Electronic Commerce Adoption by SMEs in Singapore

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Abstract

This study surveys the receptivity of Singaporean small and medium-sized enterprises (SMEs) to the adoption of electronic commerce. Utilising a portion of Rogers' model of innovation diffusion as the framework and treating electronic commerce (EC) as a form of new innovation, we analyse factors affecting EC diffusion. A multiple regression analysis is carried out, with the five attributes of innovation highlighted by Rogers, to determine the attributes that affect the willingness to adopt. Of the five factors affecting adoption of electronic commerce by SMEs, only relative advantage, compatibility and trialability appear significant, with the overall regression explaining around 36 per cent of willingness to adopt.

1. Introduction

Electronic commerce (EC) is the culmination in business of increasing computing power and declining telecommunications costs; it is revolutionising transactions as well as radically changing supplier and customer relationships in business.

The value of worldwide EC is expected to reach US$300 billion by the year 2000, according to Dryden [7]. Despite this high potential, Asian businesses are still reluctant to infuse EC into their business processes. Asia as a whole appears less engaged in EC compared to the United States and Europe. One apparent explanation could be that many Asian countries tend to be less developed than Western countries. A more complete explanation of the lag, however, must include related problems that Asian countries have, including lower personal computer penetration, inefficiently-managed telecom monopolies, language barriers, hierarchical corporate cultures, and often intrusive and bureaucratic governments [2].

In spite of the inertia, several Asian countries (e.g. Hong Kong, Malaysia and Singapore) are in the process of creating IT infrastructure that will facilitate EC innovation and are attempting to remove the above-mentioned barriers. These countries are aware that the next several years will see tremendous growth in business-to-business EC. Businesses in Asia will need to link their value networks in order to maximise resources and economise on costs given the potential offered by EC. Businesses that fail to take advantage of technological advances will decline [7].

This study's focus is on Singapore, which is currently promoting EC with various initiatives [16, 18]. For instance, the Electronic Commerce Hotbed (ECH) programme by the National Computing Board (NCB) is designed to bring together major EC players in order to hasten realisation of EC in Singapore. There are other initiatives that are designed to turn Singapore into an EC hub. In particular, several initiatives in Singapore are targeted at small and medium-sized enterprises[1] (SMEs) [28]. There are 92,000 SMEs in Singapore and together, they make up 92% of all establishments, and employ 53%

[1] The Association of Small and Medium-Sized Enterprises (ASME) of Singapore defines an SME as a company with employees not exceeding 100 and an annual turnover not exceeding $15 million (see http://www.asme.org.sg). Singapore statutory boards, such as the Singapore Productivity & Standards Board (STPB) and the Economic Development Board (EDB) have different definitions that consider other factors (e.g. local equity and/or fixed assets). Our research will utilise the ASME definition given that our survey respondents are members of ASME.

of the workforce. Yet, SMEs contribute only 34% to Singapore's GDP [28]. Although this contribution may look small, SMEs are important to Singapore economy in several ways. "Many MNCs today were SMEs of yesteryear. SMEs are the incubators of our future economic giants" [28]. Moreover, many SMEs engage in international businesses.

This study is significant for several reasons. Firstly, it fills a knowledge gap about EC diffusion in Singapore, and aims to identify which factors are important for encouraging willingness to adopt EC. Prior research in Singapore has indicated that merchants are still uncertain about the business potential of the Internet as a medium for trading and payment [14]. Security concerns emerged as the most important consideration to merchants when using the Internet [14]. Retailers are still more comfortable with traditional forms of retailing than with on-line sales transactions [1]. They are unwilling and/or unable to invest sufficient resources to make on-line shopping successful here [1]. Although these studies focus on business-to-consumer rather than business-to-business EC, they indicate a low level of willingness to adopt EC.

In the same vein, the results of a 1999 NCB survey of 666 Singapore businesses echoed the same low appeal for business-to-business EC. Results indicated that 8.5% of the surveyed firms were current users of business-to-business EC and that a further 4.7% were "extremely interested" in adopting business-to-business EC. In contrast, 23.3% were "somewhat interested" and 63.5% were either not interested in adopting business-to-business EC or did not feel sufficiently well informed to answer the question [26, pp. 8].

