A Study of the Agent-based DSS which supports the Marketing Strategy

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ABSTRACT

The purpose of this paper is to examine the possibilities for agent-based Decision Support Systems (DSS). Interest in the new scientific discipline of Computational Social Science has been growing over the last several years. However, what seems to be lacking is a consensus on how to use it. In this article, we would like to explore a little further toward ideal usage of the agent-based approach. We developed an agent-based DSS, which has an agent-based model and applied it to an actual company in which the marketing manager was considering marketing strategy to overcome his competitors.

Our case study made it clear that, in the social science field, an agent-based model is appropriate for the model within a DSS, because it is able to describe the mutual impact among subjects easier than a mathematical model.

We would like to assert that the methodology of developing the model should be not based on the right observation of the real world, but rather on the right observation of the DSS users own internal model.

Keywords: Decision Support System, DSS, agent based approach, simulation, marketing strategy

1. INTODUCTION

A concern with the scientific discipline of Computational Social and Organizational Science has been growing for the last several years[1]. As a considerable number of studies and application systems have been conducted in various fields, it has been recognized that such a new method is effective for obtaining some wisdom, which was not obtainable by conventional methods.

In this paper, we apply a multi-agent approach to DSS studies. Fundamentally, it is usually a significant issue within DSS studies to determine precisely how decision makers build a model to solve their problems, and how they use or modify it by using a DSS system, which is designed to be supported by the users themselves.

The outline of this paper is as follows: First, we packaged the internal cognitive model that the decision makers held in their mind, into a multi-agent based DSS. Secondly, we studied what kind of results, as shown by the interactions among agents, caused modifications to the decision maker's internal model.

2. SURVEY OF DECISION SUPPORT SYSTEM(DSS)

DSS was proposed by Scot Morton[2] in 1971, and is characterized by three concepts (interactivity, use of data and models, and unstructured design). In the DSS fields, mathematical models have been resumed by most DSS researchers, using methods such as linear programming or data mining methods.

However, it is difficult to analyze or solve the socially complicated problems faced by decision makers, because social phenomena are not only concerned with various subjects, but also the mutual influence each agent exerts on the other. As a result, social phenomena are being developed dynamically. We propose an agent-based DSS, which has models using this agent approach.

3. CHARCTERISTICS OF AN AGENT BASED DSS

It is assumed that traditional DSS is able to support users in obtaining satisfactory solutions for the problems facing them. However Takahara[3] argued against traditional ideas and proposed a different concepts of a DSS. He asserted that it was more important for users to get satisfactory solutions rather than strictly accurate models, when they were involved with facing extremely difficult ill-structured problems. Further, it is important to build models easily, and the main theme of a DSS

study should be concentrated on the support of model building for users. We propose an agent-based DSS, which has the following scheme:

① An agent-based DSS is composed of several template models. Each template model is designed to express the activities of one subject.

② A user sets into template models, his own specialized knowledge of his firm and the competitive conditions among other firms.

③ A user sets up the rules of behavior for mutual interactions among subjects, based on his own knowledge.

④ After running an experiment by using simulation, a user is expected to verify the models by reviewing the difference between the behavior of the models and that of the real world (through observation).

⑤ A user is also expected to obtain new knowledge about the real world through these considerations. The user modifies the models and runs an experiment again, when he needs to verify or confirm any arising ideas.

Thus, the processes mentioned above are considered the knowledge creation process. Figure1 shows the process of obtaining user's knowledge.

