Agents and E-commerce: Beyond Automation

Full Paper

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Abstract

The fast-growing information and communication technologies have shifted the contemporary commerce in both its information and market spaces. Businesses demand a new generation of agile and adaptive commerce systems. Towards this end, software agents, a type of autonomous artifacts, have been viewed as a promising solution. They have been taking an increasingly important part in facilitating e-commerce operations in the last two decades. This article presents a systematized overview of the diversity of agent applications in commerce. The paper argues that agents start playing more substantial role in determining social affairs. They also have a strong potential to be used to build the future highly responsive and smart e-commerce systems. The opportunities and challenges presented by proliferation of agent technologies in e-commerce necessitate the development of insights into their place in information systems research, as well as practical implications for the management.

Keywords

Agents, software agents, intelligent agents, e-commerce, B2C.

Introduction

The current paper presents a variety of types of agents (i.e., software agents or intelligent agents) applied in B2C e-commerce. Agents have been increasingly employed in businesses. However, they often make little impression on users, as they may not have any visual form. In many cases, users may not even know about their existence while they actually provide important support to users or large scale systems. Their innovative features and diversified applications necessitate development of insights from management and information systems research community.

Agents can be defined as autonomous computing entities, which are capable of carrying out tasks for users without continuous instructions. There is no consistently agreeable notion of agent among researchers. The notion adopted here emphasizes the basic behavioral traits of agents, which are independent from the technologies used to implement them. Agents were initially introduced in the field of artificial intelligence and then extended to distributive intelligence and multi-agent systems. Agents and multi-agent systems fit in complex environments that require distributed control (Wooldridge 2002). Agents can be designed to have certain types or levels of intelligence. However, intelligence is not a defining feature of agents. They may have different capabilities and behaviors required for various environments.

Global economy requires businesses to continuously innovate their commerce practices, models, and technologies. The Internet has extended contemporary commerce in multiple dimensions, including its information and market spaces. Agents are deemed as a promising technology in the new commerce environment (Jennings 2001). There are several existing surveys of agents in commerce (e.g., Guttman *et al.* 1998; He *et al.* 2003; Palopoli *et al.* 2006). These surveys focused more on the technological perspective. Currently, there is no review targeting to the audience of management and information systems research according to the knowledge of the authors. To this end, this article extends and integrates the existing surveys and broadens the scope of representative applications. Meanwhile, particular attention is allocated to the roles and behaviors of agents, rather than technical details.

Businesses can benefit from using agents in multiple aspects. For instance, businesses may be able to reduce costs, because some tasks can be automated. Using agents also helps to enhance the interactivity between businesses and customers, which has important implications for marketing. However, businesses also need to be careful of some potential undesirable impacts. Artificial intelligence starts taking more determining role in social affairs, e.g. when agents are applied to select merchants, review offers, and make agreements. There is a need to address the issues of effectively combining artificial and human intelligence, as they have different strengths and weaknesses.

The remainder of the current paper is organized into three sections. The next section will classify and review agent applications in e-commerce in four sub-sections. The potential impacts of using agents will then be discussed in another section. The last section will conclude the article by suggesting directions in the future research of e-commerce agents.

The participation of agents in e-commerce

The rapid improvement of information and communication technologies drives the growth of e-commerce (Coppel 2000). The Internet offers an efficient way to integrate organizations. It is an open environment that lowers the barriers for new entries. Various kinds of markets are connected to each other. Overall, the Internet-empowered commerce environment exhibits some features to all of its members. First, all businesses have limited observability to the market. It is impossible or too costly to acquire complete or quasi-complete information. Second, the environment is not deterministic. Each participant has partial control over and is able to apply limited influence on the environment. In a distributed environment, the effects of decisions and actions become less predictable. Therefore, it is perhaps a good strategy to take actions based on available information and knowledge and keep observing and learning from the environment. Third, the response of the Internet to events is quick. Businesses need to develop their agility in order to better survive. Fourth, the Internet-empowered commerce environment is increasingly dynamic. New technologies and business models, such as mobile and smart phone commerce, are continuously invented.