Secondly, this study focuses on a relatively unexplored sector in Singapore – the SMEs. Little research has been conducted on this size of firm. The importance of SMEs stems from their increased role in job creation [13]. They differ from larger firms in that they have a tendancy to operate in niches which stimulate competition, be diverse in activities and technical activities, possess hands-on managerial styles that facilitate quick decision making, have lower specialisation of factors of production and have less formality in their internal and exteral information systems [13]. As mentioned above, SMEs are perceived as lagging in terms of EC adoption. SMEs in Singapore are using the Internet mainly as a communication and information tool [3]. Since SMEs' web pages are essentially static media, the advantages of the Internet remain an untapped source; they are unable to enjoy potential benefits [3]. Whilst Chong et. al. [3] show that the SMEs are still in the infant stage of EC, they do not explain why SMEs are at this stage. Most research on inhibitors of EC (see for example [24]) explores EC's usage for all sizes and types of institutions, or investigates the issues at a macro multi-country level [20]. Research is also scanty on investigating business-to-business EC by Asian SMEs. Our study, focusing on SMEs and on business-to-business, is a preliminary attempt to quantify this area.

Thirdly, this study adapts a portion of Rogers innovation diffusion theory, which has been cited widely in innovation diffusion research. We treat EC as a new innovation (distinct from other organisational or technical innovations), and try to determine which factors, according to Rogers framework, influence EC adoption. In particular, we focus on measuring attitudinal belief toward EC through the use of five perceived attributes (relative advantage, compatibility, complexity, trialability and observability) (Taylor & Todd [23] as discussed in Tan & Teo, [22]). A study of adoption of Internet banking in Singapore [22] also makes use of this framework. However, we believe our work is one of the first to quantify these factors within the EC context.

In essence, our interest is in discovering factors affecting SMEs' willingness to engage in EC as well as in quantifying their relative importance. Specifically, through surveying SMEs and utilising an adaptation of Rogers [21] model of innovation diffusion, we are interested in identifying and rank-ordering factors affecting willingness to adopt EC in Singapore by SMEs.

The reminder of the paper is organised as follows. The theoretical framework underlying the study (Rogers model of innovation decision process), the study's research model and the hypothesis formulation are first explained. Next, the research methodology is described, followed by data and analysis. This is followed by a discussion of the results. The final sections discuss limitations and directions for future research and examine the implications of the results for research and practice.

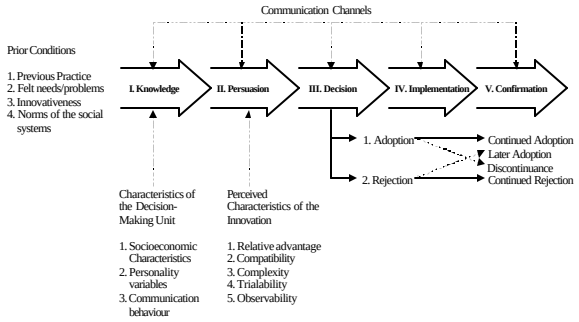
2. Theoretical Framework and Research Model

Rogers Model of Innovation Decision Process

The adoption of a new product is a decision process that moves through different stages over time. Further, diffusion is defined as the process by which an innovation is communicated through certain channels over time among the members of a social system. As shown in Figure 1, the decision process begins with knowledge of the existence of the innovation. This is followed by a persuasion period. During this phase, potential adopters gather information from various sources and attempt to determine the utility of the innovations. Often, early adopters who are typically innovators themselves, or in some cases change agents, attempt to convince the general user population of the benefits of the innovation. If the decision is in favour of adoption, an implementation phase follows. Implementation is a critical period in the diffusion process since it requires overt action on the part of adopters to put the new idea into practice. As Rogers notes, "It is often one thing for an individual to decide to adopt a new idea, but quite a different thing to put the

innovation into use." At this stage, the innovation may become incorporated into the culture of the user population, or it may undergo changes (re-invention), or it may be discontinued [12].

