# EVOLUTION OF SOFTWARE AGENT-BASED E-COMMERCE: BASED ON AGENT COMPETITION MODEL

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## ABSTRACT

*Many changes have been expected to occur in existing e-commerce paradigm by the emergence of agent-based e-business. In this paper, to find these changes we establish agent-based e-commerce framework consisting of five actors, which are agent-based e-business, existing e-business, user, other agent and external entities. We also propose a simple agent competition model, which can be used to explain the stages of evolution by mutual impact among major actors. Considering the stages of evolution represented in the competition model, two issues are derived as research problems to solve in order to study the evolution of agent-based e-commerce. For issue 1, we conduct a case study in order to figure out the changes occurred to existing e-business and user by the emergence of agent-based e-business. For issue 2, we analyze the change of agent-based e-business by reactions of two actors. To do this, we analyze representative agent-based e-business sites to derive hypotheses on the longevity of agent-based e-business using inductive learning technique. Finally, we provide strategic implications of the longevity of agent-based e-business by reactions of two actors based on these hypotheses.*

**Keywords:** software agent-based e-commerce, evolution of agent-based e-business, software agent

## INTRODUCTION

Many changes have been expected to occur in existing e-commerce paradigm by the emergence of software agent-based e-business. The Internet that has grown so dramatically in the past few years would by now becomes unmanageable without these business (1). It is claimed that within the next decade, the Internet could be populated with billions of agents exchanging information goods and services with one another and with people (7). Agent-based e-commerce has been considered as a solution to information overload problem of users and broadens their bounded rationality. This business has been also expected to give other opportunities to existing e-business like cost reduction, new business, etc. Although the emergence of agent-based e-commerce is expected to give new opportunities to existing e-business& user on one hand, it has also been a new threat to them on the other hand. Existing e-business like shopping mall site have suffered from severe price competition among them by agent-based price comparison shopping sites and have lost their revenue model by banner advertisement removal agent like Adeater (8). Also, Users may purchase goods and services by paying higher price than normal (13).

These opportunities and threats made existing e-business and user cooperate or resist against agent-based e-commerce and change their business model, technical platform, usage patterns, etc. Then, agent-based e-commerce changes in response to these changes. The objective of this paper is to examine what changes will occur eventually to agent-based e-business. To find these changes, we establish an agent-based e-commerce framework with five actors such as agent-based e-business, existing e-business, user, other agent and external entities. This framework

shows the interaction among its five actors, participating in agent-based e-commerce. We also propose a simple software agent competition model, which can be used to explain the stages of evolution by mutual impact among three major actors.

## FRAMEWORK FOR SOFTWARE AGENT-BASED E-COMMERCE ANALYSIS AND AGENT COMPETITION MODEL

Agent-based e-business in e-commerce can be defined as a business enabled and operated by software agent technology. In agent-involved e-commerce environment, principal actors include users, agent-based e-business, existing e-business and other agents. We may add external environment variables to this framework. We depicted a framework for agent-based e-commerce analysis in Figure 1 (6).