These features of e-commerce demand for innovative commerce systems. Agents have several generic features that are attractive. They are autonomous and do not need continuous instructions. They can be programmed to be intelligent and adaptive. They can either responsively or proactively take actions, with or without supervision. Agents and multiple agent systems are suitable to an open, stochastic, and dynamic computing environment in which the participants only have partial control (Wooldridge 2002). Applying agents to e-commerce may bring about both new opportunities and threats. It is important to keep reflecting on at least two questions (Jennings 2001): 1) could agents provide better solutions to known problems? and 2) could agents solve problems in a way beyond the scope of automation?

E-commerce embraces a broad variety of activities taking place between businesses and customers. These activities can be roughly classified into to four phases: information, contracting, settlement and after-sale. The interaction and decision making of businesses and customers differ when they are in different phases (e.g.,Runyon 1977). For instance, the primary activities of customers in information phase focus on identifying own needs and obtaining the knowledge about goods. On the other side, businesses need to deliver the relevant information to potential customers and make offerings interesting and impressive. After customers and businesses enter into the contracting phase, the information on goods may become less important. They need to determine details of their deals and transactions. A cycle containing the four phases is used to visualize the classification of agent applications (see Figure 1). Similar idea can be found in other reviews (e.g., Guttman *et al.* 1998; He *et al.* 2003; Palopoli *et al.* 2006). Our review shows that

agents can participate in all phases of e-commerce. Examples of the potential applications are discussed below.

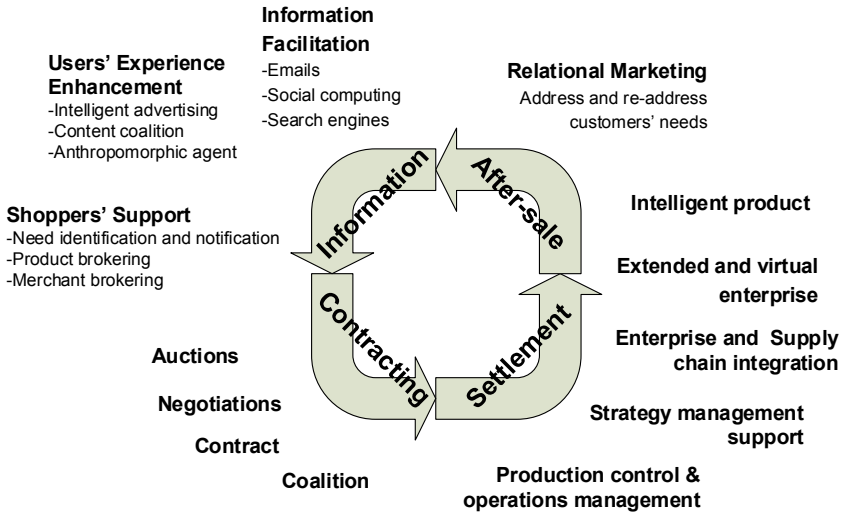

Figure 1: The Participation of Agents in E-commerce

Information phase

Customers' buying behavior often starts from an ambiguous and probably long process of need identification. During this stage, customers are often characterized by their emerging awareness of unmet needs and uncertainties about their thoughts. They are likely to collect more information about goods and allow their ideas to mature (Runyon 1977). During this stage, customers' needs can be strengthened or clarified by multiple means. In this phase, agents are found to facilitate information exchange, enhance users' experiences, and support shoppers.

Information facilitation

Information is critically important in commerce. The speed, volume, and ways of exchanging information are significantly enhanced on the Internet. However, it is less known that agents are used to support e-mails, search engines, and social computing systems. E-mail function is sustained by a large group of heterogeneous and dispersedly deployed agents. E-mail clients (e.g., Thunderbird) are technically mail user agents. The email systems on the Internet also need delivery agents, retrieval agents, submission agents and transfer agents. They collectively establish the e-mail infrastructure. Search engines need web crawlers, who work in groups and autonomously collect hyper-text based web content. Crawlers may carry their interests about content. Thereby, search engines can be specialized. The current popular social computing systems (e.g., Bloggers) usually adopt event-driven architecture. Agents are often used to implement both event publication and notification.

