls. Shopbot was unable to learn a shopping mall that did not conform to these strong biases. To overcome this difficulty, Yang and et al. [26] proposed a more scalable comparison shopping agent that adopts an intelligent learning algorithm. By contrast, the only bias of their method is that the result of a product search should be displayed in a semi-structured way, that is, each product description unit has the same output format. They have pointed that PersonaLogic is a comparison shopping system that compares not the shopping malls but the product itself. Kasbah, AuctionBot, and Tete-a-Tete are negotiable mediators with which the user can buy and sell products based on negotiation strategies between agents in the virtual marketplace.

III. GLOBAL COLLABORATIVE COMMERCE MODEL

A. Collaborative Business Model

The electronic markets offering full support for all market transactions provide the following services or phases; knowledge exchange, articulation and management of intensions, negotiation and contracting and settlement in the form of payment and delivery [7, 19, 20, 21]. Our model is based on the services and specifies the negotiation and contracting step when a purchaser area is different from a receiver's one and the selling agent is different from a delivery one. Usually the online shopping takes place within a same country. When a consumer who lives in Korea wants to buy a product at Internet shopping mall and present it to a relative who live in America, there are two ways to do. First way is to access a Korean online shopping website that is written in Korean and to make the company deliver to America. If the consumer who lives at Korea orders the items at the Korean merchant's WWW page and makes the merchant ship the goods to America, he or she must pay for the extra shipping cost [13]. The merchant has to perform such business processes as delivery by airline or ship. Second way is to access an American website at his or her relative's area and to make the company deliver it within the same country. The consumer doesn't need to pay for extra delivery from Korea to America. In order to use the web site at another country, there are such limitations as language, shopping culture, and so on [12, 22].

The global collaborative commerce has been growing rapidly keeping the pace with web. We suggest a collaborative global collaborative commerce model under the situation that a purchaser's residence area is different from receiver's one. This model is based on a shared product map that defines similar products between the collaborative companies. The following procedure for the global collaborative commerce is performed. Firstly, an user who wants to purchase a product at Internet shopping mall accesses an website at his or her own residence areas. The user finds the product with which he satisfies and the user would provide the mall with his information. If the delivery site is different from his or her residence area, the mall searches similar products with the selected product at the collaborative company in the receiver's area. When the consumer satisfies with the suggested product, the collaborative company performs a delivery process and the transaction is terminated. The detailed process for this business model is presented in next section.

B. Collaborative Commerce Process

In this paper, a detailed process will be presented under the situation that a company at receiver's area delivers products to reduce delivery time and cost if a purchaser's residence area is different from receiver's one. For the knowledge exchange and intention services of EM transaction services, purchaser's search and order processes for seller's product will be performed. The receiver information entry and product matching steps are for negotiating a desired product. Finally, transaction loading step is similar to processes for delivery and payment services. The detail process in this paper consists of 4 steps, purchaser's search and order entry, receiver information entry, product recommendation, and transaction loading steps.

Step 1: Search and Order Entry

This step includes search and discovery for a set of products capable of meeting customer requirements. An user who wants to give a present at Internet shopping mall accesses an website at his or her own residence areas. The user surf the web and find a product in a product catalog. If the user searches for the desired product, the user would provide the mall with his information. The information includes selected product information as well as the purchaser's demographic and credit information.

Step 2: Receiver Information Entry

The purchaser selects a delivery address type of whether a receiving address is within the residence area. If the receiver address is within the purchaser country, a current delivery process is performed. If the purchaser country isn't same as receiver one and is delivered to another country, a transaction server find a collaborative company close to the receiver address and search a same product among the catalog of the company. The server finds companies in the nearest order.

Step 3: Product Matching

This step includes search and discovery for a selected or similar product from the collaborative company based on product specification values and inquiry of purchaser's acceptance. If the merchant at the company fails to find the same product that the purchaser has selected and ordered, the transaction server search similar products at the product map of a shared product database. The product map is a product relationship matrix that defines the exchangeable relations between products that has been produced at the areas of order placement and product receipt in the situation that the area of order placement is different from one of product receipt. We suggest it as a mean of enabling a shared business process between collaborative companies. They share orderable products and their customer orders any product among their shard products. The product map makes the company is able to drive down delivery cost and reduce prices to its customer. Furthermore, it increases cooperation between the companies as they strive for quick deliveries and low inventories. The product map registers products similar to a product at a shared product database. A detail algorithm for finding the similar product is presented at next section.

