A MODEL OF DEMAND CHAIN MANAGEMENT WITH VIRTUAL INTERACTIONS

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ABSTRACT

We discuss new virtual relations between consumers and firms in terms of demand chain management (DCM), and explore the properties of virtual interactions through simulations based on an agent-based model. In a website community, firms may accumulate information about consumers' needs in order to develop products and enhance servicyes. Examples of such websites can be found at http://www.tanomi.com/, or http://www.cuusoo.com/.

We develop an agent-based model of DCM in terms of virtual interactions among consumers and firms in a website, and simulate the outcomes of virtual interactions with respect to varieties of products, consumer segmentation, and consumer satisfaction.

The results of the simulations suggest that development of a word-of-mouth community (including weblogs) can be a viable way to increase consumer satisfaction.

Keywords: demand chain, virtual interaction, virtual community, agent simulation

INTRODUCTION

In this paper, we discuss new relations between consumers and firms. We develop an agent-based model of demand chain management (DCM), and explore the properties of virtual interactions by computer simulation.

Concept of Demand Chain Management

Successful businesses provide products or services that consumers want. However, the ability to provide products or services that consumers want can incur large costs and risks to create a lineup responsive to various demands. To raise profit, dead stock should be reduced, and lead time should be shortened, though these risks can be covered by demand forecasts, etc.

Recently, firms can use consumers' needs information, because information systems and networks have developed rapidly. The firm can obtain consumers' needs information from web communities, weblogs, etc., on the Internet. Firms that use such information for creating products or service or for improving have appeared.Below, we describe the evolution of past business models and discuss demand driven development, production, and distribution. After that, we describe the purpose of this paper and the hypotheses of the discussion.

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Previous research

The firms search for a way to communicate with the consumer by using the web. They want to understand what consumers desire. There are many cases of doing so on the Internet (Seybold 1999). The concept of managing the demand chain developed from such searches for new relationships between consumers and firms. Tokiwa describes that the demand chain is a flow of consumer's ideas that exist in the market to firm. Consumer ideas are invented from the demand side (Tokiwa 1998). Kokuryo (1998) described the effectiveness of consumer-to-consumer interactions and the effectiveness of consumer-to-firm interactions in terms of a value creation model with interactions between customers.

There is research on incorporating consumer demand information and innovation into the product development process (Hippel 2006). Moreover, there are even cases of product development initiated by consumers who use the Internet. Cases of involving consumers in product development by using the Internet have begun to be researched (Ogawa 2002,Ogawa and Piller 2006).

It is necessary to discuss the characteristics of a society when studying consumer driven product development. New virtual consumer-to-consumer and consumer-to-firm relationships can arise on the Internet. Below we discuss what may happen under certain conditions.

Agent-based simulations have been used to study the characteristics of people interacting in social relationships(Axelrod 1995). In this paper, we refer to consumer-to-consumer interactions and consumer-to-firm interactions on the Internet as 'virtual interactions'. We develop an agent-based virtual interaction model, and examine the characteristics of the virtual interactions.

Purpose of this paper

We assume that the DCM is a business model of offering consumers products developed based on a consumer demand model. The products are developed based on new ideas from consumers' and are supposed to meet with the consumers' demand. The increasing possibility that various products are proposed by consumers is a strong point of DCM. However, it is necessary to gather consumer demand information. We consider consumer generated media (CGM) to be a way to get this information. CGM exploits the idea that consumers all over the world can provide a huge amount of information. CGM influences consumers' behavior and its various media include weblogs of individuals, virtual communities (BBSes, forums), mailing lists, and so on. Such media induce word of mouth behaviors on the Internet.

Hypotheses

In the future, products will be developed based on ideas expressed by consumers on the Internet. The firms that offer such products will become more numerous. We consider the following hypotheses are valid in this environment.

- Consumers who have various demands might buy individually customized products.

- Word of mouth activity on information networks might bias the consumers' product selection. A winner-takes-all phenomenon might occur.

- The length of the long tail will depend on the market scale of the products. Consumers might want more varied products in a large scale market and less variety in a small scale market.

