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SCIENCE DIRECT®
Information & Management 42 (2004) 89–102
INFORMATION & MANAGEMENT
www.elsevier.com/locate/dsw

Adopters and non-adopters of business-to-business electronic commerce in Singapore

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Received 3 December 2002; received in revised form 30 June 2003; accepted 20 December 2003

Available online 11 March 2004

Abstract

Although there has been an increase in research studies of business-to-business (B2B) electronic commence (e-commerce), most studies were carried out in the United States or Europe. There are very limited studies on B2B e-commerce in the Asian context. Our effort examined Web-based B2B e-commerce initiatives in Singapore, an island of 650 km^2 in South–East Asia. Data were collected from 108 firms using a mail survey, which showed that 52.8% firms have adopted B2B e-commerce; of these, two-third had a formal plan and/or task force for B2B e-commerce deployment. Customer-related applications were generally more common than supplier-related applications. Problems in B2B e-commerce adoption included the difficulty of measuring benefits, fear of granting suppliers and customers access to corporate systems and insufficient time for staff to develop new skills in e-commerce. Implications of the results are discussed.

Keywords: B2B; Business-to-business e-commerce; Singapore; E-business; Electronic commerce

1. Introduction

The term ''e-commerce'' emerged only a few years ago when businesses started to realize the role of the Internet as a powerful medium for conducting business. Researchers believe that e-commerce on the Internet goes beyond simply buying and selling electronically as it involves a wide variety of pre- and post-sales activities, such as advertising, maintaining business relationships, and enhancing business communication [25,43]. At the core of e-commerce, however, is the use of electronic means to expedite commercial transactions and improve efficiencies in business processes within and across organizations [11]. Based on the parties involved in the business transaction, e-commerce can be divided into:

1. business-to-customer (B2C): the sale of products and services to individuals; and
2. business-to-business (B2B): the buying and selling of products and services among businesses.

In this paper, we focus on B2B e-commerce, which has become an increasingly important topic for both researchers and practitioners. Despite the failure of hundreds of B2B exchanges since the dot-com crash in early 2000, businesses are plunging ahead with B2B

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0378-7206/$ – see front matter
doi:10.1016/j.im.2003.12.005

e-commerce [6]. In fact, eMarketer predicted that global B2B e-commerce will reach US$ 2.77 trillion by 2004 [22].

This paper is an exploratory, descriptive study that attempts to understand the current trends and business practices in B2B e-commerce in Singapore. There are at least three distinct motivations underlying our study. First, while there were numerous market research reports and anecdotal case studies on B2B e-commerce [7], there was very limited knowledge on the managerial mechanisms and business practices that firms were using to conduct B2B e-commerce. Second, there were very limited studies on B2B e-commerce that have been conducted in the Asia-Pacific region. Third, our goal was to examine, report, and contribute to the B2B e-commerce practices in Singapore organizations; those adopting B2B e-commerce was increasing and we wanted to document their experiences to provide guidelines to others in their B2B initiatives.

Here, we define *B2B e-commerce* as the use of the Internet and Web-technologies for conducting inter-organizational business transactions. Our focus was on initiatives of traditional brick-and-mortar firms and we sought to understand how they apply Web technologies for conducting inter-organizational business transactions. We did not explicitly focus on independent e-marketplaces or exchanges operated by pure dot-com players. Therefore, our study focused on initiatives by traditional firms in Singapore rather than pure ''Internet'' dot-com players. Singapore was an ideal location to examine this, as its technology infrastructure was well developed [41] and ideal for B2B e-commerce adoption. Singapore also has one of the highest Internet penetration rate in the world, since more than half the population is ''Internet savvy.'' Further, the Singapore government had been very active in promoting the adoption of e-commerce among government agencies and businesses.

2. Method

2.1. Instrument

Data were collected using a questionnaire-based survey. The survey was prepared using items and questions found in prior literature. It was pretested with six academic experts and iterative refinements were made. Subsequently, the survey was pretested with eight senior IT managers and consultants who had considerable experience in e-commerce. They were asked to comment on the survey and provide suggestions. Interviews were then carried out to gather their opinions on various issues and problems that firms face in adopting and conducting B2B e-commerce. The list of items was expanded, refined, and iteratively validated based on this feedback. Specifically, we captured the following information in our survey by developing and adapting scales from previous research:

1. extent of B2B adoption;
2. demographic profile;
3. presence of champion for e-commerce efforts;
4. formal plan and task force for e-commerce;
5. years of e-commerce experience;
6. customer- and supplier-related B2B e-commerce activities;
7. expected and realized benefits from B2B e-commerce;
8. management support for B2B e-commerce efforts;
9. risk orientation and cost–benefit perceptions; and
10. problems in deploying B2B e-commerce.