The server shows the user a list of similar products to the item he/she has just selected. If the user doesn't satisfy with anything of interest, he or she doesn't purchase it on-line and the transaction is finished. If the user does find alternative product of interest, he or she elect to purchase it on-line, make an order and provide payment information. The consumer selects the means of payment. The different means of payment include digital cash, electronic checks, or credit cards.

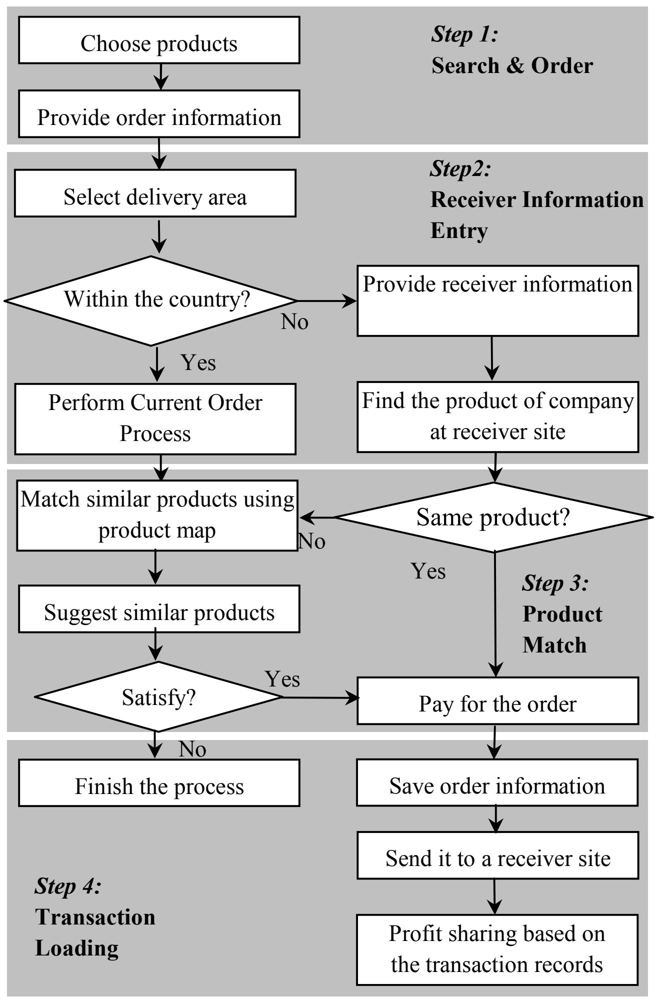

Fig. 1. Collaborative Commerce Model

Step 4: Transaction Loading

The consumer sends the merchant a complete order including receiver's address. The merchant requests payment authorization from the consumer's bank and sends the customer a confirmation of the order shipment and payment. The merchant save the transaction and make the collaborative company at the receiver area ship the goods to the recorded address. The server saves the transaction. The company at the receiver's area ships the goods in the shipment way requested by the purchase.

However, we need to consider the following issues in developing the above business processes. First of all, the collaborative company clearly sets up profit or cost sharing rules with their partners. It can be solved by a current physical profit sharing method. The second issue is how to select similar product. An algorithm suggested at next section deals with this issue.

IV. Product Matching Procedure

A. Product Taxonomy

In most Internet shopping malls, product taxonomy is available. A product taxonomy is practically represented as a tree that classifies a set of products at a low level into a more general product at a higher level. The leaves of the tree denote the *product instances*, SKUs (Stock Keeping Units) in retail jargon, and non-leaf nodes denote *product classes* obtained by combining several nodes at a lower level into one parent node. The root node labeled by *All* denotes the most general product class. Fig. 2 shows an example product taxonomy for an electronics Internet shopping mall, where *Pentium4/LCD, Pentium 4/17 inch Flat CRT, and Pentium 3/17 inch Flat CRT* are classified into *Desktop*, etc. A number called *level* can be assigned to each node in the product taxonomy. The level of the root node is zero, and the level of any other node is one plus the level of its parent. Note that a product class at a higher level has a smaller level number. The product taxonomy of Fig. 2 has four levels, referred to as level 0 (for root), 1, 2, and 3.