VIRTUAL INTERACTIONS

Outline of Virtual Interactions

There are many virtual communities in a society. Firms can gather consumer needs information by analysing word of mouth activity (WOM) between consumers in a virtual community dedicated to a specific purpose. The firm can the make products and provide services adjusted to the consumer needs. We assume that the consumer-to-consumer and consumer-to-firm relations in virtual communities are virtual interactions.

Case Studies on Virtual Interactions

Morita (1999) reported that interactions between consumers in an Internet forum were used for improving "Lets' note" (a laptop PC made by Panasonic). In this case, DCM using virtual interactions helped to improve the product.

Some products developed from an initial idea offered by a consumer, ex., TANOMIKOMU and KUSOSEIKATSU.

TANOMIKOMU1 has a 'Request Board'. The request board has functions for consumers to offer ideas and for other consumers to add comments. The firm produces products based on ideas posted on the Request Board.

In KUSOSEIKATSU2, the designer makes a product image by using a consumer's initial idea and by using others' opinions on enhancements. KUSOSEIKATSU has steps including 'Wanted: your voice', 'Wanted: design' and 'Cheer for commercialisation'. The product images are proposed for consumers to rate in each step. Because the image is shown, consumers exchange more definite opinions (see WHITE PAPER on Information and Communications in Japan 2002).

A model of DCM with Virtual Interactions

DCM is a business model offering consumers products based on a model of consumer needs. The model covers two kinds of product development:

- Product development based on new ideas proposed by consumers

- Product development based consumer needs

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The advantage of DCM is that consumers propose various products. DCM using virtual interactions has the advantage that consumer's opinions can be easily obtained.

Kokuryo (1998) suggested that interactions between consumers and firms and between consumers to be a value creation model with interactions between customers. The paper described cases exploiting values that customers produced and support costs being reduced by mutual support between customers. The interaction between customers has the key role in the relation between the customer and the firm. Additionally, there is research on new value creation by analysing interactions between consumers, e.g., Seybold (1999) and Morita (1999).

Morita (1999) researched interactions between consumers and firms and did a quantitative analysis. In this paper, we develop the interaction between consumers and firms and the interaction between consumers as a model of virtual interaction. We develop an agent-based model of DCM, and explore the properties of virtual interactions by computer simulation.

Our model is based on the agent based model by Axelrod (1995). In addition, the Shinba-Ohta model (Shinba, Ohta 1997) about forming boundaries was used to enhance this model. There are three points of improvement. Our model has consumer and firm agents. The consumer agents create new product models by using a shift filter on consumer needs. The consumer agent may participate in many communities. The actions of the agents are as follows:
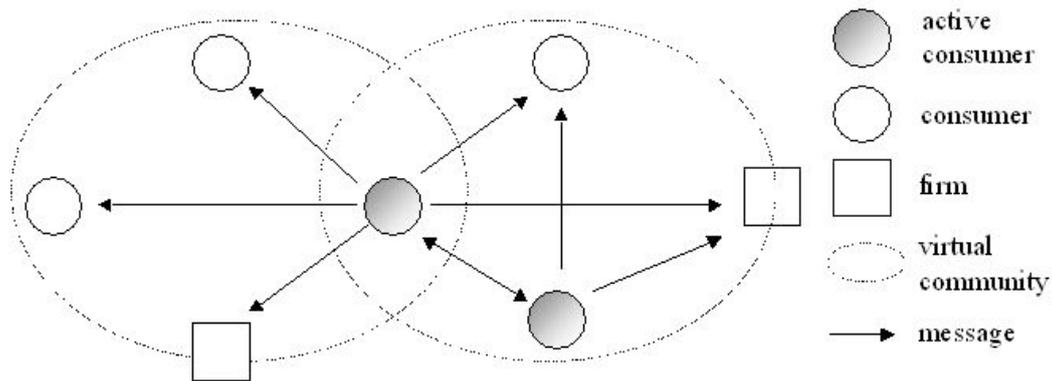
1. Consumer

- Messages are exchanged among consumers.