2.2. Data collection

A field survey method was adopted. The sample was derived from the Corporate 1000 directory, which lists the top 1000 companies in Singapore. A total of 600 organizations were randomly selected and survey questionnaires were sent soliciting their participation. Two follow-up mailings were carried out to increase the response rate. Eighteen firms declined participation, citing reasons such as: a policy not to respond to surveys, firm undergoing restructuring, etc. Seven questionnaires were eliminated due to missing responses. A total of 108 usable responses were obtained, giving an overall response rate of 18.8%.

3. Results

Out of 108 valid responses, 45 firms (41.7%) are currently using B2B e-commerce applications while 12 (11.1%) were then in the process of implementing one or more B2B applications (Table 1). Twelve firms (11.1%) indicated no intention, while 39 (36.1%)

Table 1
Extent of B2B e-commerce adoption

Status of B2B e-commerce	Number	(%)
No consideration of any B2B applications	12	11.1
Some discussion on B2B e-commerce applications, but no further action	12	11.1
Some consideration but no decision yet	27	25.0
Decision to have B2B e-commerce applications made, but implementation is in progress	12	11.1
We currently use one or more B2B e-commerce applications	45	41.7

reported some consideration but either took no action or had not yet made a decision.

For further analysis, we grouped the first three categories in Table 1 as non-adopters and the remainder as adopters (i.e., firms who were currently implementing or using e-commerce applications). This classification is consistent with prior studies. Based on this grouping, we had 57 (52.8%) adopters and 51 (47.2%) non-adopters. This indicated a moderate level of awareness about B2B e-commerce among Singapore firms.

The demographic profile of our respondents and their organizations is shown in Table 2. Chi-square

Table 2
Demographic profile

Demographic profile	Adopters	Non-adopters	Chi-square
Job title of respondents			
CEO/managing director/general manager	8	4	Chi-square = 2.08, d.f. = 3, $P = 0.55$
CIO/IT/e-commerce manager	41	31	
Other managers	4	6	
Others	4	5	
Industry			
Manufacturing	15	22	Chi-square = 3.38, d.f. = 1, $P = 0.07$
Services	42	29	
Organization type			
Multi-national	25	23	Chi-square = 8.79, d.f. = 3, $P = 0.03$
Government-owned	14	3	
Locally-owned	13	18	
Local with foreign ownership (joint venture)	3	6	
Annual revenue (S$ million)			
<1	2	1	Chi-square = 5.85, d.f. = 4, $P = 0.21$
1.1–5	3	3	
5.1–10	2	5	
10.1–50	3	7	
>50	40	25	
Annual IT investment (S$ million)			
<0.1	7	23	Chi-square = 27.01, d.f. = 4, $P = 0.00$
0.11–0.5	11	17	
0.51–1	5	4	
1.1–5	19	4	
>5	10	1	
Presence of champion			
Yes	31	9	Chi-square = 18.14, d.f. = 1, $P = 0.00$
No	20	39	

Note: 1 S$ = US$ 0.57 approximately

tests were carried out to determine whether there were any significant differences among adopters and non-adopters of Web-based B2B e-commerce in terms of various organizational variables such as industry type, organization type and firm size.

3.1. Hierarchical level of respondents

More than 90% of the respondents hold management positions. There was no significant relationship between respondents' hierarchical level and B2B e-commerce adoption. The high hierarchical levels of respondents provided some assurance on the validity of responses, since the respondents in senior management levels could generally be expected to be more knowledgeable about their firms' e-commerce activities than those from lower levels.

3.2. Industry and organization type

The results also show that there was no significant difference between the adopter and non-adopter groups in terms of industry type at a 5% level of significance. One reason is that, regardless of industry sector, B2B e-commerce has proliferated throughout the economy as firms have sought new ways to rationalize their operations and compete effectively. A closer examination indicates that most B2B adopters are from service sector. This is consistent with the IDA [21] report that B2B sales revenue tends to be concentrated on services rather than the manufacturing sector.

In terms of organization type, we asked our respondents to indicate if their organizations were multinationals, government-owned, or locally-owned with local or foreign ownerships. We examined if there were any significant differences in the adoption behavior among these four types of firms using chi-square tests. As can be seen, there were significant differences among the organizations based on their type. Interestingly, government-owned firms comprised a higher percentage of adopters than other firms. This was not surprising, since the Singapore government has consistently taken the lead in technology adoption [37]. In fact, the *E-commerce Hotbed Program* was introduced in 1996 to develop the e-commerce legal and technical infrastructure, and e-commerce services in Singapore. In 1998, the *Electronic Commerce Master Plan* was launched to mark the start of a campaign to bring e-commerce to mainstream businesses and the public and to attract international e-commerce activities to Singapore [13].