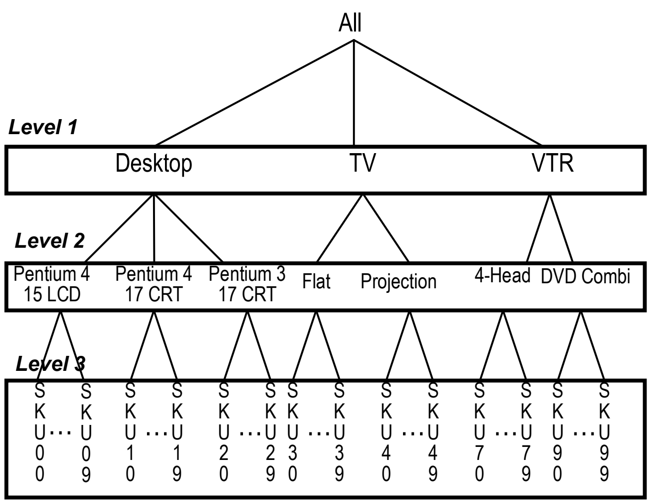

Fig. 2 Example of a Product Taxonomy

The product taxonomy can be used to identify similar products and to group them together since it represents domain specific knowledge of Internet shopping malls. The formal use of product taxonomy as one of background knowledge is introduced by Han, Cai and Cercone [8]. Brew [3] has shown that taxonomies are important in knowledge representation and reasoning. Adomavicius and Tuzhilin [1] proposed a useful way for the domain expert to examine multiple rules at a time by grouping similar rules together on given product taxonomy. Lawrence et al. [16] and Cho et al. [4] used the product taxonomy to capture the affinity between different products in developing a product recommender system.

B. Product matching Procedure

This paper suggests an interactive procedure for finding similar products among products classified into level 2 of Fig. 2. The procedure is based on an utility range concept that an utility of a product can be represented by a range [5, 15]. A product utility value of a specification can be computed by the normalization formula (1). The weights of specification within a same class are in the form of constraints given by users. And the aggregated product utility range of all specifications is computed by solving LP models having the constraints about the importance relationship between product specifications. Suppose that a company has totally K classes at level 2 of Fig. 2. Each class is characterized by a set of product specifications. Then a new product is assigned to a class having a same set of product specifications. The product at the *k*th class has a set of M product specifications. We define the following terminologies.

$I=\{i\}_{i=1,N}$: a set of N products at *k*th class
$J=\{j\}_{j=1,M}$: a set of M product specifications at *k*th class
w_j : importance of *j*th specification
v_{ij}: *j*th specification value of *i*th product

Multi-criteria decision analysis is applied to this problem because the analysis deals with situations in which decision alternatives, such as products, are evaluated on a finite number of attributes, such as specifications. One of the best known and the most widely used ways to evaluate the utility of *i*-th product is to utilize the weighted additive decomposition, $u_i = \sum_{j=1}^{M} w_j u_{ij}$ of a value function *u*. Here u_{ij} is the marginal value function of specification *j* such that $u_{ij} : v_{ij} \rightarrow [0, 1]$ [5].

Our procedure for matching similar products is composed of the following 4 sub-steps as shown Fig.3..

