An Integrated Model of Information Systems Adoption in Small Businesses

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ABSTRACT: Based on theories from the technological innovation literature, this study develops an integrated model of information systems (IS) adoption in small businesses. The model specifies contextual variables such as decision-maker characteristics, IS characteristics, organizational characteristics, and environmental characteristics as primary determinants of IS adoption in small businesses. A questionnaire survey was conducted in 166 small businesses. Data analysis shows that small businesses with certain CEO characteristics (innovativeness and level of IS knowledge), innovation characteristics (relative advantage, compatibility, and complexity of IS), and organizational characteristics (business size and level of employees’ IS knowledge) are more likely to adopt IS. While CEO and innovation characteristics are important determinants of the decision to adopt, they do not affect the extent of IS adoption. The extent of IS adoption is mainly determined by organizational characteristics. Finally, the environmental characteristic of competition has no direct effect on small business adoption of IS.

KEY WORDS AND PHRASES: information systems, innovation theories, small business, technological innovation, technology adoption.
improve their efficiency and effectiveness, and even to gain competitive advantage [45, 70]. With decreasing cost and ever more powerful user-friendly personal computers and better software packages, today the benefits of IS are accessible even to the smallest business. Yet, while large businesses have been using computers for some time, small businesses have been slow in adopting these technological innovations [93]. This slow adoption rate is a critical issue, since small businesses constitute over 90 percent of all businesses in many economies [58].

A review of the published IS literature shows that, to date, the majority of research on small businesses is concentrated on the implementation stage [15, 20, 35, 53, 63, 75, 76, 83, 84], with little empirical research on the determinants of IS adoption in small businesses. An exception is the study by Harrison, Mykytyn, and Riemenschneider [42], which examined the process of executive decisions about IS adoption in small businesses from a broad set of industries considering a variety of IS. They found that attitude, subjective norms, and perceived control are antecedents of intentions to adopt IS. Other studies on IS adoption [55, 92] tend to examine large businesses, and findings from these studies are unlikely to be generalizable to small businesses because of various fundamental differences between large and small businesses [9, 10, 14, 16, 18, 80, 89].

For instance, small businesses tend to have highly centralized structures, with the chief executive officers (CEOs) making most of the critical decisions [61]. The central role of the CEO suggests that the characteristics of the CEO are even more critical in the decision of a small business to adopt IS. Another characteristic of small businesses is the tendency to employ generalists rather than specialists [10]. Even if they wanted to recruit IS specialists, they face difficulties in attracting and retaining skilled IS staff because of the limited career paths available in a small business [35]. As a result, there is a lower level of awareness of the benefits of IS and a lack of IS knowledge and technical skills in small businesses [20, 53, 67]. These knowledge deficiencies, in turn, raise the barrier to IS adoption [3]. In addition, small businesses lack financial resources and are highly susceptible to short-range planning in response to their highly competitive environment [89]. Hence, they do not have funds readily available for IS adoption or tend to adopt the lowest-cost IS, which may be inadequate for their purposes [84]. Because of a tendency to adopt a short-term management perspective, they underestimate the amount of time and effort required for IS implementation, increasing the risks of IS adoption failure [35]. Further, small businesses typically have less slack resources with which to absorb the shocks of an unsuccessful investment in IS adoption.

Because of the unique characteristics of small businesses, there is a need to examine whether models of IS adoption developed in the large-business context can be equally applied to small businesses. While large businesses suffer from many of the same constraints, the effect on small businesses is more significant. The skills, time, and staff necessary for planning are not major issues in large businesses, yet these same issues represent most of the difficulties in small businesses [14]. As such, organizational theories and practices that are applicable to a large business may not fit a small business [9, 14, 16, 89]. There is a need to examine IS adoption in small businesses separately rather than in the relational view commonly used.
While technological innovation including information technology (IT) is well established in developed nations such as the United States, newly industrializing and developing nations have been creating government interventions to accelerate use of IT within their borders [51]. From their review of institutional factors in IT innovation, King et al. [48] concluded that the role of institutions such as governments must be considered an essential component in IT use. However, they added that the appropriate role of institutions has yet to be determined and additional research is required to determine the desirable types of interventions in terms of demonstrated experience. The current study attempts to contribute to this effort by studying IS adoption in the context of Singapore, which is very different in many respects from the United States. The key variables found to be important could then be incorporated into government initiatives to encourage IS adoption in small businesses.