Figure 1: A Model of Stages in the Innovation-Decision Process [15] pp. 561



In terms of the relative importance of these five stages, the second stage, perceived characteristics of innovations, has been studied more frequently and is generally considered most significant of the five in explaining rate of adoption. In explaining the rate of adoption of an innovation, Rogers [21] highlighted that five of the perceived attributes of an innovation are the main determinants explaining 49% to 87% of the variance in the rate of adoption. These five attributes are relative advantage, compatibility, complexity, trialability, and observability [21], p. 206). The same five attributes have been used frequently in past research.

By viewing the adoption of EC by SMEs as an innovation, a research model was constructed using the five attributes of innovation as highlighted by Rogers in his innovation decision process to explain adoption of EC.

Rogers Model of Innovation Decision Process: Its Applicability and Adaptation to EC

There is some question as to the applicability of Rogers' model in treating EC as an innovation. Theoretically this is difficult to answer. We see this issue as more of an empirical question; do the testable implications hold up empirically?

Electronic commerce can mean many things as noted earlier, but we focus on SMEs' willingness to adopt different stages of doing business over the Internet, ranging from having a home page to conducting transactions exclusively on-line. These stages were formulated based on the possible levels of EC discussed in European Commission [8]. We measure 'willingness' by asking at what point in the future would the SME 'adopt' that particular manifestation of EC. EC is to be distinguished from other IT innovations in that EC affects inter-firm as opposed to intra-firm relationships (business-to-business EC) and organisational structure.

The five determinants of EC adoption require additional clarification within the present context. We do so by mapping definitions back to the actual survey questions used. [2]

Relative Advantage: The benefit perceived by SMEs in adopting EC to conduct business as measured by 'lower business cost' (Question 1), 'wider market coverage' (Question 4), 'preference to upgrade other business ventures than to adopt EC' (Question 2), 'loss of core competence information' (Question 3) and 'importance of doing business on the Internet in the future' (Question 7).

Compatibility: How well SMEs think the new innovation will fit into their existing business process. This variable is measured by 'the fit of the companies' EC efforts with their suppliers and customers' (Question 5), 'the fit with their organisational structure (Question 6)', and 'the perceived suitability of the business to adopt EC' (Question 8).

Complexity: The difficulty perceived by SMEs in adopting EC. Technical knowledge is one factor (Question 9). The more knowledge/expertise one has, the less complex the innovation is perceived to be. Security is also part of complexity (Questions 10 & 11). The more secure EC is perceived to be, the less complex it will appear (assuming security to be a perception issue). A similar argument applies to the measurement of complexity via the Y2K problem (Question 12).

Trialability: The ability to engage in EC without incurring high start-up costs. The perceived high cost of implementing EC (Question 15) is a determinant. Availability and awareness of grants available (Questions 13 & 14) are relevant to this factor. When grants are given, businesses are able to reduce high start up costs. Pain associated with failed initiatives is also lessened. In short, grants will enhance the trialability of the innovation.

Observability: The ability to see beneficial results of using EC by other businesses (addressed by Questions 16 & 17). Influence of others' results on the respondents' decision to adopt EC is seen to be a measurement of observability. Knowledge of the benefits of EC is likely to be seen and understood if it is observable.

The Hypothesis

According to Rogers' model, the more abundantly the above characteristics are present during an innovation, the more likely the innovation will be adopted.

[2] Survey questions are found in the appendix

Operationalisation of Rogers' model takes the form of a linear relationship:

$$Y = A_0 + A_1X_1 + A_2X_2 + A_3X_3 + A_4X_4 + A_5X_5$$

Where:

Y is defined as the willingness to adopt EC by SMEs

X_1 is defined as Relative Advantage;

X_2 is defined as Compatibility;

X_3 is defined as Complexity;

X_4 is defined as Trialability;

X_5 is defined as Observability

$A_0 - A_5$ are coefficients measuring the strength of the relationship

Attributes are discussed in more detail in the next section.