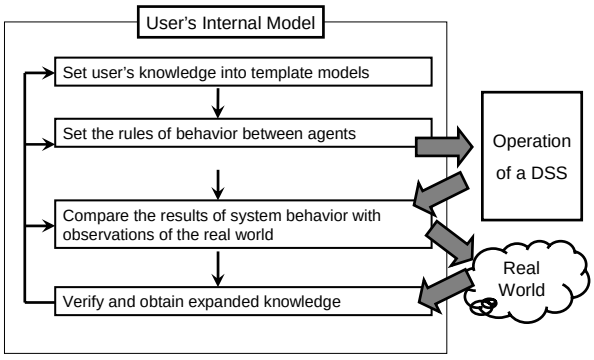

Fig. 1 Process of obtaining Knowledge

4. FRAMEWORK OF AGENT BASED DSS

The outline of the Decision Support System (DSS) in this research paper is as shown in Figure 2. Agents consist of ① customers ② stores ③ marketers, and ④ markets. The market has multiple stores. Multiple new customers are always coming to the market to purchase consumer products, which are provided by the stores. The stores provide products and services. When the customer finds their favorite goods, they will purchase them. When not finding their favorite goods, the customer will not purchase anything. The commercial products "Okaki" (rice crackers), assumed in this system, are products familiar to the public, so that the customer behavior is to purchase at regular intervals. When the customer's purchase motivation becomes low due to there being no product attracting their interest, they will exit the market.

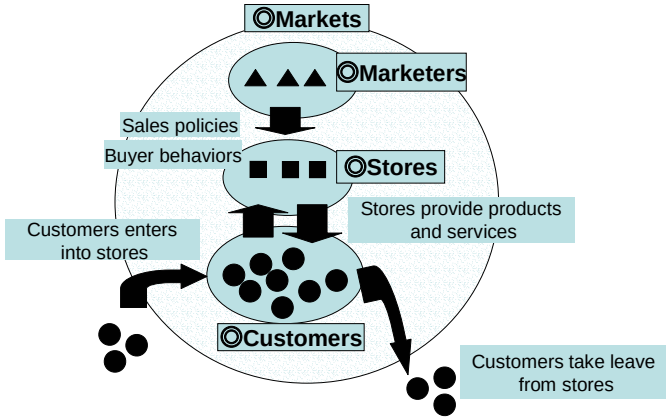

Fig.2 Framework of Model

4.1. Customer Agent

The agents (customers) are classified into four types, A, B, C, and D as shown in Figure 4. The type A customer is a customer who has high brand-oriented as well as high product oriented.

The type B customer is a customer who only has high brand-oriented.

The type C customer is a customer who is has high product-oriented, but has low brand-oriented.

The type D customer is a customer who is low in both brand-oriented and low product-oriented

When a customer enters the market such as a department store, the simulator can assign the customer one of these types as mentioned above, according to a distribution factor (for example: type A: 25%, type B: 25%, type C: 25%, and type D: 25%) which is set in the simulator.

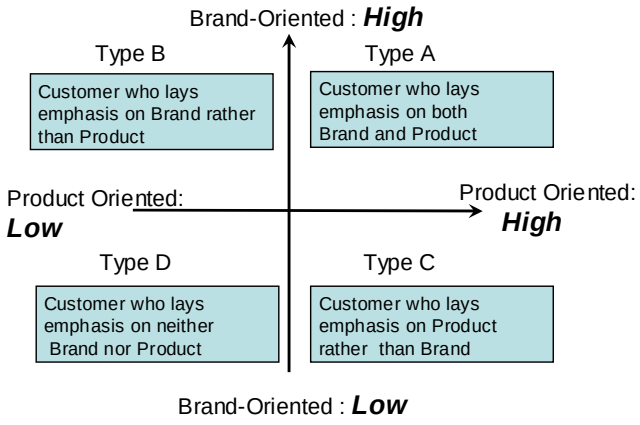

Fig.3 Customer Types

Every customer remembers previous purchases, so that He will learn and possibly change his type in some case after he purchases products. A general rule has been defined for changing the customer type in the system as follows in the template model.

(1)When a customer purchases the same products as previously purchased at the same store, the loyalty of the customer to the store becomes higher.