Customers' experience enhancement

Customers' experiences are crucial to the success of e-commerce. They influence not only customers' impression of businesses, but also purchase. Agents have been used for intelligent advertising, content consolidation, and anthropomorphic customer support.

Intelligent advertising attempts to provide dynamic, personalized, interactive, or context-aware advertisements (Hoffman and Novak 1996). In order to achieve the objective, data about audience and context are needed. When the audience is large, centralized processing becomes less effective. Agents can be used to collect data from the audience and then determine the content (Adams 2004). Examples can be found in Hristova & O'Hare (2004), Kazienko & Adamski (2007), and Kim & Du (2006).

Businesses often differentiate their goods and online content because of competition. On the other side, customers often need to process information from multiple sources that have heterogeneous structures.

The inconvenience may inhibit customers' purchase decisions. Agents have been used in content consolidation by helping customers to access the information of multiple sources from a single place. Examples can be found in Li *et al.* (2003), Bergamaschi *et al.* (2001), Yang, Lee, & Choi (2000), and Glezer & Yadav (2001).

Anthropomorphized agents are increasingly used in businesses. Many companies start using voice agents who can hear and talk on phone with customers. Similarly, the use of avatars on the Internet is growing fast. The idea of avatars surrounds the transformation of identity and image (Hemp 2006). Agents are suitable for empowering avatars. An impressive application is SecondLife. It is a virtual world, in which participants use avatars to present themselves. It is not only a place for entertainment, but also an online market. Participants can create products, offer services, and trade with each other. Other examples can be found in Joerding & Meissner (1998), Ardissono *et al.* (2001), De Carolis, Di Maggio, & Pizzutilo (2001), Zhang (2007), and Laakko & Hiltunen (2005).

Shoppers support

Shoppers support focuses on enhancing customers' shopping experiences. When visiting a commerce website, customers need to deal with volumes of information. It will be helpful if they can be supported. On the other hand, businesses may enjoy a chance of being active to convert customers' intention into purchase with appropriate information. Agent-based technologies aiding shoppers have been surveyed by (Guttman *et al.* 1998; He *et al.* 2003; Palopoli *et al.* 2006). According to these surveys, agents were used in providing three group functions to support shoppers, i.e., need identification and notification, product brokering, and merchant brokering.

Contracting phase

Agents have been used to produce contracts or agreements on behalf of human actors. The contracting phase involves substantive decision making, which determines the allocation of social welfare or the state of social affairs after. The activities in this phase are traditionally conducted by humans, who follow certain mechanisms such as negotiations, auctions, and catalogue buying. In the last two decades, agents have been increasingly participating in negotiations by taking different roles. For instance, agents have been designed to conduct trades on behalf of users (e.g., Moukas *et al.* 2000). They were able to mediate negotiations of buyers and sellers (e.g., Shih *et al.* 2005). They could also support human users who are engaged in a negotiation process (e.g., Chen *et al.* 2005).

The use of auction robots to eBay auctions is a good example. Academic research has demonstrated more possibilities. A variety of agent-based negotiation frameworks have been invented, including: game theory based (e.g.,Zlotkin and Rosenschein 1989), heuristics based (e.g.,Faratin *et al.* 1999), constraint based (e.g.,Kowalczyk and Bui 2001), case based (e.g.,Sycara 1991), and argumentation based (e.g.,Rahwan *et al.* 2003). Agent-based negotiations caught intensive attention, probably because negotiation is a general mechanism used to solve issues involving dependencies, conflicts, concurrency, and decentralized control. Negotiation is also an underlying mechanism supporting coordination and collaboration (Jennings *et al.* 2001).

