

IS Innovation: Adoption of B2B e-Commerce

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Abstract: A logistic regression analysis based on completed questionnaires from 135 companies within the Danish steel manufacturing and wholesale business segment suggests that “market positioning and power issues” along with “organizational issues” are the primary, positive drivers for adopting B2B e-commerce. Also, our study found that recommendations from business partners clearly had a negative influence on the adoption. Technical barriers were not found to be significant. Our results challenge the overall thinking of diffusion with respect to the need for ‘muddling through’ and technical capabilities. Finally, our study did not find any difference in adoption motives due to company size.

Keywords: B2B e-Commerce, adoption of innovations

1. INTRODUCTION

Business-to-business electronic commerce (B2B e-commerce) represents the bulk of e-commerce in terms of financial transactions mediated as part of the exchange of goods and services enabled by digital technologies (Coppel, 2000). E-commerce is broadly defined as any form of economic activity conducted via electronic connections (Wigand, 1997). However, when it comes to B2B e-commerce, it is implicitly expected that e-commerce supports intra and interorganizational information systems (Timmers, 1999; Zwass, 1998). The result is a scope that goes beyond the mere exchange of goods and services (Masseti and Zmud, 1996). The front runners of B2B e-commerce did not use the Internet. Instead, they used direct dial-up and vendor based services to align their data transaction systems. In some cases, they even transported the magnetic disk by means of physical transportation and had the computer read the digital stored information. Developing

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standards was in various sectors a front runner for the digitalization of the data exchange – for example in the banking sector (Millard, 1961). During the 1970s, 1980s and the first half of the 1990s, B2B e-commerce was diffused among the big industry players and their value chains. Some of the major players in forwarding B2B e-commerce were the automobile sector (Rassameethes, 2000) and logistics & freight (Williams and Frolick, 2001; Huff et al., 2000). The Internet has provided new means of transporting messages, new means of storing back-up files and even new technologies for standardizing messages.

Various business associations and governmental players in First World countries expect that the business sectors are at a cross road with technologies that might bring a revolutionary change in diffusion pattern (US Chamber of Commerce, 2000; Yoshimitsu, 2000).

Rather than being a diffusion process controlled essentially by the major market players and fueled by motives of controlling the value chain and cost reduction, the Internet based B2B e-commerce might give SMEs the opportunity to position themselves and perhaps use B2B e-commerce for expansion and collaborative strategies. With OECD expecting that digitalization of business transactions will be a major contributor to continual economic growth (OECD, 2000), it is essential to study the adoption of B2B e-commerce. Yet, looking in the back mirror at the surge of studies published on B2B e-commerce and its antecedent – EDI - there are both substantive and epistemological needs for gaining a further insight into the digital innovation of our businesses.

Our study aims at finding explanatory factors for the decision to adopt B2B e-commerce. Thus, our research question is: Which of the selected research items have the best explanatory power to predict the adoption of B2B e-commerce? The main purpose of the study has been to explore the determinants for the adoption decision rather than looking at barriers and drivers for B2B e-commerce adoption.

B2B e-commerce is considered to be a subclass of Information Systems (IS) innovation. The term innovation, which can be seen as a product, process, or political innovation (Zaltman et al., 1973), does in our research refer to the process innovation. Thus, IS innovation is here defined as innovation in the organizational application of digital information and communications technologies (Swanson, 1994).

The IS environment is, however, a fast changing realm (Galliers, 1999) where names and ideas change quickly (Abrahamson, 1996). The core idea – to exchange information via digital networks to improve front end and back office operations - is none the less unchanged even though the label for the process might change.

The structure of the paper is as follows. Section 2 addresses the multiplicity of IS adoption, concluding that the traditional diffusion of innovations theory has to be altered to depict the adoption decision in IS.

Section 3 introduces the model that guided our research. Based on the specific features of B2B e-commerce, the measures in the model are operationalized. Section 4 focuses on describing the data collection. Section 5 presents the analysis and results. The final section is dedicated to a conclusion and a few comments on limitations and further research.