3.3. Annual revenue and annual IT investment

Firm size was measured in terms of annual revenue and annual IT investment. Previous research had generally found that larger firms tended to adopt new technologies more rapidly than smaller firms [38]. A common explanation (the Schumpeter hypothesis) is that larger firms have more resources and may have a greater need to stay at the forefront of technology.

The results also showed that there is no significant difference between adopters and non-adopters in terms of their annual revenues. However, there is significant difference in their average annual IT investments. This was an interesting result as it implied that annual IT investment has a stronger association with adoption of B2B e-commerce than annual revenue. Hence, although larger firms are more likely to adopt e-commerce, it is not size alone (in terms of annual revenue) but the level of annual IT investment that determines whether a firm adopted it.

3.4. Presence of champion

Previous research consistently found that the presence of a champion facilitated the adoption of a new technology [2] by providing the necessary drive and effort to initiate their adoption. In our sample, among adopters, 60.8% firms indicated the presence of such an individual. In contrast, among non-adopters, only 18.8% firms indicated the presence of a champion. As expected, chi-square test confirmed that adopters are more likely to have a B2B champion than non-adopters. This indicated that a champion is often necessary as indicated by the following quote from one respondent:

> Our B2B initiative was suggested by a Senior VP who became the champion for the project. The Senior VP has been with the company for a long time and was well respected. As a champion, he was able to see the big picture and has the clout to get various departments to cooperate on the B2B initiative. (Director, e-Business)

Our analysis further revealed that the job designation of the champion tended to be from the business (68%) rather than the IT group (32%). This result is insightful as it indicates that e-commerce applications have assumed greater importance in firms and tend to be driven by business needs. Such findings are consistent with Rifkin and Kurtzman [34] who noted that "a few enlightened corporations have made the Internet work for them by assigning e-business efforts to senior-level executives who know the business side intimately–and by placing technology-focused CIOs in the role of partner." Recent practitioner thoughts also seem to complement our findings on the position of e-commerce champions. "The real action driving e-commerce was on the marketing side and the business side. . . . Future leadership in e-commerce depends on who is the best available 'athlete,' and power arrangements and politics in a company. Whoever emerges as the next e-commerce champion will be an executive steeped in his company's customer needs" [39].

3.5. Formal plan and task force for e-commerce

Adopting e-commerce is a strategic business decision and not just a technology decision [16]. As such, it is important to have a formal plan and task force to provide direction and focus. In addition, the presence of a task force can enable the firm to respond to new developments and opportunities, minimize duplicated efforts by different business units, minimize incompatible systems and wasted resources, and establish priorities for the effort [17].

Hence, we asked adopters whether they had a formal plan and a task force dedicated to deploying e-commerce. The results showed that 54.4% of adopters had both. Another 12.3% of adopters had either a formal plan or task force. This is quite encouraging, as it showed that firms were increasingly viewing the Internet and e-commerce as important to the firms' activities and strategies. One of the interviewees during our pilot tests said:

> During the late 1990s, the CEO set-up an e-commerce team to explore opportunities brought about by the Internet. This team was headed by a senior staff and comprised other staff from both the IS and business units. The team was tasked with proposing a formal plan for how the firm could leverage on the Internet to lower costs, increase revenue and enhance customer service. (Manager, E-commerce Unit)

However, some of our interviewees also indicated that they had not drawn up a long-term e-commerce plan, as they wanted to be flexible to changes in the technological environment. As an executive pointed out:

> There cannot be a concrete three to five year plan for B2B e-commerce [now] as there are lots of changes going on. The technologies are still evolving, new standards are coming up and the way we use these technologies is also changing fast. So it is better to have a flexible approach.

3.6. Years of e-commerce experience

About three-quarters of the adopters were relatively new to e-commerce implementation, having done so only 3 years previously or even less. The remaining one-quarter had had more than 3 years experience. This is perhaps not surprising since e-commerce is still relatively new and firms tended to adopt a "wait-and-see" attitude before adopting new technologies. The distribution of the number of years of e-commerce experience is shown in Fig. 1.

3.7. Areas of B2B e-commerce application: customer and supplier-related activities

B2B e-commerce includes applications that focus on providing better services to customers and/or streamlining supply chain activities. Among firms who had adopted e-commerce, 19.3% did not indicate the type of e-commerce application used while 31.6% had both customer- and supplier-related applications.

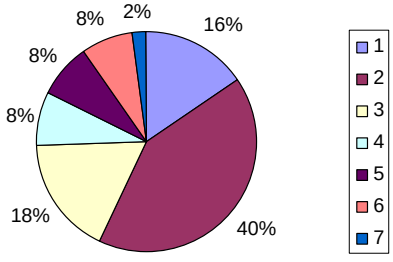

Fig. 1. Number of years of e-commerce experience.

