Automated Mechanism Design for B2B e-Commerce Models

W.K. Chong, E.M. Tadjouddine, M. Shafaghi and B.L. Tan

Abstract-**Business-to-business electronic marketplaces (B2B e-Marketplaces) have been in the limelight since 1999 with the commercialisation of the Internet and subsequent "dot.com" boom [1]. Literature is indicative of the growth of the B2B sectors in all industries, and B2B e-Marketplace is one of the sectors that have witnessed a rapid increase. Consequently, the importance of developing the B2B e-Commerce Model for improved value chain in B2B exchanges is extremely important for SMEs to expose to the world marketplace. There are three research objectives (ROs) in this study; first (RO1) to critical review the concepts of the B2B e-Marketplace including their technologies, operations, business relationships and functionalities; second (RO2) to design an automated mechanism of B2B e-Marketplace for Small to Medium Sized Enterprises (SMEs); and third (RO3) to propose a conceptual B2B e-Commerce model for SMEs. The proposed model is constructed by the analytical findings obtained from the contemporary B2B e-Marketplace literature.**

Index Terms-**B2B e-Commerce; B2B e-Marketplace; SMEs**

I. INTRODUCTION

B2B e-Marketplace, as one of the major trading platforms brought about by the Internet technologies has made a significant business contribution, especially to SMEs. The larger organisations are taking advantages from the vast array of suppliers/buyers via the B2B e-Marketplace [2]. However, SMEs who are keen to compete in the electronic environment remain concern as how their businesses can gain benefits from B2B e-Marketplace. With significant online and offline publications from both academia and industry [3, 4], there is a growing awareness of the contribution from B2B e-Marketplace in the global environment. Nonetheless, there is a lack of understanding of the issues associated with performance of B2B e-Marketplace. This study is intended to develop an interoperable B2B e-Commerce model for SMEs that wish to adopt a proactive approach in the use of Information and Communication Technology (ICT) for business efficiency and competitive advantage, and those

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who wish to explore the Internet technologies for business activities.

The paper has four main sections. First, we outline the motivation and main purpose of the proposed B2B e-Commerce model for SMEs. Second, we review the concepts of B2B e-Marketplace. Third, we describe the designed mechanism and the proposed model. Finally, key findings are presented and the implications for future research are discussed.

II. WHAT IS A B2B E-MARKETPLACE

B2B e-Marketplace has been in the limelight since 1999 with the commercialisation of the Internet and subsequent "dot.com" boom [1]. However, [5] first discussed this concept years before, recognising technology advances would allow multiple buyers and sellers to link via electronic communication networks. To provide an overview of works in the B2B e-Marketplace field and providing a model organising the B2B e-Marketplace literature, the research model covers the main idea, B2B business relationships, essential technologies of B2B e-Marketplaces, relationships with SMEs and their operation in Asia B2B markets (see Figure 1).
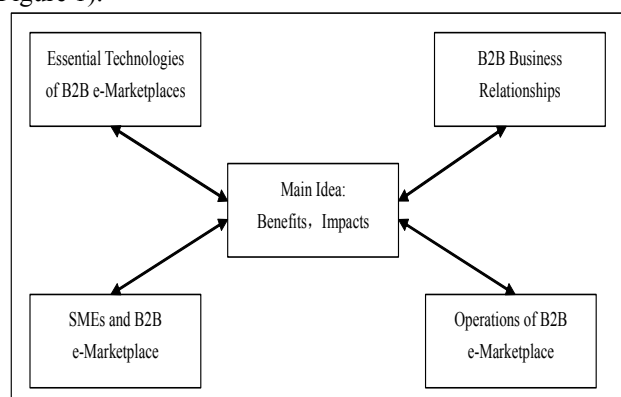

Figure 1: Conceptual Model of B2B e-Marketplaces

A. Main Idea

B2B transactions over public and private sectors uses the Internet as a delivery vehicle for transactions including; financial transfer, on-line exchanges, auctions, delivery of products and services [6]. Many practitioners are predicting B2B e-Marketplace to have a massive growth and majority of the organisations will have to give consideration to be involved with B2B e-Commerce. Referring to Figure 2, B2B consists of three main elements and the e-Marketplace performs the main tasks such as sourcing, automated purchasing, and processing to facilitate the sellers and buyers
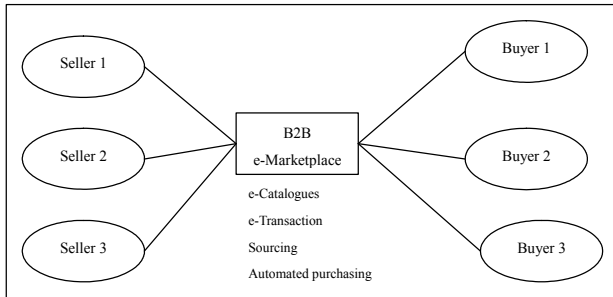
to do business transactions.