3. Research Methodology

A survey instrument was formulated (see Appendix B for selected portions) to obtain feedback from SMEs in Singapore, assessing their awareness, receptivity and adoption of doing business over the Internet. In order to focus on SMEs, assistance was sought from the Association of Small and Medium Enterprises (ASME) of Singapore. A letter of endorsement, signed by the president and contacts of all its members were given by ASME. As such, the surveys sent out were personally addressed to the directors of each member SME.

Details of the survey design are found in Appendix A. Table 1 shows the mapping of questions to the five characteristics.

Table 1: Mapping of Survey Questions to Perceived Attributes of Innovations

Perceived Attribute	Questions (Part B of Survey)
Relative advantage	1, 2, 3, 4, 7
Compatibility	5, 6, 8
Complexity	9, 10, 11, 12
Trialability	13, 14, 15
Observability	16, 17

4. Data Collection

The survey questionnaire (See Appendix B) was disseminated electronically by fax and Internet as well as by post to all members of the Association of Small and Medium Enterprises of Singapore. Three hundred fifty surveys were distributed by fax and 50 were sent out by post and by hand in January 1999. Although a web version of the questionnaire was placed on the Internet, the overwhelming majority of ASME members replied by fax. A total of 58 responses were received; 43 by fax, 10 by post and the remaining 5 electronically online. In order to encourage participation, Andersen Consulting kindly provided multimedia CD-ROMs on EC for the first 50 respondents to the survey.

5. Analysis

General Profile and Summary Statistics

Fifty-eight ASME members responded to the survey, representing 14.5% of the 400 total number sent out. This represents considerably less than 1% of the total SME population in Singapore. Although, there is no reason to suspect undue bias (except as noted below) in the responses, inferences made will have to be viewed with caution due to higher likelihood of sampling variability.

Of the 58 surveys received 41 companies (70.7%) engaged exclusively in business-to-business transactions in the course of their normal (and mostly non-Internet) operations. The remaining 17 companies (29.3%) engaged in business-to-business as well as business-to-consumer transactions.

Respondents of the survey also can be grouped into three main categories: manufacturing (28%), service (36%) and trade (31%), with 5% unknown (not stated). This represents a rough cross section of industries in Singapore.

Table 2 presents a breakdown of Internet use by SMEs. A high percentage of those surveyed (91.4%) have Internet access within the company. The majority of companies who have Internet access use it for seeking information (92.6%) as well as for electronic mail (90.7%). In contrast, only about a quarter use the Internet for transactions (27.8% cited buying items, and 24.1% cited the selling of items—categories not necessarily mutually exclusive).

Table 2: SME Internet Activities

Activity	Percent
Seeking Information	92.6
Email	90.7
Buying of Items	27.8
Selling of Items	24.1

From the surveys received, 55.2% of the respondents have a homepage. The time from when companies first created a web site ranges from 4 months to 48 months. The mean time period is 1 year 6 months. Thus, these companies are relatively new to this medium. Responses indicate that

companies have a web page in order to 1.) gain competitive advantage (72.7%), 2.) explore a new mode of business (65.7%) and 3.) in response to pressures from competitors (24.2%).

Whilst the sample represents an approximate cross section of SMEs in Singapore, respondents are relatively IT savvy and are generally interested in finding out more about EC. This may bias them in more in favour of adoption of EC, relative to the population. This can be inferred by the high percentage (91.4%) of companies having Internet access in their companies and the relatively high percentage (55.2%) of them having a web site. The mean amount of time that the companies have been adopting homepages (1.5 years) shows that the group of companies surveyed has had reasonable exposure on the Internet (considering its rapid rise). Most of these companies realise the importance of the Internet and have carried out some form of activities over the Internet (Table 2). We discuss the impact of possible IT bias in the section on limitations below.

With reference to Rogers' model of innovation-decision process (Figure 1), the overwhelming majority of respondents have had Internet exposure and can be said to have moved from the knowledge stage to the persuasion stage. In the persuasion stage, the five perceived characteristics of innovation highlighted by Rogers are used to explain the factors that affect respondents' willingness to adopt EC. Rogers notes that this persuasion will eventually lead the companies to the decision stage, whereby they will have to decide whether to adopt or reject EC.