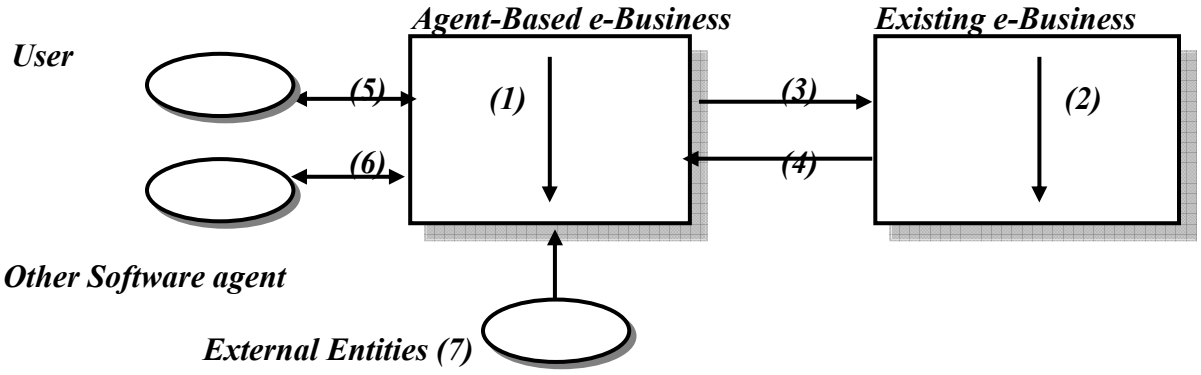



Figure 1: Framework for Agent-based e-Commerce Analysis

Agents of agent-based e-business in Figure 1 could be comparison-shopping agents, recommendation agents, negotiation support agents, networking agents, interface agents, etc. Existing e-businesses like shopping mall, portal site, etc are a business that can both affect and be affected by a specific agent-based e-business. Other agents mean agents that can cooperate or compete with the agent-based e-business. And by external entities means legal or technical variables that may affect the evolution of software agent-based e-commerce. Related research issues can be summarized as in Table 1.

Table 1: Classification of researches by the framework for agent-based e-commerce analysis.

| Arrow | Research Issue | Related papers |
|---|---|---|
| 1 | Evolution of agent-based e-business | (6), This paper |
| 2 | Change of existing e-business | This paper |
| 3 | Impact of agent-based e-business on existing e-business | (4), (5) |
| 4 | Effect of existing e-business sites on agent-based e-business | This paper |
| 5 | Interaction with agent-based e-business and user | (10), (12) |
| 6 | Interaction between agents | (7) |
| 7 | Influence of external entity (institutional, legal etc environments) | (4), (5), (6) |

And we represent these interactions as software agent competition model revised from Crowston's model (3) (See Figures 2). Considering the stages of change represented in the software agent competition model, the followings are derived as research issues to solve in order to study the evolution of software agent-based e-commerce: 1) What is the impact of software agent-based e-business on existing e-business and user? 2) What changes will take place to existing e-business and user by the impact of software agent-based e-business? 3) What is the

impact of changed existing e-business and user on software agent-based e-business? 4) What changes will occur to the software agent-based e-business in response to the changes of existing e-business and user? We assume that these four research issues happen systematically. Among the research issues, we limited our focus to the second issue and fourth in this paper,