Figure 2: B2B e-Marketplaces Source adapted from [7]

[7] stated that B2B e-Marketplace refers to the exchange of information, products, services and payment via the Internet between buyers and sellers. B2B e-Marketplaces are typically defined as inter-organisational information system through which multiple buyers and sellers interact electronically to identify potential trading partners, select them and execute transactions [8]. [3] argued that, B2B e-Marketplace is able to remove some of the inefficiency of traditional business functionality and allow partners to streamline their marketing activities by sharing information instantaneously.

According to [9], B2B e-Marketplace builds value propositions based on three elements: (1) increased market efficiencies, (2) increased supply chain and; (3) new value creation. Increased market efficiencies occur as B2B e-Marketplace uses the speed and transparency of the Internet to intensify competition, bringing prices closer to theoretical equilibrium. Increased supply chain efficiencies occur as B2B e-Marketplace provides increased visibility across the supply chain, facilitating improved demand forecasting, inventory management, and production planning. New value creation occurs as B2B e-Marketplace promotes collaboration and allows increased information availability.

Many scholars and professionals are of the view that B2B e-Marketplace have improved and enhanced the extent of B2B e-Commerce activities; in particular in SMEs. A recent study [10] is indicative of the fact that SMEs have started to respond positively to the changes brought about by the Internet technologies. While the main concerns of SMEs are related to the generic SMEs characteristics of limited time/resources and expertise, B2B e-Marketplace provides a favorable environment for SMEs to lower operating and marketing cost, better opportunity to promote their products/services, enriching their overall marketing communications mix.

B. B2B Business Relationships

The development and use of B2B e-Commerce enabling technologies in e-Business environment have been in existence since the late 1970s. The main challenge for many companies today is to learn how to organise, manage, co-ordinate and advance daily business activities to find leverage points to improve the B2B e-Commerce performance. In addition, to provide value added to both sellers and buyers in B2B e-Marketplace, the notion of e-Commerce technologies including interactive web site, email, intranets, extranet can be envisaged.

The primary economic advantage of B2B e-Commerce is the increased in efficiency of non-value-added activities.

More specifically, B2B e-Commerce streamlines the procurement process adding efficiency to this aspect of the overall production process [11, 12]. B2B e-Commerce also lowers the cost of procurement before transaction by reducing the searching costs associated with procuring inputs and by increasing the ease of price setting [13, 14] and product comparison. Furthermore, B2B e-Commerce also reduces the cost of procurement during the transaction by reducing the level of interpersonal communication needed to facilitate the completion of the transaction. Finally, it can reduce the costs associated with monitoring contractual performance and confirming product or service delivery [14].

Today's business world is facing a plethora of managerial and technological changes which are beyond the capacity of any firm to control or absorb. Customer satisfaction, development of new products, and the introduction of new technologies are well-known driving forces, but their fast mutation and turmoil are making them unpredictable. Companies have to radically alter their business strategic to keep up with this volatile market. In this turbulent environment, B2B business relationship has evolved as the most promising approach for designing organisations. B2B business relationship is to exploit the 'wave' of available technologies to provide customers with instant access to all the products/services at any time and place. It is extremely important for companies to understand the driving forces to access to the digital business environment.

C. Essential Technologies of B2B e-Marketplace

Technological developments on B2B e-Commerce open up tremendous opportunities for the Internet economy [15]. The connectivity associated with the Internet has the potential to bring an industry's customers and suppliers a standard and economically perfect platform. For example, an organisation offering a range of products and services can now create an electronic catalogue on its website in order to achieve global reach. In addition, with the advent of Internet-enabled communications, it is now possible for an organisation to establish links with other organizations (B2B relationships) at significantly lower costs than with previous technologies.