36.8% firms had only customer-related applications while 12.3% firms had only supplier-related applications. Hence, customer-related applications were more common. This is perhaps to be expected, as many firms are aware of the importance of improving their services to business customers in order to enhance customer satisfaction and delight. Further, the demographic profile indicated that a higher proportion of services firms were adopters than were manufacturing firms.

Previous research has commonly identified various activities associated with B2B e-commerce [1,23], rather than empirically examining their extent of usage or implementation. A few other researchers have focussed on specific activities, such as electronic procurement or logistics [14,15]. To get an idea of the different functional areas where organizations were deploying inter-organizational B2B applications, we asked adopters to indicate the extent of customer-related and supplier-related activities on a seven-point Likert scale from (1) none to (7) large extent. The results are shown in Table 3.

In terms of customer-related activities, adopters used the Web mainly for accepting and processing orders (mean = 3.98), pre-sale activities (mean = 3.27), and product/service delivery (mean = 3.25).

Table 3
Use of B2B e-commerce for customer- and supplier-related activities

B2B E-commerce activities	Mean (S.D.)
Customer-related activities	
Accept and process customer orders	3.98 (2.12)
Pre-sales activities/services	3.27 (1.98)
Product/service delivery via the Web	3.25 (2.02)
Post-sale service (e.g., complaints, support, etc.)	2.92 (1.98)
Distribution activities (supply chain coordination, etc.)	2.90 (1.92)
Gathering customer data and analysis	2.73 (1.76)
Accept and process customer payments	2.58 (1.93)
Supplier-related activities	
Purchase order processing	3.42 (2.08)
Procurement from suppliers (distribution, warehouse, shipping, logistics, etc.)	2.94 (2.01)
Supplier selection (getting quotes, bids, etc.)	2.70 (1.83)
Invoicing and payment processing	2.69 (1.82)
Demand management (procurement analysis)	2.35 (1.75)

Scale: (1) none; and (7) large extent

This was expected, since the Web provided opportunities for firms to reduce cost (e.g., less sales personnel), reach out to customers (due to the global nature of the Internet), and provide new and better services (e.g., providing information to frequently asked questions). In contrast, accepting and processing payments via the Web (mean = 2.58) was used to a lesser extent. One plausible reason is that payment, especially for B2B, could be made later or via bank transfer. Further, for business transactions, there was usually a credit period before payment was due, so immediate payment via the Web may neither be necessary nor required.

For supplier-related activities, adopters mainly use the Web for purchase order processing (mean = 3.42). One plausible reason is that the use of the Web helps to reduce paperwork and reduce the time taken for such processing. In addition, adopters use the Internet for procurement activities (mean = 2.94). This was unexpected, since many firms have reported significant savings from Internet procurement [12]. One reason is that firms in Singapore were still exploring the use of the Internet for procurement; another could be suppliers' resistance to Internet procurement and B2B initiatives due to fear that their margins may be reduced significantly. One of e-commerce managers interviewed provided suppliers' perspective on B2B initiatives:

> Suppliers see B2B as largely buyer-oriented as most of these have been created for and by the buyers. Why would suppliers support B2B applications that will help only the buyers and also reduce their own profits? Moreover, the difficulties and costs of getting into B2B is another important factor that worries suppliers. Creating and maintaining online catalogs is not very easy. Also, when suppliers are faced with multiple buyers or multiple e-markets, it is very difficult for them to get involved in multiple initiatives as each client [buyer] or market may have different catalog and integration requirements. ... It will be many years before suppliers start regularly participating in B2B.

3.8. Benefits from B2B E-commerce

The emergence of Internet and Web technologies has provided opportunities for firms to streamline their B2B activities by extending market reach, providing

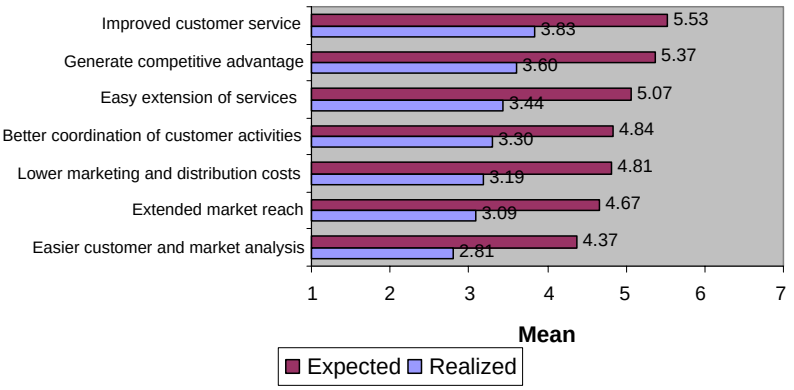

Fig. 2. Customer-related benefits.

new services, improving customer service and enhancing competitive advantage. Although B2B e-commerce adoption can result in both customer and supplier-related benefits, relatively little is known about the extent of expected and realized benefits. Hence, we asked adopters to assess their expected and realized benefits from their B2B e-commerce applications on a seven-point Likert scale ranging from (1) low to (7) high. Matched-pair *t*-test indicated that for all items, expected benefits were significantly greater than realized benefits (at $P = 0.05$). This may be expected, since most e-commerce applications are relatively new and benefits may take several years to be realized. The results are shown in Figs. 2 and 3.