Step 3.1: Compute product utility by each specification

In this step, a product manager gathers information of specification values of the products at level 2. We define the utility of a product specification as the normalized value computed by following formula and the utility is between 0 and 1.

$$u_{ij} = \frac{\max_i v_{ij} - v_{ij}}{\max_i v_{ij} - \min_i v_{ij}}$$ for specification j with better for larger

or $u_{ij} = \dfrac{\min_i v_{ij} - v_{ij}}{\min_i v_{ij} - \max_i v_{ij}}$ for specification j with better for smaller (1)

Step 3.2: Compute the utility ranges of current products

This step is to compute the utility range of products at *k*th level. The utility of *i*th product is the weighted sum over all specification utilities, that is, $\sum_{j=1}^{M} w_j u_{ij}$. It is very difficult to find exact weight values and compute the product utility. Kim and Choi [15] have proposed an interactive procedure for finding utility values using the weights relationship information. The information represents the relationship between specification weights with the 5 forms of incomplete information provided by a user. We define the relationship set as Φw which is a set derived from the user's incomplete information regarding the relative importance of specifications. For simple illustration, we present the 5 forms of incomplete information. Φw can be constructed by the following forms, for $i \neq j$:

F1. a weak ranking: $\{w_i \geq w_j\}$.

F2. a strict ranking: $\{w_i - w_j \geq a_{ij}\}$.

F3. a ranking with multiples: $\{w_i \geq a_{ij} w_j\}$.

F4. an interval form: $\{a_i \leq w_i \leq a_i + e_i\}$.

F5. a ranking of differences: $\{ w_i - w_j \geq w_i - w_j\}$, for $j \neq k \neq l$, where $\{a_{ij}\}$, $\{a_i\}$ and $\{e_i\}$ are non-negative constants

.

We can get the utility ranges of *i*th product, $[u_i(\min), u_i(\max)]$, by following formula.

$u_i(\min) = \min \sum_{j=1}^{M} w_j u_{ij}$ / $u_i(\max) = \max \sum_{j=1}^{M} w_j u_{ij}$

subject to Φ_W (2)

Finally we can get the expected utility, $E[u_i]$, by computing an average value of $u_i(\min)$ and $u_i(\max)$.

Step 3.3: Classify the products by the utility ranges

In this step we subdivide the products at same class into similar product classes using the expected utilities of products. From the expected utilities, it is obtained the abstract difference values, $DE[u_{ij}]$, between products. If the value is equal to or less than threshold value, δ, then *i*th and *j*th products are registered into product table as a similar product class. This procedure is performed over all products pairs. After having the similar product pairs, the sub-classes at *k*th class are identified

Step 3.4: Determine the sub-class of a new product

Based on the current product taxonomy and catalog, the product manager registers a new product. He/She gathers the specification values for the new product and performs the above classification steps through three steps. If all specification values of the new product are between current minimum and maximum values, it is classified into one among the pre-specified sub-classes. If it has a new minimum or maximum specification value, the utility values of all product specifications are changed and current sub-classes are changed.