(2)When a customer was previously satisfied and currently purchases the same product at the same store, the customer loyalty to the store becomes higher. When a customer was previously satisfied, but becomes dissatisfied with the current purchase of the same product at the same store, the customer loyalty to that store becomes lower. When the customer was previously dissatisfied, and again becomes dissatisfied with the current purchase of the same product, the customer loyalty to the store becomes much lower. When a customer cannot find any store to purchase from, the customer loyalty becomes low to all stores in the market.

(3)When the customer's loyalty to each store drops below some level, the customer will leave the market.
Further, even if a type D customer visits the store twice, when the customer cannot find a store to purchase products, he will leave the market.

(4)The customer retains his impression that the purchased product was good or bad each time. When a customer enters the market, the customer is assigned a customer type, but the type of the customer will change based on the purchasing experience of the customer.
When a type A customer has many bad feelings to many of the products purchased, the customer loyalty becomes low, so that the customer will change to a type C. Further, when a type B customer has many bad feelings toward many products, the loyalty becomes low, and the customer will change to a type D. When a type C customer has many good feelings toward many products, the customer will be changed to a type A. When a type D customer consistently purchases products at the same store, the customer loyalty to the store becomes high, and the customer will change to a type B.

The general rules as mentioned above have been set based on common knowledge, but, from the viewpoint of the DSS which assists decision maker, it is not important to consider whether the rule is *correct* or not. Rather, it is important to consider whether the decision maker considers it *appropriate* or not. This system has been designed so that this rule can be changed in compliance with the requested specifications of a decision maker (a simulator).

4.2. Store Agent

A store provides commercial products and services for customers who visit the store. The store provides an indicator called product readiness, which consists of price readiness and assortment readiness. Price readiness represents whether the store can meet the demanded price level of the customer. Price readiness is set as a numeric value between 1 and 100 for each store by the simulator.

Because the customer has a desired price level, the price satisfaction level can be calculated as the difference between the desired price level and the price readiness. For example, when the desired price level is 75 and the price readiness is 60, the difference of 15 is the price satisfaction level.

When the price satisfaction is a positive value, the customer is satisfied with the price.

On the other hand, when the price satisfaction is a negative value, the customer is not satisfied. Much the same is true with the assortment readiness. For example, when the assortment readiness is 80 and the desired assortment level is 85, the difference of -5 is the assortment satisfaction level.

In this case, the satisfaction level is minus, so that the customer is dissatisfied with the assortment. One store feature is the service readiness of its sales people.

In general, customers are not satisfied if the attitude of the sales people is impolite to customers, even if the customers are satisfied with the price and the assortment. The level of attitude toward helping and taking care of the customer is indexed as attitude readiness. And a customer service satisfaction is calculated as the difference between the desired service level and the attitude readiness.

However, in general, customer service is a face-to-face relationship, thus making service readiness an overriding

effect, such that a uniform approach to price readiness or assortment readiness cannot be applied. Therefore, this system defines service readiness to widely vary in level.

Putting it all together, each store has price readiness, assortment readiness, and service readiness. These become the source of competitive power and the strength of the store.

Customers have desired levels of price, assortment, and service, so that differences between desired level and actual level of price or assortment, or service may be calculated. This system calculates total satisfaction for each store from the price satisfaction, assortment satisfaction, and service satisfaction that the customer has for each store.

4.3. Marketer Agent

The simulation system assumes that a store has a marketer who takes on the role of executing sales policy. The marketer maps out the sales policy of company's store. Further, the marketer adjusts variable values of price readiness, assortment readiness, and service readiness, based on sales trends in the marketer's company and competitive companies.

These adjustments become strategic decisions as the source of competitiveness changes. At the same time, routinely performed sales activities are accomplished for events such as bargain offers on selected days, and direct mail sales promotion to potential customers. In this system, the user can set countermeasures, which the store marketer will take against the day-to-day sales policies by competing stores.