Factor Analysis and Reliability

Factor analysis enables exploration of how well the survey questions from Part B correlate with the five characteristics identified by Rogers. The technique, thus, facilitates distillation of the questions into five factors or components that are associated with Rogers' attributes. These factors, embodying the essence of the survey questions, grouped by attribute, then serve as independent variables in the regression model discussed in the next section. Initial runs showed that several questions did not correlate well, even after Varimax rotation. Questions 3, 12, 13 and 15 did not correlate highly with other questions associated with the respective characteristic and were therefore excluded from further analysis.

Table 3 presents summary results of the factor analysis run with only the included survey questions from Part B. Deciding the number of factors to retain is difficult, but it seemed justifiable, both on the basis of evidence, as well as theory, to retain five factors only, although we acknowledge that the fourth and fifth factors were very close to exclusion.

Table 3: Rogers' Attributes: Factor Analysis Summary

Component	Sums of Square Loadings			Rotation Sums of Squared Loadings		
	Total (Eigen Value)	Percent of Variance	Cumulative	Total (Eigen Value)	Percent of Variance	Cumulative
1	3.05	25.40	25.40	2.04	17.01	17.01
2	2.45	20.43	45.83	1.81	15.12	32.13
3	1.33	11.04	56.87	1.80	14.99	47.12
4	0.92	7.65	64.51	1.78	14.83	61.94
5	0.87	7.25	71.76	1.18	9.82	71.76
6	0.80	6.65	78.41	na	na	na

Notes: Extraction method: Principal Components Analysis; Rotation method: Varimax; Observations: 57

Table 4 presents a correlation matrix of the five factors and included survey questions. Generally, the questions correlate highly with the appropriate factor. The exceptions are for Question 1 (also correlates with the Trialability factor) and Question 6 (also correlates with the Observability factor).

Table 4: Factor-Question Correlation Matrix

Characteristic (Factor)	Correlations											
	Q1	Q2	Q4	Q7	Q5	Q6	Q8	Q10	Q11	Q14	Q16	Q17
Rel Advantage (1)	***.57***	***.55***	***.82***	***.81***	.18	-.13	.063	.054	-.019	-.033	.055	.14
Compatibility (4)	.062	.44	.044	.068	***.77***	***.62***	***.71***	.14	-.0047	-.17	.037	-.012
Complexity (2)	.19	-.050	-.11	-.0086	-.096	.0074	.264	***.82***	***.91***	-.28	-.16	-.25
Trialability (5)	.525	.40	-.10	.079	-.20	.048	.044	-.17	-.0015	***.79***	.16	.075
Observability (3)	-.016	-.018	.051	.23	.045	-.60	.076	-.23	-.18	.27	***.83***	***.72***

Factor analysis also enables distillation of the seven questions in Part C of the survey designed to measure willingness to adopt EC. Results presented in Table 5 are surprising in that two factors appear to be relevant in characterising these data.

Table 5: Willingness to Adopt EC: Factor Analysis Summary

Component	Sums of Square Loadings			Rotation Sums of Squared Loadings		
	Total (Eigen Value)	Percent of Variance	Cumulative	Total (Eigen Value)	Percent of Variance	Cumulative
1	3.94	56.30	56.30	2.82	40.24	40.24
2	1.20	17.07	73.37	2.32	33.13	73.37
3	0.70	9.98	83.35	na	na	na

Notes: Extraction method: Principal Components Analysis; Rotation method: Varimax; Observations: 57

Close inspection of the correlation matrix in Table 6 reveals a possible explanation. After Varimax rotation, Factor 1 correlates highly with Questions 3, 5, 6 and 7 (respectively, replace sales function, replenish

automatically, replace entire sales function and conduct all business). Factor 2 correlates highly with Questions 1, 2 and 4 (respectively, home page, conduct sales and purchase supplies). A glaring exception is Question 5, which correlates almost equally with both factors. Nevertheless, Factor 1 appears to be associated with extreme stages in doing business over the Internet that may not be relevant to SMEs, at least for their perception of the time frame measured. That is, these questions may be more appropriate for multinational corporations. This conjecture is strengthened by the fact that Rogers' variables did not explain Factor 1 in a subsequent linear regression. On this basis, we use Factor 2 as our distilled measure of willingness to adopt EC by SMEs.