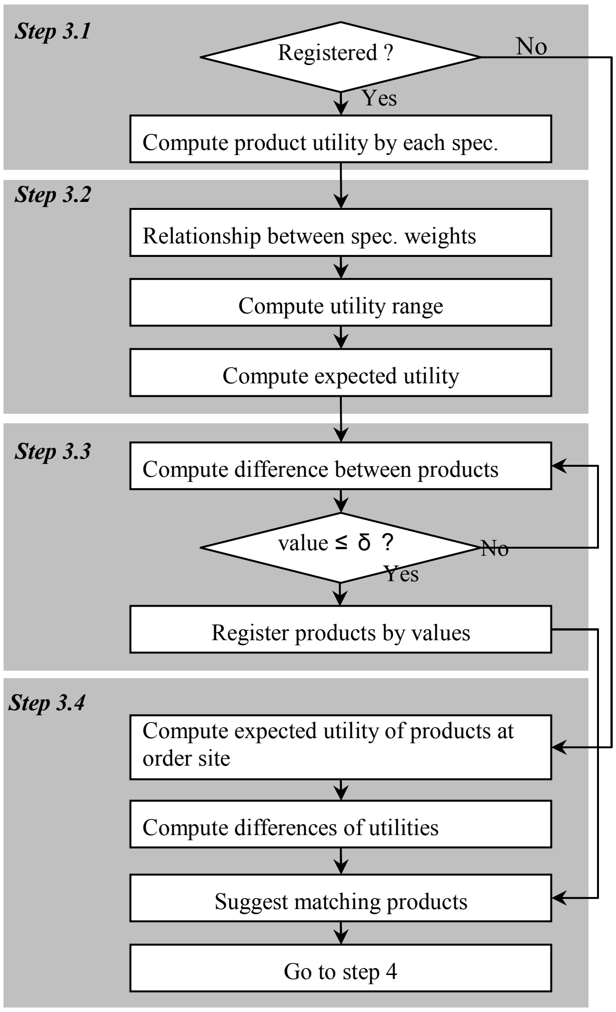

Fig. 3 Product Matching Procedure

V. Case Study

For our experiments, we suppose that Korean L Internet shopping mall selling a variety of electronic products is aligned with American H Internet shopping mall. The Korean mall has a product taxonomy with 4 levels as shown in Fig. 2. H mall also has same taxonomy and same or other products in the taxonomy. A Pentium 4 CRT 17 sub-class is at level 2 and products at the sub-class are specified by brand name, price, RAM size, hard disk size, video memory size and type of CD-ROM. The mall has 4 products at the sub-class. .

Step 1: Purchaser's Search and Order Entry

An American customer wants to sell a Pentium computer and give a Korean relative as a gift. The customer accesses to website of H Internet shopping mall and select a Pentium 4 computer model. Specification values of the selected model, Buy_PC, are brand J, $1750, 256MB RAM, 80GB Hard Disk, 64 MB Video Memory and 16 speed DVD.

Step 2: Receiver Information Entry

The customer selects that a delivery address is different from his/her residence area and isn't within the country. As the receiver is within Korean L mall delivery area, a transaction server searches a same product among the catalog of the mall. There is no same model and next step is performed to find a similar product.

Step 3: Similar Product Recommendation

The Buy_PC is classified into Pentium 4 CRT 17 sub-class. The Korean L Internet shopping mall has four products at the sub-class. The product manager at the mall wants to find similar products at the class.

Step 3.1: Gathering information of product specification vales

The manager gathers the specification values for current products. Table 1 shows the specification values for the products.

Table 1. The specification values of 4 products at *k*th class

Value (v_{ij}) / Products	RAM (w_1)	Hard Disk (w_2)	Video Mem. (w_3)	CD (w_4)	Brand (w_5)	Price (w_6)
DY2D5L31	*512*	*80 GB*	*64MB*	*32DVD*	*L*	*2260*
DV2R5L31	*256*	*60 GB*	*32MB*	*48ROM*	*L*	*1950*
MF20DV26T	*256*	*60 GB*	*64MB*	*16DVD*	*S*	*2193*
MF20CD26G	*256*	*60 GB*	*64MB*	*48ROM*	*S*	*2066*
Min. values	*256*	*60 GB*	*32MB*	*48ROM*	*L*	*1950*

Step 3.2: Compute the utility ranges of current products

Next, the manager enters the relationship information between specification weights with the 5 forms of incomplete information. He/She thinks that the weights of all specifications are equal to or greater than 0.1 and brand and price specifications are more important than the others. The following conditions of specification weights are summarized.

$$
\begin{aligned}
& w_5 \geq w_4, w_3, w_2, w_1 \\
& w_6 \geq w_4, w_3, w_2, w_1 \\
& w_1 \geq w_2 \\
& w_4 \geq w_3 \\
& w_3 \geq w_2 \qquad (3) \\
& w_5 + w_6 \geq w_1 + w_2 + w_3 + w_4 \\
& w_6 - w_5 \geq w_1 - w_4 \\
& w_1, w_2, w_3, w_4 \geq 0.1 \\
& w_1 + w_2 + w_3 + w_4 + w_5 + w_6 = 1
\end{aligned}
$$

Then we compute the normalized utilities u_{ij} for *j*th specification values of *i*th product by equation (1). The utility range values of *i*th product are computed by solving the formula (2), where Φ_W is represented by (3). For example, the normalized utilities u_{3j} of a product, MF20DV26, are (0.5, 0.75, 1.0, 0.75, 1, 0.7). The utility ranges are computed by solving the following LPs.

u_3(min) = minimize $0.5w_1 + 0.75w_2 + w_3 + 0.75w_4 + w_5 + 0.7w_6$
subject to (3)
and
u_3(max) = maximize $0.5w_1 + 0.75w_2 + w_3 + 0.75w_4 + w_5 + 0.7w_6$
subject to (3)

Finally, we get the range values [u_3(min), u_3(max)] are [0.358, 0.549].