Singapore is a small city-nation situated in southeast Asia that has seen a rapid development of its IT industry in recent years, despite the fact that it is among the world’s smaller nations and is considerably different from the United States in many geographic, cultural, and political respects [25]. As an integral part of its overall economic planning, Singapore has implemented a series of national IT plans and programs to encourage diffusion of IT in both the public and private sectors [39]. The Singapore experience is a model of very proactive government strategy with the appointment of the Committee on National Computerization under the leadership of a minister. A government agency, the National Computer Board (NCB), was set up with the mission to move Singapore toward an information society. The NCB is responsible for effecting successful application of IT in the government, building an IT infrastructure, cultivating an IT culture, facilitating the development of a strong export-oriented IT industry, and formulating IT human-resource development policies and plans. In most of these objectives, the NCB has either achieved or surpassed its goals. By the year 2000, the NCB hopes to transform Singapore into an "intelligent island" [65]. They are installing a national information infrastructure that interconnects computers in virtually every home, office, school, and factory through a high-speed broadband network. All households are expected to be connected by cables to the national information infrastructure by the end of 1999. Presently, various nationwide electronic networks are being set up to be utilized for business transactions in various business sectors including trading, legal, health care, finance, real estate, and retailing. Of these networks, TradeNet and PortNet are fairly well known. More recent networks include MediNet, which links hospitals, clinics, and other medical facilities, and LawNet, which links the various courts of justice with the law firms.

The business culture in Singapore is also very different from that in the United States. Singaporean managers tend to have lower uncertainty avoidance and lower individualism [43, 74, 88]. Lower uncertainty avoidance refers to the degree to which people prefer structured to unstructured situations. Singaporean managers tend to be less structured, to have fewer rules, to employ more generalists, and to be multiform. As a result, they are more involved in strategy, more person-oriented, flexible in their style, and more willing to take risks. Singaporean employees are also less individualistic than those in the United States and expect their employers to look after them like...
a family member, while organizational procedures are based on loyalty and a sense of duty. In the case of small businesses operating in such a culture, authority is heavily concentrated in the CEOs, reinforcing their importance in decisions to adopt IS. As research has shown that management theories, concepts, and practice developed in one culture may not be applicable in other cultures [43] and prior technological innovation studies tend to have been conducted in the United States, the current study extends the technological innovation literature by examining IS adoption in a different culture.

The purpose of this paper is twofold: first, it seeks to fill the void in research on determinants of IS adoption in small businesses, and second, it seeks to understand the determinants of IS adoption in small businesses in the specific context of Singapore. The technological innovation literature is used as the theoretical basis for the research.

Theoretical Background

The functional parallels between IS adoption and technological innovation adoption have been suggested by various IS researchers [46, 52, 59]. Since IS can be considered a technological innovation, it may be fruitful to use technological innovation theories as a reference discipline for empirical studies of IS adoption. Rogers [78], an authority on innovation theory, defined an innovation as an idea, practice, or object that is perceived as new by an individual or other unit of adoption. Thus, not only is an innovation a renewal by means of technology, but it can also refer to renewal in terms of thought and action [71]. The innovation itself need not be new, as measured by the time of its discovery or invention. It only has to be perceived as new by the unit of adoption [94]. This suggests that an innovation is any product or process that has been put into practice and is nontrivial to the business. The innovation presents potential adopters with new means of solving problems and exploiting opportunities.