2. THE ADOPTION OF TECHNOLOGICAL INNOVATIONS

Interorganizational information systems (IOS) such as B2B e-commerce has so far been sparse diffused (Timmers, 1999). Yet, diffusion of IOS at an organizational level has until recently been studied relatively sparse (Lai and Guynes, 1997). Adoption of technological innovations in organizations is, however, a major diffusion of innovations (DOI) research stream (Lai and Guynes, 1997; Prescott and Conger, 1995). The DOI theory (Rogers, 1995) has proved to possess high explanatory power in the diffusion of innovations at the individual level (Lai and Guynes, 1997). However, an extensive review of diffusion studies within IS has challenged the theory's suitability in predicting diffusion at an organizational level (Prescott and Conger, 1995). Recent studies on organizational diffusion of e.g. ISDN (Lai and Guynes, 1997) and EDI (Lyytinen and Damsgaard, 2001) indicate that it is difficult to understand adoption of innovations at an organizational level merely by looking at the traditional parameters found in the DOI theory as defined by Rogers (1995).

Chau and Tam (1997) found that the weakness of traditional diffusion theory as presented by Rogers (1995) derives from a failure to recognize the differences in unit of analysis, environment and technology characteristics. Lyytinen and Damsgaard have (2001) pointed to similar shortcomings in their analysis of the DOI theory as an explanatory tool for diffusion of complex and networked technological solutions. The study of Chau and Tam (1997) has guided our search for a broader understanding of the diffusion and adoption of B2B e-commerce, bearing in mind that other researchers have recognized the need as well.

3. RESEARCH MODEL

In their work on diffusion of technological innovations, Tornatzky and Fleischer (1990) have included organizational aspects. They suggest three elements influence the process by which innovations are adopted in organizations. (1) The external environmental context, i.e. the arena in which an organization conducts its business. It includes factors external to an

organization such as the industry, competitors, regulations and relationships with the government. (2) The technological context, i.e. the technologies available to an organization. This element focuses mainly on the innovation characteristics of technology. (3) The organizational context, i.e. the characteristics of an organization. These include size, formalization, the complexity of its managerial structure, the quality of its human resources and the amount of slack resources available internally. An exploratory study on open systems adoption (Chau and Tam, 1997) found that the framework developed by Tornatzky and Fleischer (1990) was suitable for describing the organizational adoption of IT. However, Chau and Tam concluded that it was necessary to work with more context-based models of innovation adoption. Chau and Tam did not rely on previous studies due to the specific characteristics of the unit of analysis, open systems, which they found was very different from other technological artifacts. In their operationalization, they were specific about the particular innovation that they were examining, which resulted in a low degree of reuse of research items. Inspired by Tornatzky and Fleischer (1990) and Chau and Tam (1997), we have developed a theoretical model that includes elements of importance for the adoption of B2B e-commerce. We have, like Chau and Tam (1997), rephrased the categories to meet the particular features of B2B e-commerce. The categories include (1) Overall market and power issues, (2) Technical issues, and (3) Organizational issues.

3.1 Operational measures

When operationalizing the three elements, the research items relied on previous research, in particular research on EDI, which have been studied extensively for the last decade (e.g. Arunachalam, 1995, Raymond and Bergeron, 1992).

3.1.1 Overall market and power issues

In line with the element defined by Tornatzky and Fleischer (1990), the overall market and power context includes market conditions such as competitive market forces and market uncertainty. In the process of operationalizing this construct, we depended heavily on previous studies of the power perspective as a driver for IS adoption. It refers to the obligation of a firm to adopt an innovation in order to keep a customer or supplier. Hart and Saunders (1998) explored the different ways of exerting power in relation to business partners. They distinguished between persuasive and coercive power. Iacovou et al. (1995) distinguished between competitive pressures and imposition by trading partners. Bergeron and Raymond (1992) included the benefits from strategic repositioning of the firm due to

implementation of EDI in their survey. When operationalizing the external environment, we included the persuasive power by defining an item related to whether e-commerce had been recommended to the respondent by some of the company's business partners. The coercive power was covered by an item asking if the respondent had experienced business partners who had forced the company to use e-commerce. According to Tornatzky and Fleischer (1990), the external environment should not be seen only as external forces beyond the control of the firm. Some firms have the ability to shape their environments. To cover this dimension, we have included a variable on the companies' competitive strategy.

3.1.2 Technological issues

Rather than focusing on the innovation characteristics as suggested by Tornatzky and Fleischer, we have chosen a slightly different approach by looking at efficiency gained by the technological innovation. One rationale for adopting B2B e-commerce is to increase efficiency due to improvement of intraorganizational and interorganizational routines (Timmers, 1999). The adoption of e.g. EDI can lead to direct savings (Bergeron and Raymond, 1992; Cox and Ghoneim, 1996) such as reduction in the workforce due to less rekeying and a decreased need for manual storing of documents (O'Callaghan and Turner, 1995), provided B2B e-commerce leads to a high rate of digitally exchanged documents (Masseti and Zmud, 1996). Previous research has also pointed at indirect savings such as lower inventory costs and shortened duration of transactions (O'Callaghan and Turner, 1995). Although these factors are hard to quantify before the adoption, they must be expected to play a vital role in the adoption considerations. These aspects of efficiency are operationalized under the term sufficiency of technical solutions.