Agents have also been used to produce agreements in swarms, such as coalition formation and contracting. The requirements, market mechanisms, and behaviors of agents will differ from those of small groups when the number of participating agents is large. The notion of coalition indicates that a set of agents forms a group in order to achieve a larger objective (Shehory and Kraus 1998). In e-commerce applications, where the agents are normally value-oriented, the benefits of joining a group are often the fundamental drive. The potential benefits include monetary benefits, risk reduction, and trading power (Fasli 2007).

Yamamoto & Sycara (2001), proposed a coalition formation scheme, named GroupBuyAuction. In the scheme, buyers could post quotes. Buyers specified their reserved prices. On the other side, sellers could bid prices given different volumes. A leader agent then determined coalitions, selected a winning seller for each coalition, and calculated surplus division among buyers. Tsvetovat *et al.* (2001) proposed a stage-based model depicting the general process of coalition: negotiation, coalition formation, leader election/voting, payment collection, and execution/distribution stages.

Agents have been also used to form coalitions for long-term benefits. Vassileva, Breban, & Horsch (2002) designed coalition mechanism that could benefit both customer and vendor agents if they are interested in long-term objectives. Brooks & Durfee (2003) used another term 'congregating' to describe a long-term coalition. In their view, if agents had to seek other agent to collaborate to finish a task, they would prefer those with whom they had successful outcomes in the past. They showed that this method is helpful in reducing coordination costs.

In contrast to coalition formation, contracting approach focuses on decomposing a large task into sub-tasks and assigning these tasks to participants. Contracting has been applied in many fields, such as electricity markets, bandwidth allocation, and electronic trading of financial instruments (Sandholm and Lesser 1998). Smith (1980) invented the first multi-agent contracting protocol, ContractNet. This protocol had been extended in several ways. Examples can be found in Sandholm (1993), Anderson & Sandholm (1998), and Collins *et al.* (1998).

Settlement phase

After a customer puts an order, the corresponding business needs to deliver the purchased service or product to the customer. From the customer's perspective, the processes can be as simple as his or her selecting a product and paying for it. The processes on the business side are usually much more complex. They often involve in a series of interaction and coordination of multiple functional units or firms. In many scenarios, decisions need to be made at multiple levels within the hierarchy of a single firm and propagate to business partners.

An important research focus of applying agents on the business side is industrial or manufacturing control. This stream of research recognizes that conventional centralized and hierarchical decision making approach is not adequate to handle the increasing complexity and dynamics in manufacturing, production, planning and scheduling, and supply chain management. Centralized and hierarchical decision making may still has its advantages in some situations. For instance, it is often effective for small firms or simple production environment. It is easy to understand, apply, and verify. However, the approach becomes less effective when the scale and complexity of production increase. A decision with failures within a centralized system can lead to serious dysfunction in the whole production (Marik and McFarlane 2005).

The growing global competition posits new challenges for businesses as well. For instance, customers increasingly require high quality products at low cost. They may prefer highly customized products that are actually used in shorter life cycles. Businesses need to keep enhancing themselves in terms of quality, response, agility, and flexibility. In order to effectively adapt to the new environment, businesses are forced to adopt flatter organizational structures (e.g., more and smaller sub-companies) and heavily rely on collaboration and coordination. The modern business practices require distributive decision making and control. The behavioral traits of agents well fit the requirements and offer promising opportunities (Leitão *et al.* 2013).

Agents have been applied to enhance businesses at different levels within the hierarchies of firms, such as real-time production, operations management, and strategy management (Marik and McFarlane 2005). The real-time production involves assignment and execution of production tasks to work units. Problems on this level generally have narrow scopes and are relatively clear. Time and dependencies are often the focal constraints. Distributed production control becomes more preferable because businesses are required to have a robust production system in order to better deal with volatile demands, rapid environmental changes, and technology updates. Agents can be used to represent production units (e.g., a packaging robot), parts, or products. They could identify themselves and interact with each other to determine the best production process and plan. Successful applications include production planning, job dispensing and scheduling, and workshop management. An impressive achievement is holonic manufacturing systems. A holon is a self-contained autonomous entity that is able to handle its decision contingencies without the continuous instructions from the higher authorities. Different types of holonic methodologies have been developed and applied to build real-time production systems. There have been other applications of agents in production control as well (e.g., Leitão *et al.* 2013; Metzger and Polakow 2011; Shen *et al.* 2006).