The characteristics of an innovation can be differentiated along four dimensions [71]. First, there are process innovations and product innovations. Process innovations are innovations that improve the production process through the introduction of new methods, machines, or production systems. Process innovations apply not only to the traditional definition of production but also to data processing, distribution, and services. IS adoption would fall under this category. Product innovations, on the other hand, involve the development, production, and dissemination of new consumer and capital goods and services. Second, innovations can be either radical (shock-like) or incremental (gradual). Basically, radical innovations are fundamental changes that represent revolutionary changes in technology, while incremental innovations are minor improvements or simple changes in current technology [22]. IS are radical innovations. For a small business with little IS knowledge, embarking on IS adoption for the first time is nontrivial; it involves a lot of uncertainty and risk. The adoption of IS is likely to cause changes in work procedures and to increase computer anxiety among the employees. Third, innovations can occur because of technology-push or market-pull. Technology-push implies that an innovation is developed and offered in
a matured form on the capital-goods market. Under pressure exerted by the competing suppliers and the ascribed superiority of the new innovation, the market is required to absorb the new innovation. In a market-pull, a social need is felt, acknowledged, and translated into technical demand. In response to this demand, a new technology is developed. Both technology-push and market-pull have had an effect on adoption of IS [48]. Finally, a distinction can be made between planned and incidental innovation. Planned innovations are innovations that are carried out according to plan where the business aims to control the market through its innovation. Innovations are considered incidental when they occur as a specific reaction of a business to new market demand. Both approaches are applicable for the adoption of IS.

The technological innovation literature has identified many variables that are possible determinants of organizational adoption of an innovation. This large number of variables suggests that more research is needed to identify the critical ones [79]. In an agenda for innovation processes research, Eveland, Hetzner, and Tornatzky [29] contend that a closer consideration of organizational variables with a primary focus on rigorous empirical studies is warranted. However, some researchers question the possibility of developing a unifying theory of innovation adoption and diffusion that can apply to all types of innovations [23, 32, 47]. They argue that a unifying theory might be inappropriate in view of the fundamental differences between types of innovations. Fichman and Kemerer [32] claim that the variations in innovations (e.g., product versus process, administrative versus technical, incremental versus radical) and the adoption contexts in which they may be applied (e.g., individual versus organizational adoption, autonomous versus nonautonomous adoption decisions, competitive versus noncompetitive adoption environments) are simply too great. In a review of eighteen empirical studies of IS diffusion, Fichman [31] found that IS innovations may have different levels of knowledge burden and locus of adoption (individual versus organization), and classical innovation theories need to be tailored to the adoption context.

In response to the lack of a unifying theory of innovation adoption, it is essential to include the distinctive characteristics of context in the development of a strong theory to study innovation adoption [32, 85, 95]. Various researchers have attempted to identify these contexts. An important context identified by Rogers [78] is characteristics of the innovation. This is supported by Prescott and Conger [73], who reviewed seventy IS-related papers and concluded that Rogers’s [78] diffusion of innovation theory appears to be most applicable to innovations with an intraorganizational locus of impact. While Rogers’s [78] innovation characteristics are an important context, IS researchers have combined them with other contexts to provide a richer and potentially more explanatory model [72]. Kimberly and Evanisko [47] identified three other clusters of predictors of innovation adoption—characteristics of organizational leaders, characteristics of organizations, and characteristics of environmental context. Tornatzky and Fleischer [85] conceptualized the context of technological innovation as consisting of three elements—organizational context, technological context, and environmental context—that influence the technological innovation decision. In summary, four elements of context can be identified in the technological innovation
literature: (1) characteristics of the organizational decision makers; (2) characteristics of the technological innovation; (3) characteristics of the organization; and (4) characteristics of the environment in which the organization operates.

Research Model

There are two related but distinct research questions: (1) What variables determine the decision of small businesses to adopt IS? and (2) If the decision is to adopt IS, what variables determine the extent of IS adoption? The first research question is concerned with whether a small business is using IS or not, while the second research question is concerned with why some small businesses make more use of IS than others. Based on the technological innovation literature, an integrated model of IS adoption specifically for small businesses was developed (see figure 1). Each of the variables is discussed below.

IS Adoption

The dependent variable is adoption of IS. In this study, adoption of IS is defined as using computer hardware and software applications to support operations, management, and decision making in the business [17]. This implies that the IS are used productively and are not "white elephants." There are two measures for the dependent variable. The first measure, likelihood of IS adoption, was operationalized as a dichotomy: whether the business is or is not computerized. This measure is commonly used in innovation diffusion research [31, 86]. A dichotomous measure was used because the first research question of this study is to identify variables that distinguish a computerized small business from a noncomputerized one. Following the example of Alpar and Reeves [1], a business is defined as computerized if it uses at least one major software application listed in the software application table (see appendix A). This list excluded word processing packages. The second measure of IS adoption, extent of IS adoption, was operationalized by the number of personal computers [4, 55] and the number of software applications in use in each business. This measure indicates the degree to which IS has been adopted. In the case of minicomputers, the number of terminals was used to derive an equivalent number of personal computers. By using the above measurement of IS adoption, this study will include only active users of IS as adopters and exclude small businesses that have discontinued their IS usage.