5. CASE STUDY

5.1. Overview of Companies of Utilizing the Simulation System

In this research paper, we explain about testing a system developed for Company A, which has a shop in a famous department store. The product that Company A's store sells are top-grade "Okaki", (rice crackers), a product favored as a gift item and for personal consumption. Company A is a small company of about 20 employees, but offers consistent commitment, from making to selling their own "Okaki". Therefore, the high quality products remain competitive.

Eight companies other than Company A have opened stores in the grocery department of the department store. Competition among the companies is intense. The recent trend in the "Okaki" industry has become more multifaceted in taste, and the life cycle of the "Okaki " products have been shortened.

The system we developed is called a base system. We have constructed the DSS based on that system, with the user being the marketer of Company A. When constructing the DSS, the following two requirements were stated. First, build a simulation model on the base system by considering the conditions of Company A in the competitive environment. Points to remember at this moment: These conditions are not objective information, but rather subjective knowledge that is obtained from the experience of the marketer. Because the DSS model should be a model, as mentioned above, that the marketer can understand and accept, otherwise the marketer will not accept the validity of the simulation result. Second, the functionality to support the marketer's decision-making should be expressly included, and statistics information required for decision assistance should be provided. When the marketer performs simulation, operating variables are verified through the marketer's user interface, included in the system. Further, the developed DSS is customized so that required data is collected during the simulation, and so that the user can analyze the collected data from many angles.

5.2. Knowledge Acquisition and Adoption

We obtained knowledge by interviewing the marketer about the competitive setting of Company A's store, as follows:

(1) Nine company stores have opened in the department store. Company A only acknowledges Company X as a competitor. Therefore, the marketer may run simulation only for Companies A and X.

(2) Because the brand awareness of Company X's store is well established, the B store has the ability to pull in more customers. Further, the X store has a wide assortment of merchandise with a wide range of prices. On the other hand, the Company A's store is worse than X store for the brand awareness, assortment of merchandise, and range of prices, but better than B store in attitude toward helping and taking care of customers. Company A considers that they can be competitive against Company X in such custom services.

(3) The customer visit count of the "Okaki" selling space is 20-30 people depending on the season. This parameter of visit count can be entered by the marketer in the simulation system.

(4) Approximately 70% of new customers will buy "Okaki" as a gift item, and the rest for their own consumption. The purchased amount is from 2000 to 3000 yen for both the gift item and own consumption. The customers will be split into 4 types as shown in the Figure 2. However, it is difficult to decide on the split rate.

(5) When the customers are satisfied with “Okaki”, they will become regular customers, and will again visit the store to buy “Okaki”. In that case, 50% of customers who bought “Okaki” as a gift item are visiting the store to buy it for their own consumption. The repetition rate of visiting the store will be once a month for a gift item, and once a week for personal consumption, which widely varies among the customers because the customers who visit the store very frequently attach importance to the degree of freshness.

(6) After customers buy products in a store quite often, we have no doubt that customers evaluate the store, products, and customer service, and place a value on the store. If the score is high, the customer will visit the same store next tome, if the score is low, the customer will not visit the same store again.

The levels that customers ask of the product widely vary. When a customer, who is strict about products, purchases the product next time, the customer’s score becomes lower, if the satisfaction to the store is lower than the previous time. This point is a difficult part for business.

The knowledge, as mentioned above, is built into the model of the base system. The DSS has been constructed so that the marketer can change variable parameter values as desired.

5.3. How to Operation of developed System

We modified the model structures and parameters by trial and error in order to adjust the user’s internal model. In these processes, the user recognized that customers sometimes changed their own type by themselves.

From our discussion with him, following facts became clear.

Type A-customer, who often goes to the department store to purchase “Okaki”, and who is always dissatisfied with the quality and price of the products, becomes less loyal to his favorite shop. In this case, loyalty level and satisfaction level are low so his Type changes From Type “A” to Type “B” .