The problems on the operations management level differ from those of real-time production level. First, time is still very important, but not so critical. Second, the scope and impacts of decisions are broader and more profound. Third, problems are by default distributed as coordination and collaboration of multiple functional units are common. Many researchers have been probing into the opportunities and effectiveness of using agents to enhance enterprise integration, coordination, and collaboration. For instance, agents have been used to create wrappers for legacy systems to improve the overall inter-operability of heterogeneous systems. They can also be used to automate business processes, facilitate information exchange, and then support decision making. They could make some decisions on behalf of users, such as automated request of quote screening and order processing.

Strategy management is at a higher level in an organizational hierarchy. Decision making on this level deals with more complex problems and has impacts on the long-term performance. The flatter and more distributed are organizational structures, the more challenging it becomes for firms to verify their strategic choices. When functional units have more autonomy, the achievable performance at the firm level is not so straightforward to predict. Agents can automate many processes and tasks involved in the organizational information flows. They can make businesses more agile to collect, process, and respond to data. In addition, agent-based simulation becomes a useful tool to support firms when making important decisions. For instance, the community studying complex adaptive systems has designed agent-based simulation tools and methodologies that can be used to model the complex issue involving multiple autonomous entities (Tesfatsion 2006).

Firms needs not only organize activities within their management hierarchies, but also deal with inter-organizational issues. Inter-organizational issues have at least two important features. First, the decision making is definitely distributed. Second, information is often private. Agents have been applied to enhance the inter-organizational collaborations. For instance, the agent applications for enterprise integration can be extended beyond the boundary of firms, resulting in a new concept of extended enterprise. Similar applications can also be extended to supply chains. Another influential example is the application of agents to help build virtual enterprise, which is a temporary close collaboration of multiple firms to achieve larger joint objectives. The recent growth and quick adoption of service oriented architecture give better chances for agents to enhance business in multiple ways (Ribeiro *et al.* 2008).

After-sale phase

The prior section pointed the possibilities in which agents can enhance business processes. Their applications are not restricted in facilitating information flow and decision making. If coupled with the techniques introduced in the information and settlement phase, businesses could build better connections with their customers. Below we discuss some examples.

The nature of the Internet as a hypermedia significantly shifts the communication between businesses and customers (Hoffman and Novak 1996). The Internet can support large scale many-to-many communications that are more dynamic and personalized than ever before. Thus, it will become not only a rich media but also a useful relational channel. One of the most recent thrusts in marketing is direct and interactive marketing, in which companies can apply more targeted, personalized, unobtrusive, and continuous interaction with individuals. The interactive approach views the customers as important stakeholders in a conversational fashion (Deighton, 1996). Managing and maintaining the interactivity with customers is costly. It is almost impossible to do it in the classical ways that involves intensive human resources when the number of customers is large. Once again, agents have behavioral traits that fits to the requirement. At the very least they are able to do simple tasks, such as sending personalized emails to existing customers, collecting and managing customer information from multiple sources, analyzing data that are relevant to each individual customers.

Recently, intelligent product as an innovative business approach has been proposed. The essential idea of intelligent product is that a product can identify itself and determine the path in its life cycle. For example, if a car is ordered, the car is able to obtain an identifier and invite relevant manufactures, suppliers, logistic providers, and even recycling companies into the process of its life cycle (McFarlane *et al.* 2013). Agents have been used to verify technical solutions that are able to support this innovative idea. Demonstrative systems have been developed. If a product can invite relevant businesses into its life cycle, it can also invite its consumer (or customers) as well. If end consumers are able to not only consume products, but also be involved in their life cycle, businesses need to change on many aspects. Consumers

will have stronger influence on the decision of how a product should be made and handled. Thus, they may be better satisfied.