Electronic Data Interchange (EDI), which is described by [16] as the electronic transmission of information or documents between computer systems in different organisations based on a standard, structured, and machine retrievable format. EDI has become an important tool for companies to transferring data between them by using internet or computer networking [3]. However, compared with B2B e-Marketplace, the technical capabilities of EDI only focus on technology and functional parameters, ignoring the important aspects: collaborative functions to overlook the importance of inter-firm relationships, and the ability to facilitate supply chain by integrating people, IS/IT, business processes, products/services. [17].

B2B e-Marketplace as a technological approach to market operations is an effective platform to improve the relationship between buyers and sellers and to bring about the benefits from closer and integrated relationships in the supply chain. B2B e-Marketplace technical solutions such as the Internet, Information technology/information system, and

Extensible Markup Language (XML) make it more efficient and effective for users to link to electronic marketplaces. The solutions with buy-side and sell-side application will allow for portability, flexibility (e.g., adding, removing or substituting components), sustainability and investment protection for SMEs. Referring to Figure 3, XML serves as the most natural evolution of Web technologies used for catalog hosting and management as well as transaction services such as auctions, logistics and payments [18].
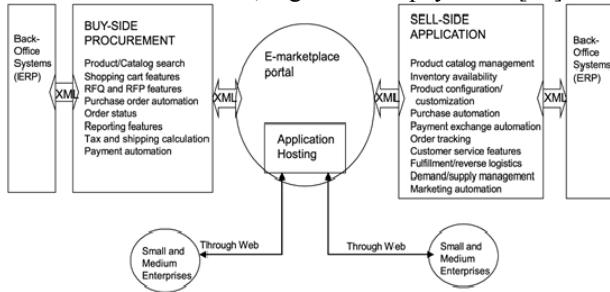

Figure 3: e-Marketplace Embedded Technology Source adapted from [18]

D. SMEs and B2B e-Marketplace

SMEs play an increasingly important role in many economies [19]. For instance in China, a total of 2,370,260 SMEs accounted 99.7 percent of the total companies operating in China by the year of 2007, and they contributed over 66 percent of total industrial income [19]. In Malaysia, only 600,000 SMEs are registered but their contribution to the manufacturing sector was 29.3 percent of their GDP or RM75.2 billion (US$22 billion) by the year of 2005 [20]. Thus, SMEs are now a main element to investigate the extent of usage in terms of the attitude and perception to the economy. Whilst it is important to recognise the proliferation of SMEs, it must also be recognised that they are different from large firms. Their unique characteristics do not always endow them with great influence in their markets but nonetheless it must be recognised that their size can often provide them with competitive advantage. According to [8], SMEs are much less rigid, sophisticated and complex than in large firms, they do not inhibit the creativity and flexibility which are necessary for continued success. Much of the literature which is concerned with SMEs definition is inextricably linked with the measurement of size, such as number of employees, sales turnover, profitability etc.

[21] reported that "SMEs have to keep pace with technological changes if they want to keep a competitive edge". With the large population in the business world, SMEs are eager to seek a new business model for the source of revenue. B2B e-Marketplace remains a popular online trading platform for SMEs [22, 23]. For instance, Alibaba.com has received much attention from the SMEs in Asia. To date, Alibaba.com has 531,471 paying members now, and accounted total revenue of RMB908.3 million (US$133.0 million) in the second quarter of 2009 (Alibaba.com, 2009). Alibaba.com now is becoming the priority destination for buyers and sellers especially SMEs to find trade opportunities, promote their businesses and conduct transactions online [22].

The literature on exploitation of B2B e-Marketplace services by SMEs is limited, SMEs remain concerned on how their products/services can expose to the world marketplace. Most of the B2B e-Marketplaces only provide information platform for buyers/sellers to exchange information on products/services via the Internet. They have no actual transaction through the web site [22]. Hence, there are more to explore for higher levels of online business activities and electronic-based add-on features, especially on providing a comprehensive guideline for SMEs to trade on the electronic environment. However, research in the area of B2B e-Marketplace is limited and there is no clear strategy or model to guide them for adaptation. The challenges for SMEs to identify and understand the factors to success in businesses in utilising B2B e-Marketplace remain sustaining to organisation's competitive advantages. Hence, there are concerns that limited efforts have been diverted to the promotion of B2B e-Marketplace. Although SMEs who use conventional marketing practices have increased their online presence, the majority of them are still not achieving even minimal levels of adoption [2].