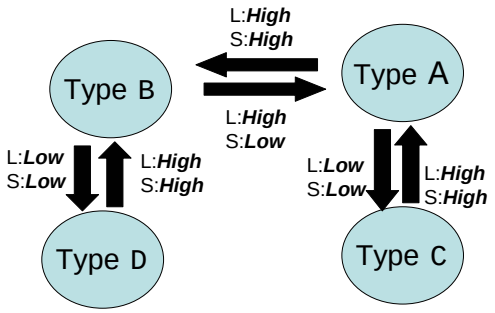

Fig.4 Customer’s Type Change

Similarly, a Type-B customer who is always dissatisfied with the quality and price of the products, becomes less loyal to his favorite shop. Since his loyalty level is low, his Type changes From Type “B” to Type “D”.

In other types, besides “A” and “B”, type changes are apt to occur. Figure 4 shows the condition for the type changes.

User Interface is shown in from Figure 5 to Figure 7.

The user sets a simulation period with use of a keyboard (see Figure 5). Customers visit stores from day to day, and will purchase products in the simulator. The regular interval of purchasing products by a customer has been set using random numbers, which is 15 to 30 days. Figure 5 shows 4 buttons. When you click on the “Start” button, the simulation will start. The simulator is making collection of various purchasing behavior of customers. The data can be stored in the PC, when you click on the “Save the Result” button. When you click on the “Clear” button instead, the data are cleared. When you click on the “Transfer Data to Excel” button, the Excel application starts up, and transfers the data to the Excel sheet.

Fig.5 User Interface (1)

Figure 6 shows the window of setting the parameters about store agents. The user set up the levels of each item of price readiness, assortment readiness, service readiness, and brand awareness which are the source of competitive power of store. Figure 6 shows the fact as data in quantity that comparing A store with X store, the A store is worse than the X store for the price readiness, assortment readiness, service readiness, and brand awareness, but better than X store in attitude toward helping and taking care of customers.

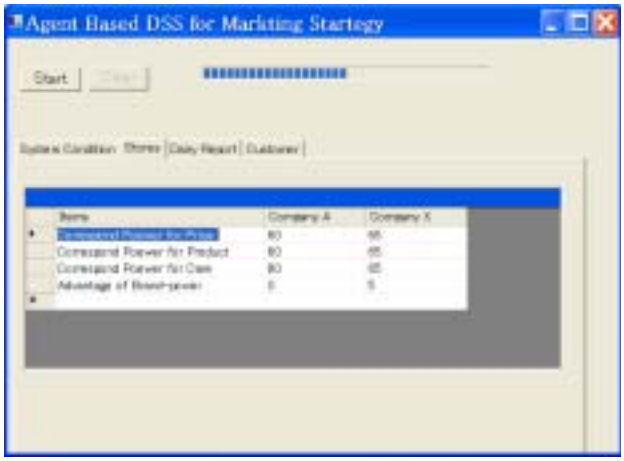

Fig.6 User Interface (2)

Figure 7 shows the window of setting the parameters about customer agents. The user sets up the number of new customers who visits every day in the window. Further, the user sets up the percentage of each customer type. Each setting-up ratio is 30%, 15%, 35%, and 25% for respectively customer type A, B, C, and D as shown in Figure 7.

Fig.7 User Interface (3)

5.4. Result of Simulation

We can obtain knowledge by simulating the marketing competitive about Company A's store. In other words, For the A store, there are many customers of type C and D, For the X store, there are many customers of type A and B. Although the A store is worse than the X store for the quality readiness and price awareness, the A store gets many customers type C and D by high service readiness. On the other hand, the brand awareness of the X store becomes the source of remain competitive against the A store. Therefore, the A store needs to strengthen more service readiness, and need to get turned on by the A store for customers of type D as strategy. When taking the strategy to strengthen the service readiness, it becomes threat.