- There are consumers who send positive messages and ROMs (Read Only Members). ROMs don't send messages.

- Consumers participate in many communities.

2. firm

- The firm reads messages that have been exchanged among consumers.

- The firm decides the model of the products.

- The firm doesn't send messages.

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Figure 1. Virtual interaction model

AGENT BASED MODEL OF DCM WITH VIRTUAL INTERACTIONS

Consumer Agent

The consumer agent decides its consumer satisfaction based on an internal model, and participates in a high value community depending on its satisfaction. There are two types of consumer agent: active agents and passive agents. ex. $0\{0\}(33012)(- - -)$, $1\{0\}(42142)(- - -)$, $3\{1\}(11301)(- - -)$.

Properties of consumer agent
The consumer agent has a name, strategy, internal model of consumer needs, and history of product purchases (e.g., three, recently).

Value of consumer satisfaction
The consumer compares the characteristics of their internal model and product model. The consumer agent decides if it is satisfied by counting the number of identical characteristics.

Purchase product
The consumer agent chooses the product with the largest satisfaction level from among all products.

Change in consumer needs (Shift filter of consumer needs)
The consumer needs change by using the shift filter. The consumer agents create new products model by using the shift filter.

Market scale
We assume that the number of consumer agents is a market scale.

Maker agent (product)

The maker agent produces products based on an internal model. The internal model changes as a result of gathering opinions in the community.

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Properties of maker agent

The maker agent has a name, model of product, and internal model of the next product. ex. 0(00230)(00230), 1(20222)(20222), 2(30031)(30031).

Virtual community (virtual interaction between consumers)

The community is a group of consumers. These consumers have a certain consumer satisfaction level for a certain product.

Product model change (virtual interaction between consumer and maker)

The makers gather the opinions in the community, and change the internal model of the next product. They change the product model to a new one when the difference between product model and the internal model of the next product exceeds the threshold of changing the product line.

Table X. Parameters of this simulation

Consumer agent	Market scale (number of consumer agents)	100, 1000
	Number of active consumer agents	10%
	Threshold of consumer satisfaction	2 / 3
Maker agent	Number of maker agents	10