CEO Characteristics

In a small business, the CEO is usually the owner-manager. Since the CEO is the main decision maker, the characteristics of the CEO are crucial in determining the innovative attitude of the small business [77]. This is because the CEO's qualities are the determinants of the overall management style of the business [79]. In fact, the rate at which a small business changes depends not only on factors such as business size or
Figure 1. IS Adoption Model for Small Businesses

market forces, but also on the abilities and inclinations of the CEO and the extent to which he or she is able or prepared to devolve management [8]. It is the role adopted by the CEO that determines the innovativeness of the business [12]. There is also evidence in the technological literature that those who allocate organizational resources influence innovation adoption [6, 40, 90].

CEO's Innovativeness

In his theory of innovativeness, Kirton [49] contends that everyone is located on a continuum ranging from an ability to do things better to an ability to do things
differently. He calls the two extreme ends of the continuum adaptors and innovators, respectively. In the case of a small business, the adaptor CEO would seek solutions that have already been tried and understood. On the other hand, the innovator CEO would prefer solutions that change the structure in which the problem is embedded—in other words, solutions that have not been tried out and are therefore risky [50]. Unless the CEO has the will to innovate, there is little that other members of the business can do to expedite IS adoption or increase the extent of IS adoption.

\[ H1a: \text{Innovativeness of the CEO will be positively related to the likelihood of IS adoption.} \]

\[ H1b: \text{Innovativeness of the CEO will be positively related to the extent of IS adoption.} \]

CEO’s IS Knowledge

Attewell [3] conceptualizes the diffusion of complex technological innovations in terms of decreasing knowledge barriers. Because of obstacles with developing the necessary skills and technical knowledge, many businesses are tempted to postpone adoption of the innovation until the barriers to adoption are lowered or circumvented. The implication of this theory is that overcoming the lack of knowledge of the innovation will lead to greater likelihood of adopting the innovation. Ettlie [27] has also found that CEOs with more knowledge of the technological innovation are significantly more likely to implement an aggressive technology adoption policy. Gable and Raman [36] found that CEOs in small businesses tend to lack basic knowledge and awareness of IS. Many of them reject the notion that IS could be of any use to their businesses as they have no idea of the potential benefits IS offer. This seems to imply that, if these CEOs could be educated about the benefits of IS, they would be more willing to adopt such technology.

\[ H2a: \text{CEO's IS knowledge will be positively related to the likelihood of IS adoption.} \]

\[ H2b: \text{CEO's IS knowledge will be positively related to the extent of IS adoption.} \]

IS Characteristics

Perception of IS Attributes

Research on innovation has identified characteristics of the innovation as perceived by the adopting business as having influence on the adoption of innovations [78]. According to Rogers’s [78] innovation theory, an individual forms an attitude toward the innovation, leading to a decision to adopt or reject and, if the decision is to adopt, to implementation of the innovation. The perception of the potential adopter toward the IS is the primary determinant of IS adoption. Based on a meta analysis of the
technological innovation literature concerning characteristics of innovations. Tornatzky and Klein [86] identified relative advantage, compatibility, and complexity as innovation characteristics that are salient to the attitude formation. Relative advantage is the degree to which an innovation is perceived as better than its precursor [78]. The positive perceptions of the benefits of IS should provide an incentive for the small business to adopt the innovation. Compatibility is the degree to which an innovation is perceived as consistent with the existing values, needs, and past experiences of the potential adopter [78]. If the IS are compatible with existing work practices, the small business will be more likely to adopt them. Complexity refers to the degree to which an innovation is perceived as difficult to use [78]. The perceived complexity of the IS is expected to influence the decision to adopt them negatively.