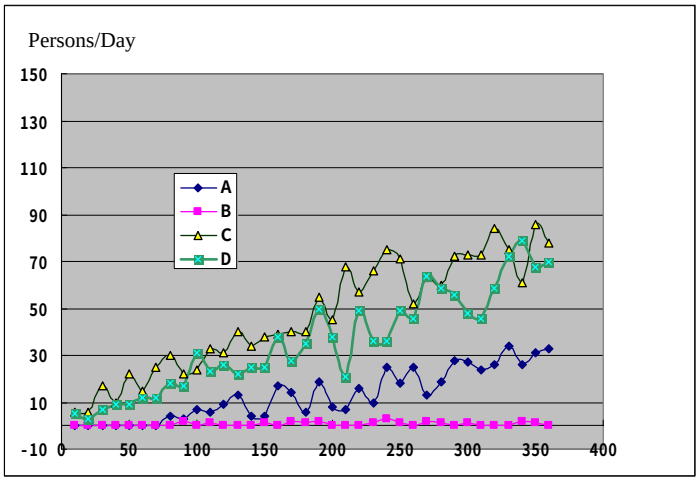

Fig.8 The Number of Customers in Company A

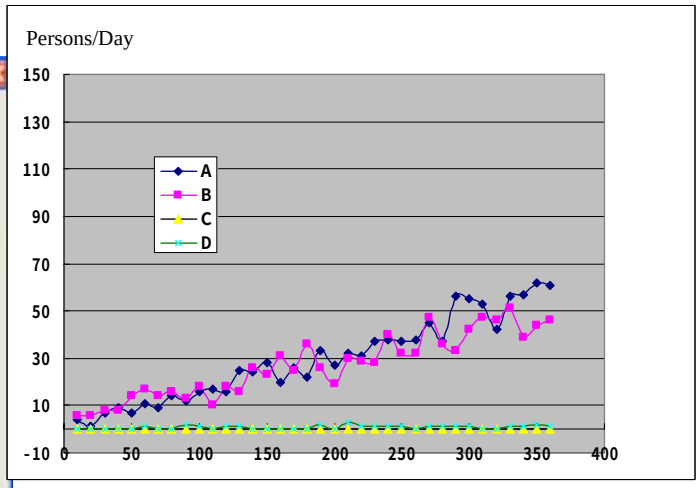

Fig.9 The Number of Customers in Company X

The knowledge as mentioned above was knowledge that Company's A marketer who is user, had been indefinitely feeling.

However, because the results from the simulation are the same as the knowledge, the user has a very high degree of confidence.

6. DISCUSSION

The simulator provides you data that are ungraspable in the real world. This is the advantage of simulation.

Figure 10 shows the number of customers who did not purchase from any stores because they were not satisfied to the A or the X store. Figure 10 shows that customers of type A and C were often fail to purchase. Further, Figure 11 shows that the ratio of changing type due to repeat purchases. The customers, who changed the type from C to A, take over 71% of total customers. Furthermore, the customers, who changed the type from B to D, take over 20% of total customers.