Table 6: Factor-Question Correlation Matrix (Survey Part C)

	Correlations						
Factor	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
1	.071	.26	***.87***	.30	***.65***	***.89***	***.84***
2	***.83***	***.86***	.22	***.69***	.55	.22	.15

Table 7 shows results of the internal consistency of questions associated with the five characteristics using the Cronbach Alpha model (based on the average inter-item correlation). Reliability estimates range from .60 to 0.83. For early stages of research Cronbach alphas of at least 0.60 are considered acceptable [19]; [22]. Thus, overall results appeared robust enough to carry out further analysis.

Table 7: Cronbach Alpha Reliability Analysis—Independent Variables

Characteristic	Questions from Survey Part B	Alpha
Relative Advantage	(Q1,2,4,7)	0.73
Compatibility	(Q5,6,8)	0.60
Complexity	(Q10-11)	0.83
Trialability	(Q14)	NA
Observability	(Q16,17)	0.63

Questions associated with willingness to adopt (Part C of the survey) exhibited a high reliability estimate of 0.87.

Regression Analysis

A statistical linear model was estimated so that inferences can be made about the linear relationship that exists between SMEs' willingness to adopt EC and the five characteristics identified by Rogers.

As mentioned above, the dependent variable Y was Factor 2 generated from Part C of the survey. As noted above, 'willingness' is measured by how far in the future will the SME EC that particular form of EC. The five independent variables X_1 to X_5 were generated from factors based on questions from Part B of the survey questionnaire as mentioned above.

The data of the 58 companies collected from the SMEs' survey were compiled and analysed with SPSS. Fifty-seven of the responses were used with one rejection due to incomplete data. The linear regression was estimated with results presented in Table 8.

Table 8: Statistical Results

Willingness to adopt electronic commerce	**Constant**	**Relative Advantage**	**Compatibility**	**Complexity**	**Trialability**	**Observability**
Y =	0.00	$-0.54X_1$	$-0.26X_2$	$0.11X_3$	$-0.21X_4$	$-0.028X_5$
p-value	1.00	0.000**	0.019*	0.296	0.051**	0.80
R^2 = 0.41	**Adjusted R^2** = 0.36		**F-statistic** = 7.2**	**Durbin Watson** = 1.78	**Obs** = 57	

** Significant at the .01 level; * Significant at the 0.10 level

As seen from Table 8, the null hypotheses for the constant, Complexity and Observability are not rejected. In other words, there is not enough evidence to show that these variables have an effect on SMEs' decision to adopt EC. On the other hand, we reject the null hypothesis for Relative Advantage, Compatibility and Trialability, which means that statistically, there is a negative relationship between these variables and SMEs' willingness to adopt EC.

The negative signs are correct in the sense that the dependent variable is measured as time to adopt stages of EC. The further in the future the firm indicates they are willing to adopt, the lower is their receptivity. This is consistent with Rogers' model of the decision process, which noted that the willingness of a person to adopt EC increases with higher perceived attributes.

However, the regression model has less explanatory power than previous work in other areas in which the five characteristics of innovation used in the regression model would explain 49 to 87 percent of the adoption of an innovation. In our analysis, only three out of the five characteristics emerged to be of significance to the adoption process. In total, the regression model showed that the five characteristics explained only about 36 percent of the SMEs' willingness to adopt EC. Conjectures as to why this happened are discussed *anon*.

6. Discussion of Results

The attribute relative advantage emerged as the most important factor affecting SMEs' willingness to adopt EC, both in terms of magnitude as well as significance. This can be logically explained, as relative advantage is akin to the perceived benefits and costs of adopting an innovation. Rogers mentions that diffusion scholars have found relative advantage to be one of the best predictors of an innovation's rate of adoption [21], p. 216). Indeed, Tan & Teo (2000) also find it to be an important determinant of willingness to adopt Internet banking. Fifty-seven percent of the respondents perceived that EC could lower their business cost (Question 1) and up to 81 percent agreed that EC would enable their business to cross international boundaries (Question 4). The high numbers indicate that SMEs see benefits of EC to their business.