Implications for businesses

The above examples demonstrate a broad scope of agent applications in e-commerce. A direct benefit of successful applications of agents is the possibility of reducing costs by enhancing information facilitation and integration. For instance, e-mails, search engines, and social computing applications all rely on agents. Buyers and sellers can send emails, search the internet, and exchange interests easily. When agents are applied to automated business processes, the related transaction cost can be reduced as well. They are able to replace some costly resources. For instance, businesses might be able to reduce human resources to take orders, review bids, or respond to quotes.

The examples also show that agents can assume different roles when participating in e-commerce. They were initially used to solve mostly technical issues. Nowadays, they have been increasing their influence to our social sphere, as illustrated in Figure 2. Although the adoption of agents in e-commerce is still limited, there is little doubt that the scale of their applications will increase in the future. This prediction can be made because of the increasing competition in market and diversified customer requirements. Modern e-commerce is under the pressure of emulation. If a business is able to respond to its customers and market and organize its production more quickly, what will its customers feel and what will the competitors do? The behavioral traits of agents and the demanding e-commerce environment will drive the adoption of agents in business practices. The potential impacts of agents is not limited solely to economic aspect, they may affect businesses in many other aspects. The benefits and challenges of these impacts present promising research opportunities.

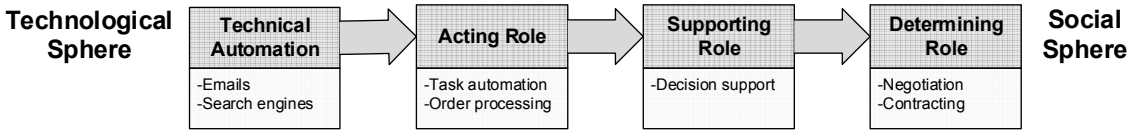

Figure 2: The Diffusion of Agents into Social Sphere

First, agent applications may change the relationships between businesses and customers. Agents help deliver more agile and personalized content. Their use can improve the interactivity between businesses and customers. The prior examples demonstrate that customized, personalized, and adaptive content can be more precisely delivered to the targeted customers. Meantime, customers may guide businesses by showing their interests. The interaction between buyers and sellers is boosted in that both sides will have stronger influence on each other.

Second, the applications of agents may change larger scale e-commerce environments. It is likely that the market will be organized according to the emerging and diversified interests, rather than products and services, when sharing interests becomes increasingly easier. The market can be further segmented into more and smaller niches sustained by the interests. Agents may also bias the market because of the interests they carry. Redmond (2002) compared two types (i.e., do-as-I-say and do-as-I-do) of shopping agents. It was shown that buyers and sellers may achieve different welfare if buyers use different types of shopping agents. Implemented welfare can be an important force that drives the market change in a long run.

Third, the application of agents may change business relationships. The complexity derives from both the roles of agents when participating in social affairs and their capabilities of representing social actors. For instance, contracting is traditionally conducted by humans, who fulfill social responsibilities and subject to social consequences as well. Agents themselves lack legal personality (Andrade *et al.* 2004). Moreover, agents are computing entities that do not have the natural capabilities of sympathy and empathy as humans. Humans are born with and develop these capabilities in their life-span of learning within social interaction. Therefore, it is controversial that artificial intelligence agency is appropriate and meaningful for humans. The application of agents may incubate e-bureaucracy, in which decisions are made according to computing rules.

Forth, the appropriate leverage of the strength of agents is challenging. Agents have advantages compared to humans. They have stronger computational capability as they can operate faster and handle more transactions simultaneously. Thus, they may have better chances to effectively optimize a deal under multiple constraints. They do not get distracted or tired. They can be programmed to be immune to some reasoning flaws to which humans may be susceptible (Greenwald *et al.* 2003). However, agents may cause some over-responsive effects in businesses. Automated trading systems have been blamed for causing some unnecessary loss of funds in financial market (e.g., Gibson 2007). Moreover, it is also questionable that artificial intelligence would be adequate to handle real business complexity. The intelligence of humans is ecologically developed. Apparently, agents and humans are situated in different environments and confront different issues. Miller (2008) showed that intelligent agents may not exceed zero intelligence agents when simple uncertainties are present. In contrast, the natural intelligence of humans is flexible and robust to resolve the same problem easily.