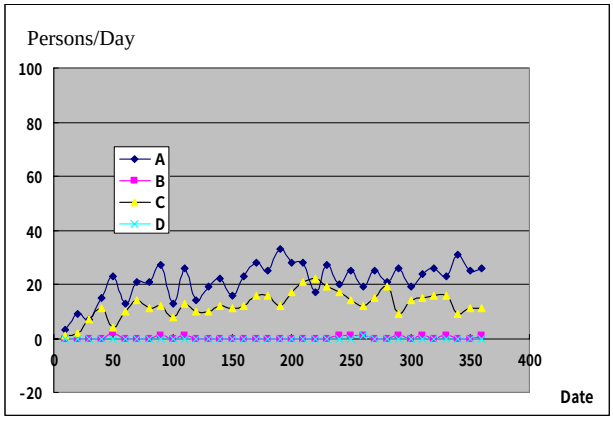

Fig.10 The Number of Customers who purchased neither A nor X Companies

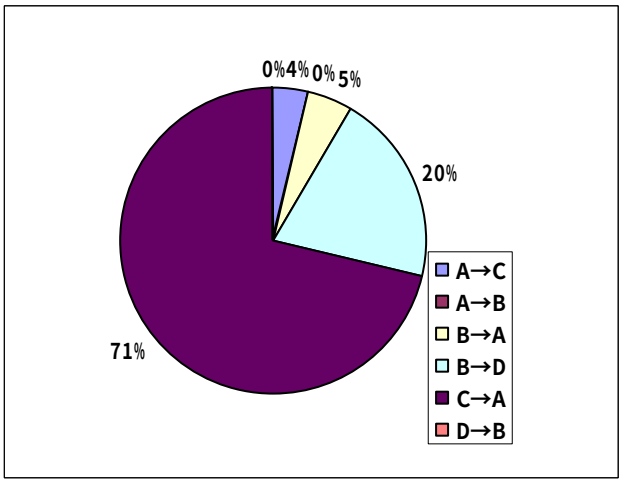

Fig.11 Ratio of Customer's Type change

From the facts as mentioned above, the knowledge about the competitive and delicate balance between the A and X stores can obtained. The reason that there are many customers of the type B in the A store, is that the A store takes the customers of type B from the X store by high service readiness.

The X store takes the customers of type C from C from the A store by brand awareness. However, the reason that many customers change from type B to type D is that the A and B stores are quite weak to satisfy customers. In truth, such reason is shown in Figure 10.

In the simulation, comparing A store with X store, the A store of number of customers is larger than the X store. However, when the X store simultaneously takes the strategies of strengthening brand awareness and service readiness, the superiority of the A store will be easily turned.

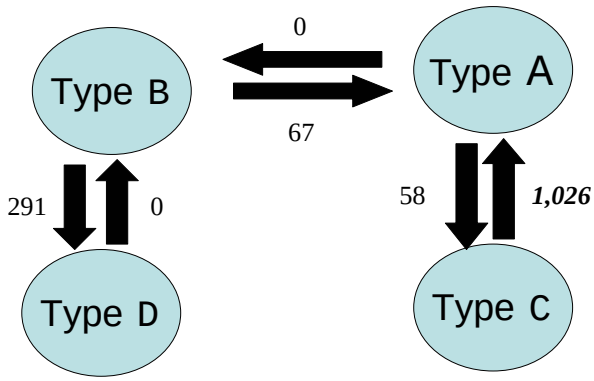

Fig.12 Result of Customer's Type Change

7. CONCLUSION

In the conventional DSS systems, the model of the real world has been represented as a mathematical model. However, in the case of simulating a social system from the real world, the mathematical model has limitations. This is because self-organizing agents in the social system not only exercise an influence on each other, but also the agents dynamically change the structure of the social system during the influence process. In this research paper, we constructed the DSS model taking an agent approach, and indicated the validity of the model based on the case study.

It is comparatively easy to model the social system by taking the agent approach; because each action pattern of the agent is obtained by observation of the social system that consists of customers, stores, and markets, and can be converted into customer, store, and market logic functions in the simulation system, then into software program code. Therefore, object-oriented programming is required.

Behavioral patterns of agents within a social system don't exist anywhere without exaggeration and omission. It is important that the behavior pattern matches with the self-awareness of the DSS user. If the matching is guaranteed, then the knowledge obtained from complicated and dynamic behavior in the social system

(as represented in the simulator implemented on a computer), will provide useful knowledge for the DSS user.

REFERENCES

[1] k.M.Carley, Computational organizational science and organizational engineering, Simulation Modeling Practice and Theory,VOL10 pp253-269,2002

[2] Scott-Morton,M.S,Management Decision Support System:Computer-Based Support for Decision Making,Cambridge,Mass,Division of Research ,Harvard Univ,1971

[3] Y.Takahara, An implementation of unified programming on act DSS,Int.J.of DSS，**18**（1996）

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