Compatibility is also nearly as important in explaining SMEs' willingness to adopt EC. From the summary statistics, up to 79 percent of respondents agreed that EC would be important for their business in the future (Question 7). According to the description of 'compatibility with needs' [21], p. 228), when SMEs recognise that they have a need for EC, and when they understand its consequences, a faster rate of adoption usually occurs.

Trialability has nearly the same effect as compatibility on SMEs' willingness to adopt EC with a coefficient of -0.21 and p-value of 0.051. This supports the idea that grants/subsidies may matter in SMEs' decision to adopt.

Remaining variables did not appear to be important attributes in SME's willingness to engage in EC. This may be related to our earlier question of applicability of these attributes to test for adoption of EC. It could also be related to the type of survey questions used and also to the fact that the sample was biased towards mostly IT-savvy SMEs.[3] The latter reason may explain the insignificance of complexity. SMEs that might be deterred by complexity could have been omitted. Observability may be insignificant due to the way in which EC develops in certain industries. Emergence of new intermediaries changes the nature of competition and need for EC by other players but cannot be observed until the change actually happens. Alternatively, observability also may not have been operationalised adequately. Moore and Benbasat [15] divided observability into two constructs, visibility and result demonstrability.

[3] The authors wish to thank an anonymous HICSS 2001 reviewer for pointing this out.

7. Limitations and Directions for Future Research

Considerable effort was required to encourage the SMEs to participate in the survey, given their busy schedules. We also note that our sample could be biased in favour of companies who are IT savvy given that such companies may have been more inclined to respond. This may affect generalisability. Although the survey given to firms was prefaced with a title explicitly referring to business-to-business dealings, 29.3% engaged in both b-to-b as well as business-to-consumer EC. Responses could have been affected if firms were not careful in their responses. Future work may wish to address these issues.

With a total response of 58 companies, use of factor analysis pushed the limits on the data's ability to reveal significant trends. Classification by industry also was not possible for the same reasons. Whilst the survey's response rate of 14.5% (58 of 400) was acceptable in terms of the Central Limit Theorem, a larger absolute number of responses would overcome this deficiency. Stratified random sampling by industry may provide better ability to note differences between industries and may very well show differences in willingness to adopt EC.

Another difficulty was with how poorly several survey questions correlated with factor attributes. Future work would need to carefully consider how to create sets of questions that match more closely with perceived attributes. This also applies to our measure of willingness to adopt EC. The existence of two factors suggests more needs to be done to focus on questions relevant to SMEs.

As mentioned earlier, EC can be seen as a multi-level activity. Future studies could place more focus in examining the factors that will push adopters from one level to another (from a mere web presence to transacting on-line). This may serve as a valuable guide for Internet solution providers to develop successful SMEs' adoption plans.

8. Implications and Conclusions

Results of this study have implications for researchers who are interested in looking at inhibitors and motivators to EC. One of the most important findings is that the five attributes studied actually explained 36% of the variance to the willingness to adopt. Moreover, significant coefficients for relative advantage and compatibility dovetailed roughly with SME cross-country findings by OECD [20].

Although beyond the scope of this study, it would be interesting to develop a more detailed analysis based on Rogers complete framework (see Figure 2) or at least a more complete operationalisation (see Tan & Teo, 2000). It would also be interesting to study the same phenomenon at a macro-level or policy level instead of a firm level.

(For example, see studies on the impact of environmental factors, industrial policy, and industry structure on IT diffusion [4-6]).

For SMEs, the compatibility issue is significant because it deals with their perception of the importance of EC on their businesses now and in the future. Although almost 80 percent of SMEs agree that EC will be important for them in the future, they may not understand what EC is about and its importance now. Studies in Singapore have indicated that top management generally does not understand what EC is all about [9-11]. This lack of understanding extends to many areas, but most importantly to SMEs' understanding of the new EC business model as it pertains to their business. In addition, these studies also show that they prefer to be followers rather than leaders in the adoption of EC technologies [9-11]. This lack of understanding could have led them to discount the impact of EC and led them to believe that they will have plenty of time to 'adopt' EC.