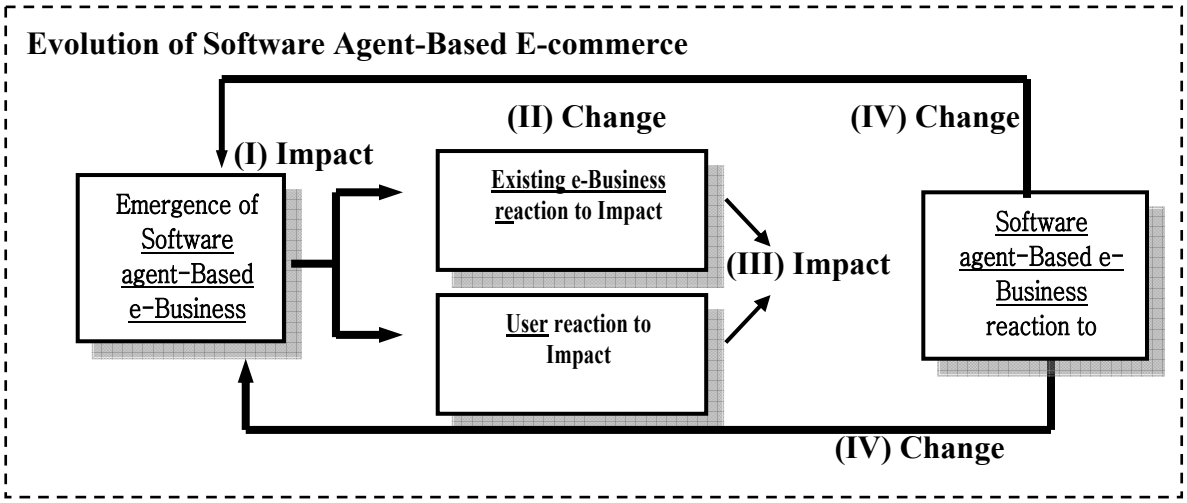



Figure 2: Software Agent Competition Model

In the second issue, we conduct a case study in order to figure out changes occurred to existing e-business and user by the emergence of agent-based e-commerce. In the fourth issue, we analyze the change of agent-based e-business by reactions of other two actors in Figure1. To do this, we analyze representative agent-based e-business sites to derive some hypotheses on the evolution of agent-based e-business using inductive learning approach.

## CHANGE OF EXISTING E-BUSINESS BY SOFTWARE AGENT-BASED E-BUSINESS

Existing e-businesses may cooperate with agent-based e-businesses when they can obtain clear benefits, which are increased user convenience, lower search cost, marketing effect improvement, new business opportunities and etc. To do this, they have changed their web site design and promotion method from HTML (Human readable intensive) based to XML (Machine readable intensive) based (5) and have paid for listings and placement to particular agent-based e-businesses (2). However, sometimes they do not cooperate with the agent-based e-business for the following reasons. For example, emergence of agent-based e-business like comparison-shopping agents raises the price competition between some e-businesses and thus become a threat to them. Also, emergence of banner advertisement removing agent like Adeater (8) became a threat to most existing e-business sites whose major revenue model is banner advertisement. And, existing e-business sites have been afraid of losing their brand effect by agent-based e-business (5). In these cases, they reject the agent-based e-businesses by changing their business model, technical platform, product configuration mechanism, and external environment including legal aspect, as follows. This conforms to reject phase of existing e-business and user in Figure 2.

**Change of Business model**
Existing e-business having revenue source like e-free model based on banner advertisement have been threatened by the banner removal agent and dwindle of Internet advertisement market in recent. For theses reasons, they have changed their business model with a new revenue source like Micropayment, merger by other sites, specialized sites, etc instead of banner advertisement. Also portal sites like Yahoo, AltaVista, etc whose revenue sources are reputation & brand effect have looked for other business model as they lose those effects. (5)

**Change of Technical Platform**
Existing e-businesses may have technical problems like server load, lowering of user access speed, etc by continuous excessive approach of software agents. In this case, they block the approach of software agents of comparison-shopping sites like BargainFinder. Selfish agent-based e-businesses are trying to generate many IDs through automation function of software agent. Some existing e-business sites like Yahoo, Lycos, etc use robot exclusion protocol or a semantic barrier by presenting a common sense question that average human being can answer. By doing so, they could block agents that cannot answer the easy question.

**Change of Product Configuration Method**
Existing e-businesses may change design mechanism of their products to frustrate the comparison by agent-based e-business like comparison-shopping agent. They gave products unique names to frustrate comparison-shopping. Existing e-businesses like Airlines Company offer many different prices and rules to make comparison difficult. (4) Some sites randomize their price to searchers and non-searchers using portioned pricing strategies. (12)

**Change of External Environment like Legality**
Existing e-business like eBay.com sued against the agent trespassing of Bidxs.com and AuctionWatch by legally. EBay.com is against software agents that would enter the auction site because they would slow down their transaction processing systems, thus reducing performance of all other eBay visitors. Also existing e-business like music distributor attacked Napster.com legally because this agent-based e-business using networking agent technology threats the revenue source of existing music distributor.