SIMULATION RESULTS

The computer simulation parameters were as follows: there were 10 maker agents; the threshold of changing the product line was 1/4; the threshold of consumer satisfaction was 2/3; the market scale was 10 or 100; the multiplicity of consumer needs was 5 or 10; and the changing speed of consumer needs was 100 or 500. The evaluation indicator was consumer satisfaction with the products.
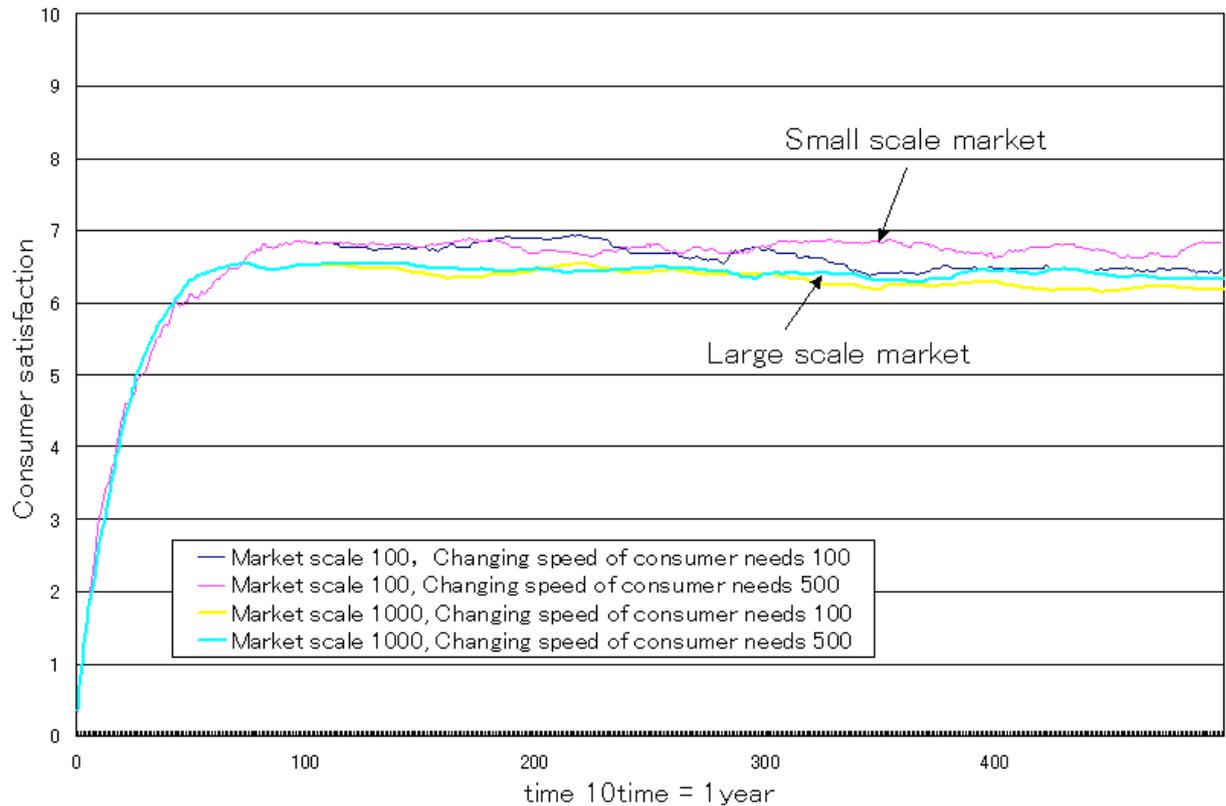
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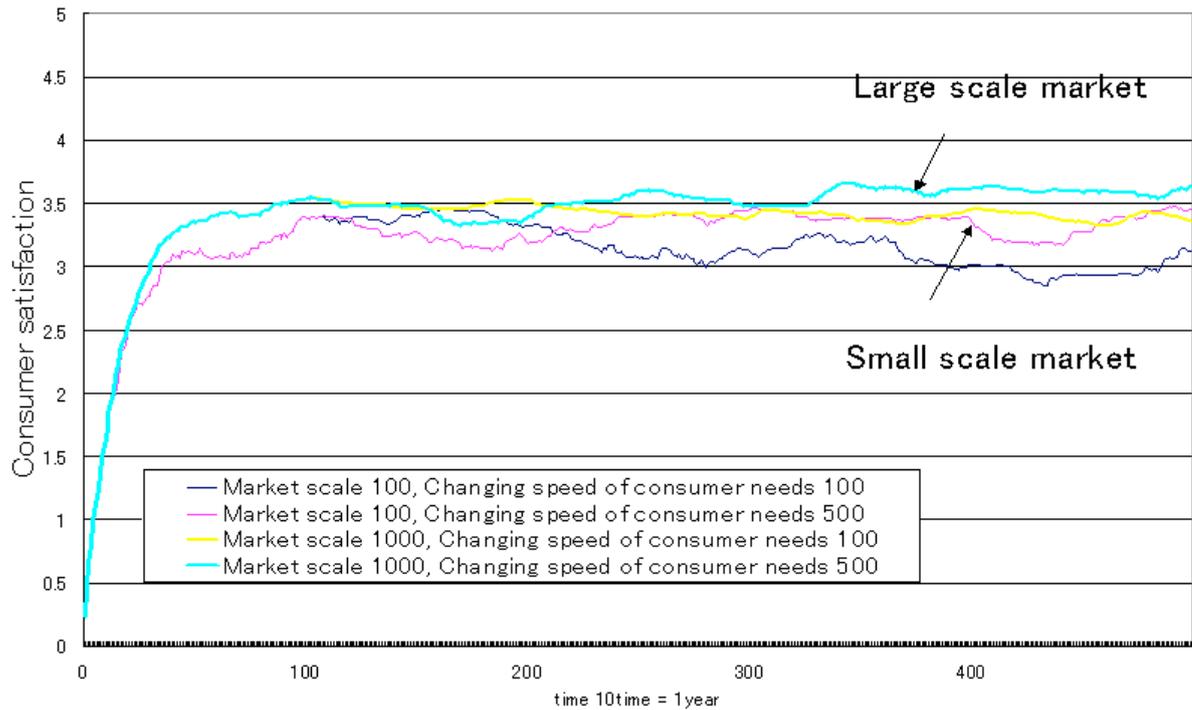
Figure 2. Consumer Satisfaction (multiplicity of consumer needs : 5)