As for the cost of technical solutions, it can be seen as the direct price of purchase. Some authors have differentiated the term by analyzing the relative advantage (Crag and King, 1993) which more or less reflects cost-benefits considerations. Other authors (Raymond and Bergeron, 1996) have included expenses due to education and training of employees in their cost calculations. We operationalized the issue by merely asking about the perceived cost savings.

3.1.3 Organizational issues

The third perspective included in our model of determinants for B2B e-commerce adoption is related to organizational issues. We have included aspects in our model to address the employees' readiness for change and the overall organizational readiness for adopting e-commerce. Both issues are well described in various studies on IT, organizations and people (Keen,

1981; Hammer and Stanton, 1995; Yapp, 1999). Rigidity in organizational structures and at employee level as a barrier for adoption of EDI was studied by e.g. Clemons and Row (1992) who found "...considerable resistance among the expected adopters of EDI within consumer packaged goods industry." Also, various organizational researchers have questioned both the existence of and the potential in expecting a fine-tuned, top-management controlled adoption of e-commerce. At the strategic level, advocates for incremental strategies place even more emphasis on the employees' readiness for change whether they are pushed by management or by changes in impulse from the business partners (Lindblom, 1959). The 'tinkering' hypothesis suggesting that major IT-developments are fueled by grass root level actions rather than formal management decision-making also supports the need for focusing at the readiness for change (Ciborra, 1991). Finally, we examined the explorative attitude of the organizations. To our knowledge, this item has not been surveyed before, which is surprising considering the massive attention that e-commerce has achieved among practitioners and researchers. Thus we asked if the respondents found e-commerce new and interesting.

4. DATA COLLECTION

In order to explain concerted activity at the industry level, it is necessary to analyze the actions of the individual firm and even at this level to split the efforts of collecting data by choosing respondents among the individuals in the organization (Johnston and Gregor, 2000). By including both adopters and non-adopters among our respondents, we expect to reveal a more multifaceted picture. The strategy of including both adopters and non-adopters has been applied in previous research (Lai and Guynes, 1997) as it is appropriate to consider the rejection of innovation as a form of behavior in line with adoption.

The method selected for the survey was a postal questionnaire. The questionnaire was prepared together with stakeholders in the two major business associations in Denmark. The stakeholders have a position where they are close to the policy decisions on e-commerce communicated to the members of the business associations. By involving practitioners in developing the questionnaire, the research items tended to be more explorative than theory-driven due to a more practical approach to the research topic. The two business associations represent 7.800 SMEs among manufacturers and wholesalers in Denmark. A pilot survey was conducted by choosing 15 companies at random. The nine responses that were received from this sample led to changes and improvements according to the opinions expressed in the returned questionnaires.

Subsequently, we sent the questionnaire to 917 manufacturers and wholesalers organized within the steel and machinery industry business associations. The questionnaires were sent to management in the organizations. A cover letter bearing the letterhead and logo of the business associations addressed to the manager was included. A pre-paid addressed return envelope was included in the package. Also, they were given the option of responding via fax. We received a total of 252 responses (27 percent). However, a number of responses did not qualify for the analysis due to insufficient information on a number of variables. The remaining 135 firms, out of which 38 used e-commerce, provided data on all key variables, which gave us a usable response rate of 15 percent. In a similar study of adopters and non-adopters of complex information systems (Lai and Guynes, 1997), the response rate was 16%. Other scholars have proposed that a response rate between 5 and 10 percent is normal for studies of this type (Angeles and Nath, 2000). The 135 firms that are used in the further analysis are all small. 83 percent of the firms had thus less than 50 employees. Only six firms were larger than 100 employees.

5. ANALYSIS AND RESULTS

In order to examine the underlying patterns produced by the above mentioned variables and determine whether the information can be summarized into a smaller set of factors, we conducted an exploratory factor analysis. In an exploratory factor analysis, no a-priori constraints are set on the number of factors that are extracted. In the factor analysis, we chose the most widely used methodology, principal components analysis, followed by a varimax rotation (Hair et al. 1995). The results of the factor analysis are shown in Table 1. Only the factors with an eigenvalue > 1 were retained. Before interpreting the factors, we stress that the factor analysis produced several factors indicating that the decision to adopt B2B e-commerce is indeed multidimensional. The loadings in Table 1 helped us define the factors. We identified four sets of factors.