The key expected and realized customer-related benefits from B2B e-commerce were improved customer service (mean = 5.53, 3.84), competitive advantage (mean = 5.37, 3.60), and easy extension of services (mean = 5.07, 3.44). It was reassuring that the top three realized benefits were similar to the top three expected benefits.

In contrast, the situation for supplier-related benefits was slightly different. The top three expected benefits were reduced operation costs (mean = 5.36), reduced cycle time (mean = 5.26), and better inventory control (mean = 5.13); while the top three realized benefits were reduced cycle time (mean = 3.50), reduced operation costs (mean = 3.38), and competitive advantage (mean = 3.27). This indicated that, while B2B e-commerce applications may help to reduce operation cost and cycle time, benefits of better inventory control may be more difficult to realize. One reason may have been that inventory control was often dependent on close linkages with suppliers as well as

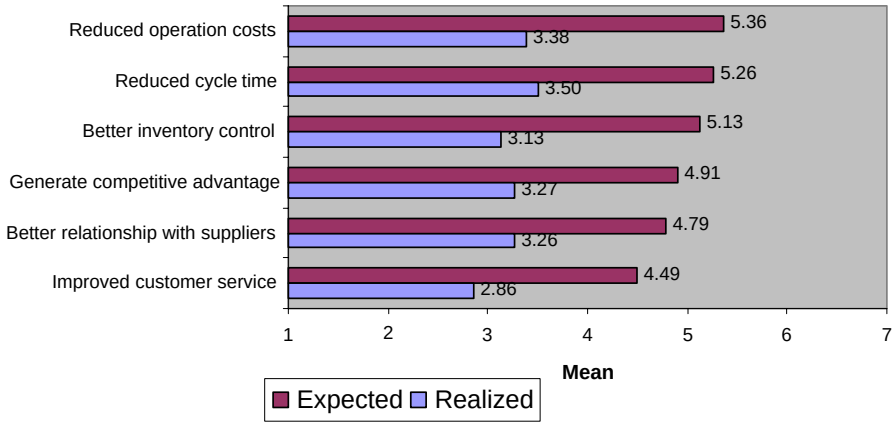

Fig. 3. Supplier-related benefits.

responsiveness of the firm and suppliers to variations in demand.

3.9. Management support

Top management support and commitment has often been found to be crucial in any development and implementation process; e.g., total quality management [3], statistical process control [20], CASE tools [30], expert systems [19], and data warehouse [36]. Studies on e-commerce have also identified top management support to be critical in e-commerce adoption and deployment [8]. Apart from top management, e-commerce initiatives also needed the support of different functional executives, as e-commerce efforts are inter-functional by their very nature. In our study, respondents were asked to indicate their extent of agreement, on a seven-point Likert scale ranging from (1) not at all to (7) greatly, to items pertaining to management support for e-commerce efforts. The results are shown in Table 4.

Adopters had significantly higher level of support from top management and functional managers than non-adopters. The relatively low level of top management support among non-adopters could be due to failure to brief and convince top management about the potential and impact of e-commerce, the resources involved, and the importance that e-commerce has on the bottom-line performance of the firm. The crash of several dot-coms and B2B exchanges could have also raised doubts about the viability of B2B e-commerce in the minds of senior managers. If this is so, then an essential task is to ensure that top management understands the scope and nature of the e-commerce effort and how it is important for the long-term viability of the firm. This comment was strengthened by an IT manager whom we interviewed:

> It is very important to have buy-in at the very top of the company. This sounds like a cliché, but it really does matter. If top management has no idea of new technology, it should trust the CIO, who must have credibility. The CIO should use this credibility to convince the top management.