Consumer satisfaction was higher in the case of the slow change of consumer needs than in the case of a fast change. Given a small multiplicity of consumer needs, consumer satisfaction was higher in the large market than in the small one.

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Figure 3. Consumer Satisfaction (multiplicity of consumer needs : 10)

Given a large multiplicity of consumer needs, consumer satisfaction was higher in the small market than in the large one. The reversal of consumer satisfaction happened depending on the multiplicity of consumer needs.

The results indicate that the changing speed of consumer needs doesn't affect consumer satisfaction.

CONSIDERATIONS

The differences in consumer satisfaction occurred with differences in multiplicities of consumer needs and market scale (Table X).

Table X. Relation between consumer satisfaction and multiplicity of consumer needs and market scale

		Market scale	
		Large	Small
Multiplicity of consumer satisfaction	Large	Consumer Satisfaction : Low	Consumer Satisfaction : High
	Small	Consumer Satisfaction : High	Consumer Satisfaction : Low

We can explain the difference in consumer satisfaction in terms of the similarity between consumers, the similarity among communities, and the effect of one-to-many communications.

This model is based on the Axelrod model (Axelrod 1995) and the Shinba-Ohta model (Shinba, Ohta 1997). These models and our model exchange messages between agents. All these models raise the similarities of agents. Additionally, our model adds the rule that consumers occasionally participate in two or more communities.

Let us consider the case of a small multiplicity of consumer needs. Consumer satisfaction is high when the market scale is large. This may indicate that the similarity between communities is high. The similarity of the products model of the firm corresponds to its rises because the similarity between communities is also high. Because the similarity of all products is high, consumer satisfaction is high. Hence why does similarity rise?

The similarity between consumers rises because they participate in the community. This is because one-to-many communications affect community members. The effect of one-to-many communication spreads one speaker's opinion throughout the community. Its effects are greater than one-to-one communication.

In addition, some consumers participate in two or more communities. The opinion by which the similarity rose in a certain community is spoken in other communities. In such a chain, the similarity between communities rises.

The rise in similarity between communities reflects the existence of active consumers. An active consumer speaks positively, and a chain of opinion is set up from a certain community to other communities. In the case of a small multiplicity of consumer needs, consumer satisfaction is high. There are many active users because the market scale is large. The similarity between communities rises multiplicatively.

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The environment for consumer's to speak freely exists today in the form of weblogs and so on. Weblogs form communities by using trackbacks. In these CGMs, A-list bloggers exist as active speakers. Weblogging is becoming a new medium that affects a wide range of people, even though it is not mass media. CGM, especially blogs, focuses on the A-list blogger and a community of consumers around the blogger. The opinions of the A-list bloggers are important because they have the possibility of raising the similarity between consumers and the similarity between communities through the effect of one-to-many communication.

Let us discuss the case of a large multiplicity of consumers needs. Consumer satisfaction is high when the market scale is small because consumer needs are too varied. A large market has a lot of active agents. However, we think that the similarity between communities doesn't rise as in the case of the small multiplicity of consumer needs.

That is, the similarity between consumers who participate in the same community rises to some degree. However, it doesn't affect the similarity between communities. Therefore, we think that consumer satisfaction is high in a small market. In a small market, consumers have various consumer needs, and there is a possibility to provide customized products for consumers.

CONCLUSION

We discuss the following three hypotheses in light of the results of the simulation.