The first factor loads positively and high on three variables: competitive demand (0.78), business partners' pressure (0.76) and cost savings (0.55). It is termed overall market and power issues as it captures the external pressures from competitors and business partners. Three variables load positively on the second factor: technical software/hardware sufficient (0.81), technical software/hardware affordable (0.74) and cost savings (0.52) (loading on both factor 1 and factor 2). In other words, the factor reflects technical issues, i.e. whether the available technical solutions are sufficient and affordable.

The third factor is highly correlated with the perception of B2B e-commerce as new and interesting and with the importance of guidance from business partners. We have labeled the third factor as trialing and 'muddling through' (Lindblom, 1959). The third set of factors on new and interesting (0.87) and guidance from business partners (0.72), suggest that these factors reflect important decisional dimensions independent of the other dimensions.

The fourth factor in our exploratory factor analysis loads on the two variables: organizational readiness (0.81) and employees' readiness for change (0.79). This factor represents the importance of the internal readiness for new B2B e-commerce solutions and is called organizational issues. The four factors explain almost three-fourths (71 percent) of the variation in the nine decision variables.

Three of the four factors resemble to a large extent the typology of factors proposed by Tornatzky and Fleischer (1990). However, the fourth factor identified in our study, "trialing and 'muddling through'", differs substantially from the framework suggested by Tornatzky and Fleischer.

Items of importance for the decision to apply B2B e-commerce	Overall market and power issues	Technical issues	Trialing and 'muddling through'	Organizational issues
	Factor I	Factor II	Factor III	Factor IV
Competitive demand	0.78	0.14	0.12	0.05
Pressure from business partners	0.76	-0.25	0.17	0.22
Cost savings	0.55	0.52	0.15	-0.07
Technical components sufficient	-0.11	0.81	0.10	0.09
Technical components affordable	0.11	0.74	-0.07	0.30
New and interesting	0.07	0.14	0.87	-0.03
Guidance from business partners	0.34	-0.09	0.72	0.22
Organizational readiness	0.31	0.19	-0.14	0.81
Employees' readiness for change	-0.08	0.17	0.37	0.79
Eigenvalue	2.71	1.57	1.10	1.01
Percent of variance explained	30.1	17.5	12.2	11.3

Table 1: Exploratory factor analysis on the nine decision variables

Based on the original nine decision variables, we created four factor scores for each observation. The factor scores are composite measures created for each observation on each factor extracted in the factor analysis. The factor weights are used in conjunction with the original variable values to calculate each observation's score. Conceptually speaking, the factor score represents the degree to which each observation makes a high score on the group of variables that load high on a factor. Therefore, a high factor score shows that an observation highly emphasizes the decision dimension

represented by the factor. The factor score will be used to represent the identified four decision dimensions in subsequent analyses.

In the analysis of whether the four decision dimensions have any explanatory power in predicting who are users vs. non-users of B2B e-commerce, we applied logistic regression (a binary logit model). This was done since our response variable was a binary variable with only two possible outcomes. The factor scores representing the four decision dimensions were included in the analysis as explanatory variables. Furthermore, we have included the size of the company as a control variable since we might expect that size, independent of the other variables, has some bearing on the probability of adopting B2B e-commerce (Horlück, 1996). The companies have been categorized into six different size levels: 1-5 employees, 6-9 employees, 10-19 employees, 20-49 employees, 50-99 employees and 100+ employees included in the analysis by five dummies.

The response variables: "non-users" and "users" were coded as 0 and 1, respectively. If we assume that x is a vector of explanatory variables and p is the probability of the response variable to be modeled (in this case the probability of becoming user of B2B e-commerce), then the estimated logit model has the form:

$$\text{logit}(p) = \log [p / (1 - p)] = \alpha + \beta x$$

where α is the intercept and β is the vector of slope parameters. The estimated model has a chi-square value for the results of the parameters of 53.89 (9 d.f.) which is highly significant ($p < 0.0001$). The null hypothesis that $\beta = 0$ is hence rejected. Including the parameters in the model reduces the variation from 160.5 to 106.6 which gives a pseudo-R² = 33.6. This indicates that the explanatory variables explain one third of the variation in the response variable. The estimation results are reported in Table 2.