## CHANGE OF USER BY EMERGENCE OF AGENT-BASED E-COMMERCE

In present, users had to navigate multiple Internet shopping sites sequentially to find out the best product. With the aid of comparison-shopping agent, users do not have to navigate all the sites, but visit only the comparison-shopping site. Internet sequential navigation pattern may be changed by the use of such software agent. Also they expect economic benefits of lower search cost using price comparison-shopping agent. But they reject the participation of agent-based e-business in following cases. For example, although Jango.com's client-based agent had been expected to invalidate blocking strategy of existing e-commerce, users reject the use of the agent program because of the inconvenience of download. (6) Although comparison-shopping agents have come into effect on the decrease of price, the decrease of price happened only to some specific commodity products (4), but not to the products that have brand effect and loyalty program (13). On the contrary, we can see the example of price increase due to price monitoring agent in Books.com (13). Many users also still enjoy Internet shopping without the aid of

software agents. According to OECD's technical report (9), some users are inclined not to trust the information and the advice of software agents. In these cases, they do not cooperate with agent-based e-business.

## EVOLUTION OF AGENT-BASED E-BUSINESS BY CHANGES OF EXISTING E-BUSINESS AND USER

In this section, we analyze the change of agent-based e-business by reactions of existing e-business sites and user. This conforms to revise phase of agent-based e-business in Figure 2. To do this, we analyze agent-based e-business sites to derive some hypotheses on the evolution of agent-based e-business using inductive learning technique. We analyze 22 representative agent-based e-business sites to derive explanatory variables that seem to have effect on the longevity of the agent-based e-business. Through this, we find variables affecting the evolution of agent-based e-business as follows. (See Table 2)

Table 2: Dependent Variables Affecting the Evolution of Agent-based e-business.

| Variable | Meaning | Related Arrow |
|---|---|---|
| TP: Technical Platform | Indicates whether the agent program is client-based or server-based | Arrow (4) |
| IQ: Input Quantity | The amount of information that a user must give to an agent | Arrow (5) |
| UC: User Convenience | Indicates whether or not it is comfortable to use an agent | Arrow (5) |
| BR: Business Relationship | Relationship between existing e-business and an agent. (Opportunity or threat) | Arrow (4) |
| TV: Technical Vulnerability | Technical weakness of an agent-based e-business | Arrow (4) |
| LC: Legal Compliance | Legal compliance of an agent-based e-business. | Arrow (7) |

Current state of agent-based e-business sites is decided as the dependable variable whose value can be either *Accepted* or *Rejected* by two actors in 22 agent-based e-commerce sites. Values of the selected independent variables and state variable of 22 agent-based e-business sites are summarized into Table 3. (Every value in cases was chosen based on the related literature review, case analysis, and site surfing.) In that table, "S" and "C" mean Server-based platform and Client-based platform in TP (Technical Platform), respectively. "O" and "T" mean Opportunistic and Threat, in BR (Business Relationship), respectively. "H" and "L" mean High and Low in other independent variables, respectively. "R" and "A" values of variable State mean Rejected and Accepted, respectively. Records in the table are used as an input to an inductive learning method, ID3 to create a decision tree in Figure 3 and we generated five theoretical hypotheses on the evolution of agent-based e-business, based on the decision tree.

**H1:** If business relationship with existing e-business is opportunistic, agent-based e-business is accepted. (Rule 1 in Figure 3)

**H2:** If business relationship is a threat, technical platform is client-based and user convenience is low, agent-based e-business is rejected. (Rule 2 in Figure 3)

**H3:** If business relationship is a threat, technical platform is client-based, user convenience is high and legal compliance is low, agent-based e-business is rejected. (Rule 3 in Figure 3)

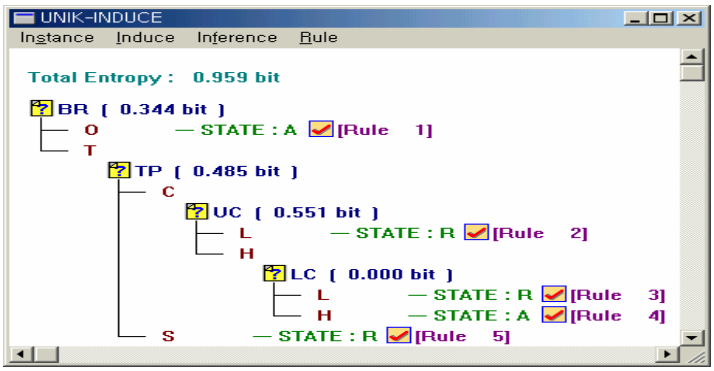
**H4:** If business relationship is a threat, technical platform is client-based, user convenience is high and legal compliance is high, agent-based e-business is accepted. (Rule 4 in Figure 3)