E. Operations of B2B e-Marketplace

The development of B2B e-Commerce has been nothing short of explosive in recent years. The Internet economy is interrelated and interconnected because of well-established business ties between private/public sectors. According to the [24], by December 2009, the Internet user population reached 1.80 billion worldwide, an increase of 342.2 percent in the period from 2000 to 2009. B2B e-Marketplace also would become the priority destination for buyers and sellers especially SMEs to find trade opportunities, promote their businesses and conduct transactions online.

Over the last decade an increasing number of companies have adopted B2B e-Marketplaces that have bolstered their presence in the global marketplace. This development has received a great deal of press coverage and academicians are demonstrating greater interest in B2B interactions. Despite such coverage, little attention seems to have been paid to B2B developments in SMEs that have positioned them for an even greater success in the years to come.

However, the success of such e-Marketplace systems will depend mainly on the ability to address issues related to the rules of engagement used in such systems, and to develop, maintain, and augment interoperable components. These pose real challenges to the computer science community as well as the business community and need be tackled so that we can advance our understanding about this very important area.

III. AUTOMATED MECHANISM DESIGN

Generally speaking, a B2B e-Commerce model is a setting wherein SMEs interact to buy or sell services online. These interactions may lead to cooperation or competition between SMEs. For example two buyers may compete for the same service or two sellers may cooperate to provide a single framework for related services. An auction is a typical example of a B2B e-Marketplace. In this kind of settings, it becomes vital to clearly define the objectives and constraints of the B2B e-marketplace and equip it with a set of rules that govern the interactions between the participants. This is

known as *mechanism design* as developed in algorithmic game theory, see for example [25].

A mechanism is simply a set of rules designed to induce a certain outcome. For the case of auctions, rules determine how items on sale will be allocated and how much one should pay [25, 26]. A prominent example of automated mechanism is the Google's auction for TV Ads [27]. Google allows for advertisers to buy TV Ads that run over hundreds of TV channels in a convenient way online. This is convenient because it offers:

1) Flexibility for an increased transparency and just-in-time services against a biased manual negotiation.
2) Automation since TV Ad requests, pricing, and allocation are entirely carried out online via a web-like interface.
3) Control for measuring the impact of Ads in terms of number of viewers that may feedback to the pricing model as well as the allocation.

In the general B2B e-Marketplace scenario, SMEs may be engaged in financial transactions in which market rules may be chosen to suit the features of the participants. This process of tailoring mechanisms given the features of the participating SMEs leads us to the idea of *automated* mechanism design. It is not obvious to provide a mechanism that induces certain behaviour of the participants in such a scenario. For example, how do we prevent participating SMEs from colluding bearing in mind it is even difficult to detect collusion between participants? In Google's auction for TV Ads [27], participants are broadcasters and Cable companies who are the owners of ad-slots, which are time-slots for various channels. These time-slots are sold via Google's TV Ads auction. Buyers are specialized companies in TV publishing; they bid for the ad-slots on sale and the mechanism determines the pricing and allocation of TV Ads automatically. This example illustrates well the idea behind the automated e-market mechanism design.

Designing B2B e-Marketplace mechanisms poses a certain number of challenges: a mechanism needs to provide incentives for SMEs to

1) participate or enter the market,
2) share information without compromising privacy,
3) buy or sell services fairly and securely.

Such incentives can be provided if the underlying mechanism is based on rules that satisfy some basic security and economic properties that encourage participation of SMEs but discourage collusive and predatory behaviours. Collusion is a concern as participants may collude to keep services' values low. A predatory behaviour can prevent buyers from entering the market; the B2B e-Marketplace risks then to be unprofitable for the seller. Reliability and secure transactions increase trust in the B2B e-Marketplace as participants will never be pleased if goods were not delivered or private account details end up in the public domain.