Independent variables:	Dependent variable: Users vs. non-users of B2B e-commerce
	Parameter estimate (Chi-Square statistics)
Intercept	-1.71***
Overall market and power issues	0.52*
Technological issues	0.49
Trialing and 'muddling through'	-1.70***
Organizational issues	0.60*
Number of employees (5) ¹	Yes

¹ The size is controlled by including five dummies for the size levels. The five parameters have not been included since size is only a control variable in the analysis. Moreover, the

Model chi-square	53.89***
Pseudo R-square	33.6 %
N =	135
Users of B2B e-commerce =	38
Non-users of B2B e-commerce	97

Table 2: Parameter estimates for Binomial Logit Model

* = 0.05 significance level; ** = 0.01 significance level; *** = 0.001 significance level

The independent variable, trialing and ‘muddling through’, is negatively significant at a 1 percent level, whereas, overall market and power issues, and, organizational issues, are positively significant at a 5 percent level. Technical issues are only significant at 10 percent level.

The estimation of the parameters reveals that the trialing and 'muddling through' dimension is highly significant and negatively correlated with the variation in our dependent variable (users and non-users of e-commerce). Thus, incrementalism and trialing appear to hold more explanatory power for the variance among the responses than the other factors analyzed. One interpretation of this finding could suggest that general recommendation and guidelines for adopting e-commerce are unlikely to have any impacts on the overall diffusion of e-commerce. Classical market- and power issues along with organizational factors are of higher importance.

The positive direction of ‘overall market and power issues’ as well as ‘organizational issues’ in our binomial logit model emphasize issues as competitive demand, pressure from business partners, cost savings, organizational readiness and employees’ readiness for change.

Our results challenge the view on adoption in the sense that respondents clearly indicated that experimenting with the new e-technologies and general recommendations to business partners were factors that had a negative influence on the decisions to adopt e-commerce. It might imply, as suggested by Chatfield and Yetton (2000), that the embeddedness of EDI is more important to be aware of than the emergence of new front-line technologies. We hesitate to interpret the low significance of the technical issues as a lack of relevance of the issues. Various studies have suggested that for example technical compatibility to be critical for the diffusion of EDI (Premkumar and Ramamurthy, 1995; Premkumar et al., 1994). Yet, given that the analyzed steel industry and wholesale segment have been involved in various technology training and workshops during the 1990s, it might reflect an awareness and learning curve rather than a general irrelevance of the technical issues. Also, our conclusions are delimited to the extent that the respondents were asked questions that made sense for both general B2B and

total effect of size (covering all five dummies) turns out to be insignificant with a chi-square value of 6.99 (p=0.22).

EDI in specific. For example decision criteria for e-commerce in terms of R&D and reconfiguring value chains were not included in our framework.

Despite these limitations, our analysis reveals a pattern in decision-criteria for adoption that adds to our overall theoreticians on diffusion. One possible implication is that the dominant market players has an important role to play in order to diffuse Internet based B2B e-commerce as they had with respect to EDI. Secondly, awareness on complementary organizational changes and information technology seem to have actually matured to be considered at the level of adoption, and not only at the level of planning or actual implementation.

6. CONCLUSION, LIMITATIONS, FURTHER RESEARCH

The decision to adopt B2B e-commerce involves a complex interplay with various determining criteria. The mix of motives is not related to the size of the company. Large size and midsize companies did not answer differently than the smaller companies. Awareness of cost issues and strategic issues is to be complementary issues rather than exclusive variables. The companies that are motivated by cost reduction are also influenced by overall market issues in their decision to adopt B2B e-commerce.

The primary positive decision-drivers are related to market and power issues as well as soft organizational issues. Soft issues such as readiness to change (individual and organizational level) came out as a relatively homogenous factor indicating that they indeed are part of B2B e-commerce decisions in the analyzed observations.

Our analysis did not identify technical issues as important for the decision to adopt B2B e-commerce. Technical issues did not play a significant role. Our conclusions on the technical issues are clearly controversial and will need to be addressed in more detail in terms of follow-up interviews with the respondents. Technical issues might be of crucial importance for successful implementation and exploitation of the adopted technologies. Yet, we have only addressed the adoption motives.

The findings might be specific to the segment of the economy surveyed. Hence, one should be careful to deduce that our conclusions are valid in other business sectors that might be more adoptive to new technologies as a means of gaining, sustaining and signaling digital work practices. During the autumn of 2001, we broaden the industry scope and conduct a similar analysis of other business sectors. This will enhance our number of respondents, incorporate a larger variety of business relations, and have a larger variety of e-commerce applications represented in the data pool.

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