**H5:** If business relationship is a threat, and technical platform is server-based, agent-based e-business is rejected. (Rule 5 in Figure 3)

Table 3: Dataset from Site Analysis.

| CASE | TP | IQ | UC | BR | TV | LC | State | CASE | TP | IQ | UC | BR | TV | LC | State |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BargainFinder | S | L | H | T | H | H | R | Adeater | C | L | H | T | L | H | A |
| C-based Jango | C | L | L | T | L | H | R | Gnutella | C | H | L | T | L | H | R |
| S-based Jango | S | L | H | O | H | H | A | Neuromedia | S | L | H | O | L | H | A |
| Bizrate | S | H | H | O | H | H | A | Bullseye | C | L | H | T | L | H | A |
| Clickthebutton | C | L | H | O | L | H | A | Bidxs | S | L | H | T | L | L | R |
| Savingbot | C | L | H | O | L | H | A | Early-AuctionWatch | S | L | H | T | L | L | R |
| Personalogic | S | H | H | O | L | H | A | Post-AuctionWatch | S | L | H | O | L | H | A |
| Fiefly | S | L | H | O | L | H | A | Early-RubyLane | S | L | H | T | L | L | R |
| Early-Napster | C | L | H | T | L | L | R | Post-RubyLane | S | L | H | O | L | H | A |
| Post-Napster | C | L | H | O | L | H | A | Itrack | S | L | H | T | L | L | R |
| Kasbah | S | H | H | O | L | H | A | | | | | | | | |

Considering the generated decision tree in Figure 3, we notice that the establishment of mutually beneficent business relationship between principal participants in Figure 1 is important.




Figures 3: Decision tree by inductive learning.

Based on the generated hypothesis, we derived two strategic implications of longevity of agent-based e-business by change of existing e-business and user as follows.

**Implication 1:** Most important variable that determines the longevity of an agent-based e-commerce is business relationship. That is, if an agent-based e-business can establish mutually beneficial relationship with existing e-commerce, it can survive.

**Implication 2:** Even though an agent-based e-business becomes a threat to existing e-business, it would survive if it were designed to provide convenience to its users and is legally compliant.

## CONCLUSION

To our knowledge, this paper is the first systematic case study of the evolution of agent-based e-business & existing e-business based on software agent competition model using inductive learning technique. In summary, the primary contribution of this research can be described as follows. First, we proposed agent-based e-commerce analysis framework and analyzed the interactions among the actors based on this framework. Second, we analyzed the impact and change of existing e-business and user by emergence of agent-based e-business. Third, we

identified the variables that affect the change of agent-based e-business against existing e-business & user. And fourth, we generated the hypotheses on the evolution of agent-based e-business using inductive learning and derived strategic implications.

However, this research shows some limitations and further research issues. Although agent-based e-commerce framework in figure 1 shows five actors, we cannot represent all interactions of actors. We suppose that the interaction with agent-based e-business and other agent is the important research issue in Semantic web including multi-agent, ontology issue and etc. And in evolution of agent-based e-business, the number of cases that we analyzed is so small that some part of the generated hypotheses might be less reliable than others. In fact, it was very difficult to get information on more agent-based e-businesses that ceased their service. If we collect sufficient number of cases in each of the category and analyze them separately, the generated hypotheses obtained in each category will give more convincing implications. In the current research of this paper, we did not mention the interaction with agent-based e-business and other actors including other agents. As a further research, we need to do research on Arrows (6) and (7) in Figure 1.

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