Step 3.3: Classify the products by the utility ranges

Through the similar procedures for four current products, we have three sub-classes as shown Fig. 4. There are two products of DY2D5L31 and MF20DV26T at the sub-class 1, DV2R5L31 at sub-class 2, and MF20CD26G at sub-class 3. In this case, the threshold value is 0.1 which is given by the product manager.

Fig. 4 Current Product Class

Usually sub-classes of current products are predefined in their own taxonomy. This classification procedure for current products was applied for explanation.

Step 3.4: Determine the sub-class of a selected product

The manager is going to find products at H mall similar to a selected product with the values, RAM 256MB, 80GB Hard Disk, 64 MB Video Memory, 16X DVD, $ 2100 made by J company. The product has a minimum specification value of Brand J. We re-compute the utility ranges of the current products based on utility values of the selected product. As a result we have found the following three sub-classes by solving 10 LPs as shown in Fig. 5.

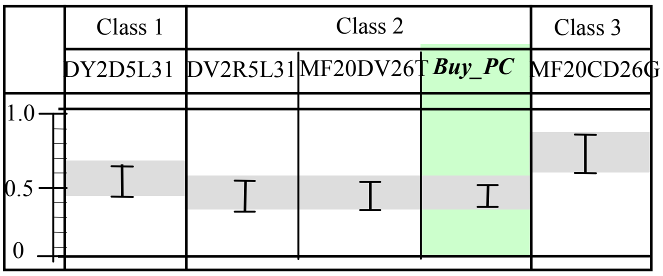

Fig. 5 New Class Finding

Finally the H mall presents similar product, DV2R5L31 and MF20DT26T, to the customer. The customer selects DV2R5L31 and follows usual payment procedure.

Step 4: Transaction Loading

H mall saves the transaction record and request Korean L mall to deliver the product, DV2R5L31. After L mall complete the delivery, L mall informs H mall of the completion and H mall let the purchaser know the information. The malls will share the profit based on activity based costing method.

The example shows that a product catalog based on the product matching algorithm helps the American customer to sell a product at his/her own area shop and present it to relative through a shop at a different area. If the customer follows current shopping mall processes, he/she purchase it at his/her area shop, make it deliver to the relative and has to pay for another expensive delivery cost. This model helps the customer to save the cost. The H shopping mall doesn't lose a sales opportunity to sell a product at other areas where the mall can't afford to offer products.

VI. Conclusion And Further Study

In this paper, we suggest a global electronic business model under the situation that a purchaser residence area is different from a receiver's one. In order to perform that business model, we suggest an interactive algorithm for finding similar products. This algorithm is based on the user's utility ranges of products. The users can easily enter his/her preferences of products. They apply this algorithm to the real world product taxonomy and classify their products in detail. They can suggest the similar products at the same sub-class when they cannot provide a product with their consumers

After completing the integration of product categories among collaborative trading partners, the collaborative business process suggested in this paper can be preformed. This process is to specifically classify products of trading partners into similar product sub-classes based on their specification values. This model helps local companies to perform a collaborative strategy of performing vicarious delivery transaction for ordered goods at another area. The business model suggested in this research makes the companies that are difficult to set up physical branches at every corner of the world enable to cooperate with another companies at the sites in a cost efficient way. The collaborative companies can extend globally their collaborative commerce business without a heavy facility investment. The companies are able to give the customer easy access to their own country and save the delivery cost.

The complexity of developing and operating a collaborative global sales and delivery model make the organizations call for a collaboration platform between the companies that contains rules of similar product registration, profit sharing, and so on. Future research in this model should focus on an in-depth investigation of the required regulations and their economic justification.

Acknowledgment

This research was financially supported by Ministry of Education, Science and Technology (MEST) and National Research Foundation of Korea (NRF) through the Human Resource Training Project for Regional Innovation.

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