Moreover, it can be seen that SMEs are most motivated by the prospects of gaining a relative advantage over other businesses. They generally believe that EC can open up the market for them, as well as lowering their business costs. This perception influenced their willingness to adopt EC. On the flip side, it can be said that if companies do not believe EC can provide them a relative advantage, then their motivation to adopt will be low.

Therefore, more needs to be done to address the issue of enticing SMEs to see the potential of EC. Recent media coverage on the potential size and importance of the EC market is a helpful start [18, 28]. Not only do SMEs need to understand the potential size of the market, but they must also believe that engagement will reap relative advantage. In other words, they need to perceive that benefits of EC will outweigh the costs of EC. One way of achieving this is to help them engage in EC with minimal investment and costs. There are at present various incentives by the Government and private sector [17, 27], and several incubation programs are already in place [25]. However, more needs to be done to reduce the cost of adopting EC if it is to gain critical mass quickly within Singapore.

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Appendix A: Survey Design

The complete SME questionnaire totalled 30 questions, divided into four main sections as noted below. A forced Likert scale was used in Parts B and C of the survey to ensure that respondents either agreed or disagreed with each question.

Part A. *General Usage of the Internet* - Information on usage of the Internet by respondents is needed to help determine if the sample is representative of the required population.

Part B. *Factors Affecting Adoption of Electronic Commerce by the SMEs* - Questions in Part B of the survey were formulated with the Rogers' five attributes of innovation in mind.

Part C. *Willingness to Adopt Electronic Commerce* - Questions in Part C of the survey are formulated from the possible levels of electronic commerce discussed in European Commission [8].

Part D. *Demographics* - Companies' information such as the number of employees, turnover and incorporation date.

Appendix B: Selected Portions of Survey sent to member SMEs of the Association of Small and Medium-Sized Enterprises (Singapore) Survey conducted January 1999

Adoption of Electronic Commerce (EC) by Small and Medium Enterprises (SMEs) for Business-to-business Dealings

Part B

On a scale of 1 to 6, (1) being strongly disagree, (6) being strongly agree, please indicate the most appropriate response with regards to how your company feels about doing business over the Internet.

1. Doing business over the Internet will lower our business cost
2. The company would rather spend more money on improving our current mode of business than to try and do business over the Internet.
3. Doing business over the Internet will allow my competitors to know about my company's products (especially our price list).
4. Conducting business over the Internet will allow my company to cross international boundaries.
5. My company would consider doing business over the Internet only when most of our suppliers and customers use it.
6. Changing of company's policy and organisational structure are necessary if my company is to do business over the Internet.
7. Doing business on the Internet will be important for my business in the future.
8. Being heavily reliant on computers would lead to business failure when the computers break down.
9. My company does not have the technical knowledge to do business over the Internet.
10. My company is concerned about the security of payment over the Internet.
11. My company is concerned that information involved in a transaction over the Internet is not private.
12. My company is concerned that the Y2K bug might affect our operations if we start doing business over the Internet before the year 2000.

13. Doing business over the Internet would involve high start-up costs.
14. My company will do business over the Internet if grants/subsidies are given.
15. My company is aware of grants/subsidies given by the government to firms who do business over the Internet.
16. Looking at the results of those who use the Internet to do business will help my company to decide if we should go into it as well.
17. My company is unsure whether doing business over the Internet will generate the desired returns in terms of profit.

Part C

On the scale provided, please indicate how soon you are willing to adopt the different stages of doing business over the Internet.

Current user	Within 1 year	1-2 years	2-5 years	5-10 years	No intention

1. When are you willing to have a homepage for your company?
2. When are you willing to conduct sales through the Internet?
3. When are you willing to replace your entire sales function and sell your products/services through the Internet only?
4. When are you willing to purchase your supplies through the Internet?
5. When are you willing to have your suppliers replenish your supplies through the Internet automatically?
6. When are you willing to replace your entire supply function and purchase from vendors through the Internet only?
7. When are you willing to conduct all your business transactions through the Internet only? (i.e. buy and sell through the Internet)