As B2B e-commerce often affects different functional areas such as purchasing, distribution, logistics, marketing and production, it is also important to obtain support from functional managers in carrying out e-commerce efforts. Without such support, management of change of business processes would be difficult. As one of our interviewees pointed out:

> Lack of ownership from the user departments is a major issue. You implement these new Internet systems for the users in an organization; they are integral to its implementation and have to be involved in it. Things become very difficult if these users refuse to be involved; then the project is doomed to fail. So, you have to identify the right users, and get them involved in the project right from its beginning. (Manager, Information Services)

Table 4
Management support for e-commerce

Support for e-commerce	Adopters mean (S.D.)	Non-adopters mean (S.D.)	T
Top management			
Top management's interest in B2B e-commerce.	5.61 (1.14)	4.04 (1.51)	6.02*
Importance attached by top management to B2B e-commerce.	5.61 (1.12)	3.84 (1.46)	6.95*
Top management's commitment and support for B2B e-commerce.	5.57 (1.16)	3.78 (1.58)	6.62*
Top management's recognition of the potential of B2B e-commerce for future success of the firm.	5.51 (1.15)	4.08 (1.45)	5.63*
Functional managers			
Functional managers' recognition of the potential of B2B e-commerce for the future success of firm.	5.09 (1.17)	3.82 (1.16)	5.58*
Functional managers' appreciation of the potential of B2B e-commerce in improving business processes	5.05 (1.19)	3.84 (1.27)	5.06*

Scale: (1) not at all; and (7) greatly.
* $P < 0.05$

Another executive suggested that an essential solution to user resistance is to form multidisciplinary teams:

> By forming a multi-disciplinary team for the e-commerce effort, we were able to streamline the implementation effort as well as reduce resistance to change. (Chief Information Officer)

3.10. Risk orientation and cost–benefit perception

IS Researchers have consistently identified risk orientation and cost–benefit perception as important variables in the introduction and adoption of new information technologies, especially inter-organizational systems. For example, Grover [18] indicated risk taking propensity to be a key variable affecting the deployment of inter-organizational systems. Premkumar et al. [32] studied electronic data interchange (EDI) and suggested cost–benefit perceptions to be a significant issue affecting its adoption and implementation in organizations. Since inter-organizational systems and EDI are historical precursors to B2B e-commerce, it was pertinent to examine the risk orientation and cost–benefit perceptions in the context of B2B e-commerce applications. Hence, we compared adopters and non-adopters in terms of their risk orientation and cost–benefit perceptions of e-commerce investments. A seven-point Likert scale ranging from (1) very low to (7) very high was used. The results are shown in Table 5.

There was no significant difference between adopters and non-adopters in terms of willingness to try new technologies. Adopters were generally more willing to accept changes in structure, work force, and skills that may result from the adoption of B2B e-commerce compared to non-adopters. However, this difference was only significant at $P < 0.10$. The key difference was that adopters are more willing to commit large investments in new IT applications or projects than non-adopters. This indicated that non-adopters are often dissuaded from adopting new technologies if the investment required was substantial. Another reason could be that non-adopters tend to adopt a "wait-and-watch" approach as they are unsure of its benefits in relation to its costs. Further, non-adopters may tend to wait for new technologies to mature (problems resolved and costs decreased substantially) before seriously considering adoption.

Interestingly, there were no significant differences between adopters and non-adopters in terms of cost–benefit perception of adopting B2B e-commerce. This indicated that both adopters and non-adopters were generally aware of the costs and benefits of

Table 5
Risk orientation and cost–benefit perception

Risk and cost–benefit	Adopters mean (S.D.)	Non-adopters mean (S.D.)	T
Risk orientation			
Willingness to accept changes in structure, work force composition, skills that may result from new initiative (e.g., e-commerce)	4.55 (1.48)	4.14 (1.08)	1.68*
Willingness to try new technologies with which the organization is not familiar	4.55 (1.43)	4.18 (1.44)	1.36
Willingness to commit large investments to new IT applications or IT projects	4.54 (1.57)	3.96 (1.34)	2.05**
Cost–benefit perception			
Costs of integrating B2B applications with other information systems	5.52 (1.14)	5.41 (1.10)	0.49
Initial investments/costs for hardware, software and application development	5.29 (1.06)	5.29 (1.14)	−0.40
Costs to train employees to effectively use the new e-commerce application	4.50 (1.08)	4.65 (1.11)	−0.70

Scale: (1) very low; and (7) very high.
* $P < 0.10$
** $P < 0.05$

e-commerce investments. Also, firms were likely to feel that the cost was quite substantial despite the potential benefits, as evident by the relatively high mean scores of 4.50 and above in Table 5.

3.11. Key challenges to B2B e-commerce deployment

Understanding the severity of deployment problems is important so that appropriate steps can be taken to mitigate them. B2B e-commerce deployment is a complex undertaking (as it spans organizational boundaries) and its success depends on paying attention to details, especially to possible problems [33]. Hence, we asked adopters to indicate, on a scale from (1) not a problem to (7) extreme problem, their opinion regarding the severity of problems typically encountered in B2B e-commerce deployment. The results are shown in Table 6.