In addition to these potential impacts, large-scale adoption and deployment of agents in enterprise systems will help to build the future highly responsive and smart e-commerce systems. When agents are broadly deployed, they may be able to collectively behave as a super-agent. It is not necessary for each individual agent to have sophisticated intelligence component to achieve such an objective. This is in line with the idea of responsive system model of agents, which states that an agent can exhibit certain level intelligence when it has sufficient sensors and effectors so that it senses and responds quickly, although its decision making mechanism may be quite simple. The more agents participate in e-commerce, the more chances that artificial intelligence will have influence on businesses. Agent empowered with artificial intelligence can make future e-commerce system not only highly responsive, but also smart. In the new e-commerce system, the integration and balance between the human and artificial intelligence become strategically important. How to effectively leverage both human and artificial intelligence is a challenge.

Valuable insights into the issues of human-agent relationships are needed. In order to harness the benefits of agents, it is important that humans and agents are able to work in teams. Teamwork is very common among socialized humans. Teamwork helps members to achieve joint objectives that are impossible for each individual. Agents have been created for team tasks. They also show certain social abilities. If the relation between humans and agents can be appropriately built, human and agent teamwork may become an influential approach of bridging both natural and artificial intelligence in order to obtain better performance (Cohen and Levesque 1991; Sycara and Sukthankar 2006). Scientists who are interested in socially intelligent agents believe that the co-evolution of humans and agents is possible (e.g.,Edmonds 2002).

In order to inhibit the potential threats, agents need to be appropriately controlled. Agents are autonomous artifacts that may make decisions on behalf of users. However, agents alone cannot assume any social responsibility because they have no social liability. Social consequences made by agents will ultimately connect to social entities, such as human users and organizations. This is an issue become particularly important when agents take a determining role in social affairs. Norman (1994) provided a general discussion about the issue of how users and agents should interact with each other. He pointed out that users must have the feeling of control of agents before they finally accept and use them. The Lack of control of agents may cause unforeseeable damages to the existing social or commerce systems.

Conclusion

The current article identified types of agents, varying from simple to very sophisticated ones, which can play important roles in e-commerce operations. Examples show that agents have been increasingly assuming a role of determining social affairs. Agents have strong potential to change the ways of doing business. They also posit new challenges to management. The potential impacts of agent technologies in e-commerce could be considerable, as discussed in the paper. Given the opportunities and challenges, the IS community has so far under-investigated the place, role, and impacts of agents in modern and future business environments.

There may be many reasons that agents were not selected as an important research subject. One such reason is that we may think that agents are simple means of automation. The current review shows that the achievable effects are much beyond automation. Highly responsive and smart e-commerce systems

are desirable for businesses to be agile. Agents are believed to be the best candidate technology because of their generic behavioral traits. The current paper attempts to make a contribution to clarify some concepts, present a range of opportunities, and highlights some potential impacts. It calls for more substantial research on agents in e-commerce by the information systems scholars. Agents will have greater opportunities to shape the future businesses when other closely related technologies mature.

Based on the framework presented in the paper and illustrated in Figure 1, the following example research questions could be investigated. What is the effectiveness of employing agent technologies in identifying products and services that fit customer needs? How the contracting and negotiations conducted on behalf of human principals are aligned with the objectives and preferences of the latter? Which tangible and intangible benefits are brought about by agents involved in supply chain and operations management? Does responsive and proactive after-sales service rendered by agents improve customer satisfaction? These questions can be investigated using a variety of theoretical models from IS (e.g. task-technology fit model) and related disciplines. They could constitute a blueprint for an agenda of IS research in agent applications to e-commerce.

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