

Simulation for Business Engineering of Electronic Markets

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INTRODUCTION

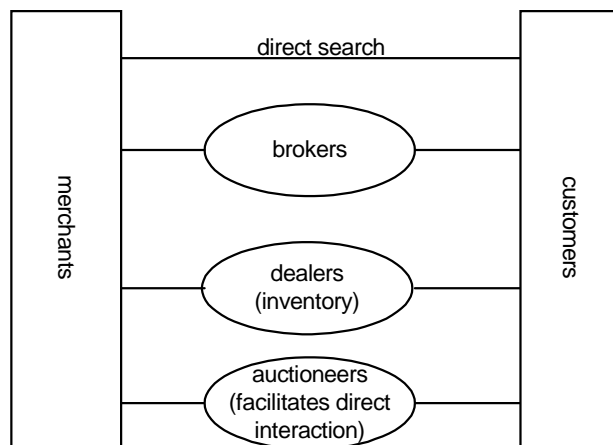
Information and communication technology (ICT) is applied to support the creation of electronic markets (e-markets). Electronic data interchange (EDI) is the exchange of structured data between information systems of different organizations. EDI is often considered as the first step towards e-markets. In the course of time EDI was extended and interorganizational information systems (IOS) were used to create electronic marketplaces. IOS serve as intermediaries between buyers and sellers. Probably the most well known examples of IOSs are airline reservation systems, which are closed systems having typically a limited number of participants.

With the advent of the Internet e-markets, targeting a global audience at low costs has emerged as a new way of doing business. An e-market system is an interorganizational information system that allows participating buyers and sellers to exchange information about prices and products (Bakos, 1991). Today's e-markets can be used for selling all kinds of products and even services and are typically built around publicly accessible networks, where entrance can be limited based on some kind of conditions. E-markets offer basic market functions and the current base is beginning to emphasize capabilities that aim to satisfy management information, risk management needs and enable integration of information systems (Dai & Kauffman, 2002). E-markets in business-to-business situations are witnessing an evolution

towards newer market structures (Tomak & Xia, 2002). It is still unclear what the exact effects of electronic market are, how they emerge, and which markets will eventually turn out to be the most successful in the industry (Fairchild et al., 2004).

The value propositions of e-markets often center on two key dimensions (Le, 2002). The first dimension deals with demand and/or supply aggregation to overcome market fragmentation (through search cost efficiency, price transparency and product-cost savings, market liquidity, network externalities and customer lock-in). The second dimension addresses inter-firm collaboration for greater supply chain performance (through streamlined workflows and process-cost savings, customer lock-on, and business process integration). Design decisions are critical, as they determine the market microstructure influencing liquidity, volatility and business propositions to stakeholders. The development and the introduction of e-markets requires the developer to carefully identify, evaluate, and understand the possible impact of the various design alternatives because they determine the market microstructures (Levecq & Weber, 2002). A business engineering methodology can be of help to design and develop e-markets by providing insight into current market and potential e-markets and by evaluating the implications of potential markets. Simulation can be used to compare the performance of the current and possible "to be" situations in a business engineering methodology. The *objective* of this article is to discuss research issues concerning the simulation of e-markets for business engineering.

Figure 1. Examples of market structures



BACKGROUND

E-markets can use a large variety of coordination mechanisms and market structures to coordinate demand and supply. A taxonomy of market structures based on how traders search out their counterparts is shown in Figure 1 (Garbade, 1982). In practice, all kinds of market structures and matching mechanisms can be used in accordance with traders' interest (Dai & Kauffman, 2002).

The core of e-markets is the *coordination* of the various interdependent activities performed by autonomous organizations during the information, agreement

and settlement phases (Lindemann & Schmid, 1999). There are two opposing views on coordination. In a *coordination of tasks* approach the design of processes is dependent on the coordination mechanisms that manage the dependencies between tasks (Malone & Crowston, 1994). The *coordination of commitments* approach emphasizes networks of commitments that organizations establish through intentional acts of speech (Winograd & Flores, 1987). This coordination approach emphasizes the fulfillment of human commitments and describes activities in terms of contracts and promises. The combination of these two coordination perspectives leads to the definition of an *e-market* as the coordination of interdependent activities performed by autonomous organizations by exchanging data between information systems of buying, selling and facilitating organizations, allowing them to agree on and fulfill commitments.

Requirements of traders on e-markets are not easily elicited and can demand innovative mechanisms or deliberate trade-offs. The timely sharing of information among traders is often a major issue (Christopher, 2002). Information sharing is necessary for efficient coordination of the processes of traders, whereas for example sellers want to avoid information being used to negotiate lower prices or shared with competitors. Another typical issue in the business engineering of e-markets is the selection of matching mechanisms, as buyers and sellers can have different and even opposing requirements. For example one trader might want to minimize trading time, while another might want to maximize the reliability of a chosen trading partner. The most conspicuous opposing requirement is that buyers want to have the lowest price at the best possible trading conditions while sellers want to have the highest possible price to maximize revenue.

In short, a large number of other trade-offs and decisions need to be made before an efficient and effective e-market can be established. A list of business engineering issues is shown in Table 1. Some limitations are coming from the state-of-the-art of the technology and from market and/or product characteristics; others are coming from the opposing requirements and needs of the parties involved. Simulation for business engineering of e-markets can help decision makers to gain insight into these issues. This should support them to make deliberate choices, without having to experiment in real life, which could be costly and even result in a loss of customers.

SIMULATION FOR BUSINESS ENGINEERING

E-markets are by nature complex and analytic methods that can only be applied in a limited way. Analytical

techniques analyze market mechanisms in a state of equilibrium and often focus on fair and efficient market mechanism (Mas-Colell, Whinston & Green, 1995). Although these approaches contribute to insight into and design of matching mechanisms, they do not help decision makers to evaluate the impact of e-markets for a practical situation. An e-market should be evaluated prior to implementation on criteria such as costs, utilization, trading time, delivery time, number of bids, matching chance, and so on. Analytical approaches do also not grasp the time-dependent dynamics resulting from the interplay between actors executing business processes.

Simulation of business processes constitutes one of the most widely used applications of operational research, as it allows us to understand the essence of business systems, to identify opportunities for change, and to evaluate the effect of proposed changes on key performance indicators (Law & Kelton, 1991). The philosophy behind a business engineering approach is to develop a simulation model of the current market, experiment with this model, and experiment with alternative market situations (Sol, 1982). An analysis of e-markets needs to begin with understanding of traditional market processes and should investigate how conventional transaction methods are changed as a result of e-market adoption (Lee & Clark, 1997).

Animation is often a standard feature of simulation. An animation model is a graphical representation of a problem situation and includes visualization of the time-ordered dynamics of objects, a static background, an overview of performance indicators and a user-interface (Vreede & Verbraeck, 1996). The purposes of animation are to facilitate decision makers to acquire insight into the dynamic interactions of the modeled system, the performance of the "as is" and "to be" situation and to facilitate communication between parties involved in a dynamic modeling study.

FUTURE TRENDS

Business engineering methodology provides context to the simulation technique (Greasley, 2003). Business engineering approaches proposed by Streng (1994) and Giagles, Paul and Doukidis (1999) tackled the identification of the added value of EDI by making use of discrete-event simulation. Nikolaidou and Anagnostopoulos (2003) use a simulation approach for modeling distributed systems. Janssen (2001) developed a business engineering methodology, including a simulation approach for electronic intermediaries. Business engineering using simulation should be based on the distinguished characteristics of e-markets and provide insight into current and potential

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