**H3a:** Relative advantage of IS will be positively related to the likelihood of IS adoption.

**H3b:** Relative advantage of IS will be positively related to the extent of IS adoption.

**H4a:** Compatibility of IS will be positively related to the likelihood of IS adoption.

**H4b:** Compatibility of IS will be positively related to the extent of IS adoption.

**H5a:** Complexity of IS will be negatively related to the likelihood of IS adoption.

**H5b:** Complexity of IS will be negatively related to the extent of IS adoption.

## Organizational Characteristics

### Business Size

The technological innovation literature has found that larger businesses have more resources and infrastructure to facilitate innovation adoption [22, 62, 87]. Small businesses suffer from a special condition commonly referred to as resource poverty. Resource poverty results from various conditions unique to small businesses, such as operating in a highly competitive environment, financial constraints, lack of professional expertise, and susceptibility to external forces. Because of these unique conditions, small businesses are characterized by severe constraints on financial resources, a lack of in-house IS expertise, and a short-range management perspective [89]. Consequently, small businesses face substantially more barriers to adoption of IS and are less likely to adopt IS than large businesses [24]. Alpar and Reeves [1] argue that, even among small businesses, the larger the business, the more able it is to hire people with specialized skills, such as knowledge of IS. In addition, it would appear reasonable to suppose that larger businesses have more potential to use IS than smaller businesses, simply because of their larger scale of operations [6, 55, 62].

**H6a:** Business size will be positively related to the likelihood of IS adoption.

**H6b:** Business size will be positively related to the extent of IS adoption.
Employees' IS Knowledge

Similarly, Attewell's [3] technological innovation theory has implications for employees of small businesses. Typically, small businesses are lacking in specialized IS knowledge and technical skills [20, 35, 53]. Neidleman [67] attributes the failure of European small businesses to utilize IS to lack of IS knowledge. Because of obstacles with developing the necessary skills and technical knowledge, many businesses are tempted to postpone adoption of the innovation until they have sufficient internal expertise. Hence, if employees of small businesses are knowledgeable about IS, the businesses may be more willing to adopt IS and adopt more IS. Further, there is empirical evidence that businesses with employees who have more knowledge of the technological innovation are likely to use more of the innovation [27].

\[ H7a: \text{Employees' IS knowledge will be positively related to the likelihood of IS adoption.} \]

\[ H7b: \text{Employees' IS knowledge will be positively related to the extent of IS adoption.} \]

Information Intensity

The information-processing theory of Galbraith [37] concentrates on the processes through which the environment influences a business's actions. The degree to which information is present in the product or service of a business reflects the level of information intensity of that product or service. Businesses in different sectors have different information-processing needs, and those in more information-intensive sectors are more likely to adopt IS than those in less information-intensive sectors [92]. For instance, travel agencies are more information-intensive, as their main functions are to process and package tour information. Further, the greater the information intensity, the greater the potential for strategic uses of IS in a business [70]. Greater information intensity will lead the CEO of a small business to perceive IS as a major competitive tool and therefore increase the likelihood and extent of IS adoption.

\[ H8a: \text{Information intensity will be positively related to the likelihood of IS adoption.} \]

\[ H8b: \text{Information intensity will be positively related to the extent of IS adoption.} \]

Environmental Characteristic

Competition

By competition, we mean the business environment in which the business operates. It is generally believed that competition increases the likelihood of innovation adoption [47, 56, 87]. It is tough rivalry that pushes businesses to be innovative. Empirically,
studies have shown that more intense competition is associated with higher adoption rates [38, 54]. Competition leads to environmental uncertainty and increases both the need for and the rate of innovation adoption [26, 28]. Porter and Millar [70] suggest that, by adopting IS, businesses will be able to compete in three ways. IS can change the industry structure and, in so doing, alter the rules of competition. IS can also create competitive advantage by giving businesses new ways to outperform their rivals. Finally, IS spawn new businesses, often from within existing operations of the business. Therefore, a small business in an environment that is more competitive would feel a greater need to turn to IS to gain a competitive advantage. On the other hand, a small business in a less competitive environment would not be faced with a push to be innovative.

H9a: Competition will be positively related to the likelihood of IS adoption.
H9b: Competition will be positively related to the extent of IS adoption.