The task is even greater for Automated Mechanism Design, which aims to provide tailored *computationally efficient* mechanisms given the objectives and constraints of a B2B e-Marketplace scenario. By computationally efficient

mechanism, we mean a mechanism that has those basic security and economic properties that can be easily verified. This can be possible only if rules can be specified in a machine-readable formalism and be easily checkable for some desirable properties. Examples of such verifications can be found in [28, 29, 30, 31] but this is beyond the scope of this paper. We rather focus on the design issue to further explore the contents of mechanism rules. Pursuing the idea of providing incentives, a mechanism can

1) punish deviations or collusion with higher penalties,
2) reward truth-telling or cooperation,
3) allow for competition to take place,
4) ensure privacy and security regarding information or transactions.

In non-cooperative settings, one may be interested in game-theoretic properties that harness the ideal of truthful bidding agents or optimal revenue for the seller. If the objective is to encourage cooperation, then we must ensure information is shared among participants so as to favour coalition formation. Punishing deviations can enforce a desired outcome, see for example [32]. Software-wise, the mechanism must be able to deal with heterogeneous components from different owners and may be written in different languages. In these settings, we are faced with the interoperability problem. By interoperability, we mean the ability for two or more users, devices, or components to communicate, use information or exchange it. This issue must be addressed in order to fully implement a working e-market mechanism.

IV. THE PROPOSED B2B MODEL FOR INTEROPERABILITY

SMEs will need a standard way along with detailed conformance test specifications in order to carry out these online interactions relying on automated mechanisms. In here, comes the notion of interoperability, which is needed in order to allow for machine-understandable mechanisms. Currently, protocols used in e-Commerce systems can be understood only by human experts since they are typically described in technical documents using a diverse combination of natural language, and pseudo-code descriptions of algorithms. We aim to allow for software components to understand specifications used in a trading paradigm. This is because SMEs will need to be able to move between different e-marketplaces where different mechanisms may be in use. Enabling software components to understand the specifications of foreign e-market systems is a problem that has not yet been solved. It has been noted that "the ability for agents to effectively understand and communicate in an arbitrary institution is a major challenge facing computer scientists" [33].

Machine-readable specifications in this form would allow a SME to move to a new trading house and make sense of the specification describing the protocol in use there. This will make any participant aware of what it is allowed to do. Furthermore, it will allow the actions of all participants to be analyzed at run-time in order to test for compliance with the specified rules. Furthermore, participants can be equipped with some sort of proof procedures so that they can check

what properties hold for the mechanism in use. This level of understanding is necessary to enable participants to verify that mechanisms do indeed have the properties they claim to have and to determine the optimal strategy for participation.

This kind of open standards with conformance test specifications will also allow for portability, flexibility (e.g., adding, removing or substituting components), sustainability and investment protection for SMEs. There is by now a large body of literature on software standardization, e.g., UML, Model driven architecture, or black-box testing. Our approach to interoperability is informed by the need to make use of existing devices, components or legacy software. Consequently, we aim to develop an XML-based intermediate representation to which any existing component may be translated so as to allow for communication between newly created and old components. At the same time, we need to integrate best practices used in current open standardization techniques. This means, we focus on common patterns and allow the user to extend the kernel with extra functionalities for the application at hand. In order to implement this approach, we need to address a certain number of challenges among them the issues related to the evolving aspects of technologies, the complexity of dealing with such heterogeneous systems and the necessity of a continuous dialogue between those involved in standardization, technology and in manufacture.

V. Conclusions And Future Work

To fully exploit the potential of e-commerce and to eventually achieve the vision of machine-understandable e-Commerce systems, we need to address the issues of automated mechanism design, interoperability, and verification. In summary, the motivation for this work comes from the belief that tailoring mechanisms given characteristics of participating SMEs, allowing for interoperability, and verifying desirable properties of a trading platform are useful in open e-Commerce environments only if:

1) Their protocols are interoperable in the sense that they can be published in a machine-readable formalism.
2) The properties of their protocols can be automatically verified by a participating SME.

Future work includes that of providing a suitable specification language along with detailed compliance test specifications in which existing components can be translated to and in which mechanisms can be expressed as well as associated proof procedures. We will pay particular attention on designing mechanisms in line with current e-Marketplace trends as shown by data collected on sites such as alibaba.com or Google's auction for TV Ads. Then, we will consider economic properties (e.g., maximizing seller's revenue, incentive compatibility for the buyer, openness for participation, etc.) and security properties (e.g., fictitious buyer, secure payment system), which are desirable by our trading platform and then evaluate the performance of the system.

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