The top problem was related to the difficulty in measuring the benefits (#1, mean = 5.12). This was not surprising, as the difficulty of justifying IT investments and the productivity paradox has been raised by several authors [4,5,28,35]. Top management generally expects measurable tangible benefits rather than "soft" ones from IT investments. Given that e-commerce investments could be significant and that tangible payback could take more than a few years, it was not surprising that the problem of financially justifying e-commerce investments was a significant issue. Moreover, the economic downturn in the 2000–2001 period had considerably increased the resource constraints on firms across the globe. Therefore, it is not surprising that organizations expected quantifiable, measurable benefits from their B2B e-commerce investments. As one interviewee pointed out:

> Today, there is a severe pressure on IT budgets. This is more than ever before. Spending every penny needs to be justified. Without demonstrating ROI, it is difficult to secure approvals. But, it is very hard to demonstrate tangible ROI in dollar terms.

Table 6
Problems in B2B e-commerce

Problems	Mean (S.D.) (Singapore)	Rank in our study (Singapore)	Rank in CommerceNet's study (USA)
Problems in measuring benefits of B2B e-commerce efforts	5.12 (1.40)	1	–
Internal fear of opening corporate systems to suppliers and customers	4.79 (1.42)	2	–
Not enough time to develop new skills for B2B EC efforts	4.71 (1.51)	3	–
Lack of interoperability between Web applications and those of business partners (suppliers, customers, etc.)	4.71 (1.40)	4	1
Difficulties in making changes to current corporate culture	4.70 (1.69)	5	3
Difficulties in integrating Web applications with existing applications and systems	4.66 (1.65)	6	2
Limitations posed by existing database infrastructure in firm	4.65 (1.55)	7	–
Lack of communication among the organizational members	4.63 (1.61)	8	–
Lack of adequate commitment of resources (finance, human resources, etc.)	4.63 (1.54)	9	–
Difficulties in re-designing the business processes for B2B e-commerce	4.63 (1.52)	10	4
Lack of international access and trade barriers to do e-commerce across national borders	4.52 (1.40)	11	9
Lack of clear legal environment	4.40 (1.60)	12	–
Uncertain response of business partners towards e-commerce	4.37 (1.52)	13	7
Lack of adequate IT/ e-commerce expertise in the firm	4.37 (1.42)	14	8
Unresolved security, encryption and authentication issues	4.19 (1.69)	15	5
Inadequate mechanisms for protecting data and information in B2B e-commerce transactions	4.18 (1.60)	16	6
Lack of robust and stable infrastructure for e-commerce	4.12 (1.58)	17	10
Difficulties in gaining cross-functional cooperation.	4.00 (1.71)	18	–
Lack of strategic vision for B2B e-commerce	3.84 (1.70)	19	–
Lack of top management support for B2B e-commerce efforts	3.28 (2.02)	20	–

> One way to find ROI is- What would have happened if we hadn't adopted this technology? Another way is to look at the value-added services you can offer with technology.

Another factor that compounds the difficulty in measuring returns from B2B e-commerce is the short time period in which returns are expected. However, returns and benefits typically accrue only over a longer time. One of the senior IT managers said: "Give it some time. In the long term, even non-tangible benefits become tangible."

Previous research found that presence of appropriate skills and competencies tended to facilitate adoption of e-commerce [27]. However, rapid developments in e-commerce have given rise to problems due to insufficient time for staff to develop new skills (#3, mean = 4.71) and lack of IT/e-commerce expertise (#14, mean = 4.37). This is consistent with a report by the International Data Corporation (IDC) that 75% of firms in the Asia-Pacific (excluding Japan) experienced some form of delay in fulfilling IT projects as a result of skills shortages. An estimated 42% of those surveyed experienced delays in fulfilling IT projects of up to 1 month because they were short-handed, while almost 20 suffered delays of between 31 and 60 days [42]. As e-commerce technologies were relatively new, it is not surprising that there is a shortage of staff, as evident by the following:

> Getting the correct staff with the appropriate experience is an important issue since e-commerce is still quite new. Hence, we are also focusing on training existing staff. (Chief Technology Officer)

Firms were also afraid of giving suppliers and customers access to their corporate systems (#2, mean = 4.79). This could be due to the presence of sensitive data as well as the fear of sabotage or unauthorized access to corporate systems. In fact, recent denial-of-service attacks coupled with the spread of computer viruses [24,31] have made firms more careful about granting access to their corporate systems. For B2B e-commerce to be successful, trust among partners is important. However, it was difficult to change the corporate culture (#5, mean = 4.70) to be open and trusting.