Research Methodology

Measurement of the Variables

STANDARD INSTRUMENTS WERE USED AS MUCH AS POSSIBLE. CEO innovativeness was measured by Kirton’s [49] Adaption-Innovation Inventory (KAI) instrument. The KAI is a list of thirty-two items describing the adaption-innovation scale to measure a person’s innovativeness. This instrument has been widely used in organization studies and found to be reliable and valid for measuring cognitive styles [5]. IS characteristics were measured by items taken from Moore and Benbasat’s [64] instrument, which was designed to measure the various perceptions that an individual might have of adopting an IS innovation. Business size was measured by number of employees, a popular measure used by researchers on small businesses [15, 20, 63, 75, 76] and innovation adoption (see [47, 60, 95]). Because the values of size were highly skewed, they were subjected to a logarithmic transformation to reduce the variance [47].

The operationalization of the remaining research variables was developed especially for this study. In some cases, items were adapted from previously used scales. All perceptual items were measured by five-point Likert scales representing a range from “strongly disagree” to “strongly agree.” Although objective measures would be desirable, subjective measures could be appropriate surrogates [21].

Two items were used to measure CEOs’ IS knowledge. The first item assessed the respondent’s level of understanding of IS as compared with other people in similar positions. The second item assessed the respondent’s types of IS experience. The various types of IS experience included: (1) attended computer classes; (2) use a computer at home; (3) use a computer at work; and (4) have formal qualifications in the use and operation of a computer. The items were adapted from DeLone [19]. A score of one was assigned when the respondent had no computer experience; otherwise a score was assigned according to the procedure in appendix B. The rationale for the
index of IS knowledge was that the variable is multidimensional. The CEOs were
asked to ascertain their own IS knowledge before IS adoption by the small businesses.
This was to ensure that the CEOs did not inflate their level of IS knowledge with
experience gained after IS adoption.

Employees’ IS knowledge was measured by three items. These items included: (1)
my employees were all computer-literate; (2) there was at least one employee who
was a computer expert; and (3) I would rate my employees’ understanding of
computers as very good compared with other small companies in the same industry.
Similarly, the CEOs were asked to ascertain their employees’ IS knowledge before
adoption of IS. This was to ensure that the CEOs did not inflate the level of employees’
IS knowledge with experience gained after adoption of IS.

The information intensity of a business’s service or product was measured by the
dependence of the business on three attributes of information: currency of information,

Competition was measured by three items, based on Porter and Millar’s [70] concept
of competitive forces: ease for a customer to switch to a competitor, level of rivalry
among businesses in the same industry, and effect of substitutable products and
services.

Data Collection Procedure

Data collection was conducted in two phases: a pilot study phase and a questionnaire
survey phase. One questionnaire was designed for data collection. The CEO of the
small business was chosen to be the key informant in this study. Since the CEO is
typically the owner-manager in a small business, it is reasonable to assume that the
current CEO is the same CEO who decided on IS adoption. In the pilot-study phase,
five small businesses were randomly chosen from a small business database to pretest
the questionnaires. Five CEOs completed the questionnaires. Next, interviews were
conducted with these CEOs to determine whether there were any problems with the
questionnaire. Based on feedback from these CEOs, very minor modifications were
made to the questionnaire for the next phase of data collection. Responses from these
five pilot-study businesses were not included in the final sample.

In the questionnaire survey phase, a package was mailed to the CEO of each of the
small businesses in the survey sample. The package contained three items: a covering
letter, one CEO questionnaire, and a prepaid reply envelope. The cover letter explained
the purpose of the survey and asked the CEO to return the completed questionnaire
within three weeks in a prepaid reply envelope. The respondents were assured of the
confidentiality of their responses.

The Sample

There is no generally accepted definition of a small business. Three commonly used
criteria for defining a small business were number of employees, annual sales, and
fixed assets. In this study, the criteria for defining a small business were adopted from
The names and addresses of 800 small businesses that meet the ASME criteria were obtained from a small business database provided by the National Computer Board (NCB) in Singapore. The NCB is the government agency overseeing the promotion of IT to improve productivity and competitiveness in all sectors of the Singapore economy. Although the number of businesses supplied by the NCB was large, the database was not current and some businesses might have moved or gone out of business. Hence, an additional 400 businesses were selected at random from the telephone directory. Of the 1,200 questionnaires mailed out, 294 were returned. However, 122 questionnaires were returned uncompleted because businesses had changed their addresses or were no longer in operation. Responses from six businesses were excluded from the final sample because those firms did not meet the criteria of a small business, resulting in 166 usable questionnaires.