* Consumers who have various demands might buy individually customized products.

We found the result depends on the circumstances. Consumer satisfaction depends on multiplicity of consumer needs and market scale. Given a large multiplicity of consumer needs and large market scale, firms might not offer individually customized products, because the multiplicity of consumers needs is varied. There is a possibility that the consumers would not buy individually customized products.

* A lot of word of mouth activity on information networks might bias the consumers' product selection. A winner-takes-all phenomenon might occur.

We found it possible that a firm could take the whole market depending on circumstances. This would happen given a small multiplicity of consumer needs and a large market scale. Through one-to-many effects, a comment heightens the similarity of the multiplicity of consumers in a community. The existence of A-list bloggers intensifies the similarity of multiplicity of consumers needs among communities. This phenomenon is similar to a scenario under which the society branches off from variety consumption or concentrated consumption through interactive effects between the number of information channels and the composition of consumers (Yamamoto, Okada, Kobayashi and Ohta 2002).

- The length of the long tail will depend on the market scale of the products. Consumers might want more varied products in a large scale market and less variety in a small scale market.

We found that the result depends on circumstances. Given a small multiplicity of consumer needs and a large market scale, even when products are not customized, consumer satisfaction has the possibility of rising, because the similarity of multiplicity of consumers needs in the community and among communities increases. On the other hand, given a large multiplicity of consumer needs and large market scale, there is a possibility that the consumers will not buy individually customized products.

In summary, we developed an agent-based model of DCM, and explored the properties of virtual interactions by computer simulation. Assuming DCM with virtual interactions, we found that the consumer satisfaction diverges according to the circumstances. In addition, the firms cannot identify consumers' needs if the gathering mechanism doesn't function well.

Firms are searching for a good mechanism of gathering the consumer needs information. TANOMIKOMU and KUSOSEIKATSU gather consumer needs by voting for an idea, and attaching ROMs (Read Only Members) to the argument (Ogawa 1998, TANOMIKOMU, KUSOSEIKATSU). They provide a mechanism for creating products with price classes and so on through consumers voting. However, these mechanisms are not perfect. The opinion gathering mechanism might not lead to any products. In the case of the DCM using the Internet, the production may be put off when the fewer than expected customers are gathered with the mechanism. This reduces the risk of the dead stock (Ogawa and Piller 2006).

Mechanisms of gathering from the consumer side exist in the form of SAGOOL and BuzzTunes. These are new search engines. The Google search engine ranks sites based on the number of links to the site. On the other hand, SAGOOL rankings are based on what the consumers are interested in now. BuzzTunes graphs the reputation of certain keywords (ex. company name) in weblogs. The reputation shows whether opinions are negative or positive. These tools are offered mainly to the consumer, not necessarily to the firm. However, it is possible to take a snapshot of consumer needs by using them. We consider the consumer needs gathering mechanism is from the consumer side. However, since these mechanisms are not perfect, the gathering mechanism is still a research topic.

In the DCM with virtual interactions, consumer satisfaction may not rise high depending on circumstances. We think that this phenomenon is due to the characteristics of products. The threshold of consumer satisfaction used by this model affects these characteristics. The threshold is the similarity of the internal model of consumer needs, and it can be said to be like the degree of concern. In this model, a rule of joining the community exists. A consumer does not join a community when the attractiveness of community is lower than the threshold of his/her consumer satisfaction. This threshold may be, for instance, when a certain daily commodity

cannot be distinguished from another one. A consumer may not join a community because s/he is not especially interested in it. In this case, the threshold of consumer satisfaction is low. On the other hand, their attitude might change when the threshold is high. It will be necessary to examine the domain of coverage of DCM in the future.

We proposed that the concept of DCM with virtual interactions. We developed an agent-based model of DCM in terms of virtual interactions, and simulated the outcomes of virtual interactions with respect to consumer satisfaction. The results indicate the difference in the consumer satisfaction depends on the difference in the circumstances of the multiplicity of consumer needs and market scale. We discussed the possibility of demand chain management using with virtual interactions.

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