Since e-commerce usually involves electronic linkages within and across firms, problems of integrating e-commerce applications with existing applications and systems (#6, mean = 4.66) arose. Further, external electronic linkages with business partners, customers, etc. often gave rise to the issue of interoperability between e-commerce applications and those of business partners (#4, mean = 4.71). As one of our interviewees pointed out:

> Adopting B2B technologies is not without challenges. For establishing a business-to-business private exchange, you need interoperability among a number of components, and these were quite immature in the industry. So, we had to go through lots of pain. (Senior IT Manager)

In fact, the lack of IT integration has been cited as a key reason why many B2B projects fail to deliver the benefits users expect [29]. In addition, the constraints imposed by existing database infrastructure (#7, mean = 4.65) further limited interoperability of systems. With time, such problems may be reduced.

Organizational issues, such as the lack of top management support (#20, mean = 3.28) and the lack of strategic vision for e-commerce (#19, mean = 3.84), were not viewed by adopters as serious problems in B2B e-commerce deployment. One reason may be that such issues would have been resolved prior to B2B e-commerce adoption deployment.

In order to gain a better perspective on the problems in B2B e-commerce, we provide a comparison of the perceived B2B problems between Singapore firms and US firms in Table 6. It is interesting to note that interoperability issues (both within new B2B applications and existing applications in the organization and with those of business partners) and cultural changes emerged among the top problems in both US and Singaporean contexts. Technological integration and inter-operability seemed to be a global issue facing firms implementing B2B initiatives. Most Singapore and US firms had invested significantly in building an IT infrastructure (including legacy and proprietary systems) in the past, and are now finding it hard to integrate the new Web-based B2B applications. Weill and Vitale [40] also argued that e-business initiatives placed greater demands on IT infrastructure. Organizational culture seemed to be another critical barrier facing firms globally while implementing B2B e-commerce applications. The heart of B2B e-commerce was in inter-organizational collaboration and it required a fundamental shift in the organiza-

tional mindset to collaborate and engage in effective B2B e-commerce.

It was also important to note that the top three problems facing Singapore firms were not present in the US context, as indicated by CommerceNet [10] study. Singapore firms, facing tremendous resource constraints, seemed to be under pressure to justify their B2B investments and show tangible returns. Moreover, Singapore firms seem to have considerable fear about opening up their information systems to outside parties. While US firms have traditionally been involved in inter-organizational information sharing and extensive firm-to-firm technology-based partnerships, the Singapore firms, especially those that are family-owned, have not had such a history of collaboration. Another problem that ranked quite high in Singapore, but not in the US, was related to the time required to develop the required skills and expertise for B2B. US markets had the technologies, resources and the expertise in B2B e-commerce ahead of other regions. Several US and European firms had spearheaded B2B e-commerce before it gained momentum in Asia Pacific. Therefore, it seems that the Singapore firms faced more time pressures to develop their B2B e-commerce capabilities and expertise than US firms.

4. Conclusions

While B2B e-commerce has been widely discussed, little empirical knowledge existed of the B2B e-commerce practices being followed by industry. This study provided some insights on B2B e-commerce practices in Singapore. Our results indicated a moderate level of B2B adoption, with about 52.8% adopters and 47.2% non-adopters in the sample. Further, B2B e-commerce appeared to have diffused across different industries, though most adopters came from services firms. As expected, government-owned firms appeared to take the lead in B2B e-commerce adoption in Singapore, in contrast to developed countries such as the United States where the private sector usually takes the lead in the adoption of new innovation.

Interestingly, the level of IT investments rather than annual revenue was strongly related with B2B e-commerce adoption. This implied that B2B e-commerce adoption often required the firm to commit a certain level of resources to its deployment. In addition, adopter firms were more likely to have a champion for e-commerce; this is consistent with the IS literature. Hence, potential adopter firms need to realize that a strong champion is necessary to spearhead and facilitate the B2B e-commerce efforts.

In addition, the results indicated that customer-oriented applications were more common than supplier-related ones. This is consistent with [26] where firms have increasingly realized the importance of meeting and exceeding customer expectations in order to survive in an increasingly competitive landscape. Further, the assessment of expected and realized benefits indicated that many firms have not achieved their expected benefits. This may indicate that they often take some time to be achieved. Further, Chau and Hui [9] found that perceived indirect benefits do not significantly affect the likelihood of EDI adoption. This suggests that top management is often interested in direct rather than indirect benefits from IT or e-commerce investments.

For policy makers and software providers, this study provides insights as to why some firms do not adopt B2B e-commerce. By understanding the reasons behind non-adoption, appropriate measures and incentives system can be better designed to encourage B2B e-commerce adoption. Further, the ranking of problems enables potential adopters to focus their attention on key problems in deploying B2B e-commerce.

Acknowledgements

The authors would like to thank Jasbir Dhaliwal and James Ang for their assistance in the early part of this study.

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