Small businesses are known to have a high mortality rate [81]. They are also highly mobile, depending on the rental of their premises and whether their businesses are expanding or contracting. Since the survey database was outdated, there was a high probability that a significant number was either defunct or had moved, making them uncontactable for this survey. To check for this possibility, we obtained the new telephone directory that was published just after the data-collection time frame. According to the updated directory, 433 businesses were no longer listed and 352 businesses had changed address. This list was cross-checked against the Registry of Companies and Business’s (RCB) database. In Singapore, all businesses are required to file their annual reports with the RCB. Hence, the effective sampling frame consisted of 409 businesses (1,200–433–352–6), and the effective response rate was 40.6 percent (166/409). This response rate was considered very good notwithstanding that the survey was unsolicited, without any prior knowledge on the part of respondents.

To check that these responses were representative of the larger population, nonresponse bias was assessed by comparing early respondents with late respondents in terms of three key organizational characteristics of the sample [2]. The rationale for this test was that late respondents were likely to have similar characteristics to nonrespondents. The three characteristics were number of employees, fixed assets, and sales turnover. T-tests showed no significant difference between the two groups of respondents in terms of number of employees (t = 1.23; p = 0.228), fixed assets (t = 1.29; p = 0.208), and sales turnover (t = 0.64; p = 0.528) at the 5 percent significance level, suggesting that nonresponse bias was not a problem.

Nonresponse bias was also assessed using an alternative approach of comparing the profile of this study’s sample with other available data on IS adoption [34]. Of the responding sample, 120 small businesses (72 percent) had adopted IS. This figure corresponded closely with the national average of 68 percent for small businesses,
Table 1. Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adopter (n = 120)</th>
<th>Nonadopter (n = 46)</th>
<th>Cronbach alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std dev</td>
<td>Mean</td>
</tr>
<tr>
<td>CEO’s innovativeness</td>
<td>3.01</td>
<td>0.38</td>
<td>2.86</td>
</tr>
<tr>
<td>CEO’s IS knowledge</td>
<td>2.86</td>
<td>1.01</td>
<td>2.15</td>
</tr>
<tr>
<td>Relative advantage of IS</td>
<td>4.17</td>
<td>0.57</td>
<td>3.71</td>
</tr>
<tr>
<td>Compatibility of IS</td>
<td>4.09</td>
<td>0.75</td>
<td>3.45</td>
</tr>
<tr>
<td>Complexity of IS&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.45</td>
<td>0.91</td>
<td>3.01</td>
</tr>
<tr>
<td>Business size&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.37</td>
<td>0.48</td>
<td>0.99</td>
</tr>
<tr>
<td>Employees’ IS knowledge</td>
<td>2.81</td>
<td>0.98</td>
<td>2.07</td>
</tr>
<tr>
<td>Information intensity</td>
<td>3.79</td>
<td>0.99</td>
<td>3.53</td>
</tr>
<tr>
<td>Competition</td>
<td>3.65</td>
<td>0.95</td>
<td>3.84</td>
</tr>
</tbody>
</table>

<sup>a</sup> A low score means high complexity.

<sup>b</sup> Measured as log(number of employees). Remaining variables measured on 1 to 5 scale.

Instrument Validation

The psychometric properties of the research variables were examined. Measurement of a variable must be reliable to be useful and yield stable results. For each composite research variable, the reliability or internal consistency was assessed by calculating the Cronbach alpha coefficient. Table 1 presents the standardized Cronbach alpha coefficients for the research variables. All the reliability coefficients, except for CEO’s IS knowledge, met the generally accepted guideline of 0.70 and above to qualify as reliable measures [41]. The lower reliability of CEO’s IS knowledge may be due to the use of only two items, since the Cronbach alpha coefficient tends to increase with the number of items. Further tests of the reliability of the variables are discussed below.

Besides being reliable, measurement of a variable must be valid, that is, it must measure what it is intended to measure. Construct validity is the extent to which a particular item relates to other items consistent with theoretically derived hypotheses concerning the variables that are being measured. The construct validity of the specially developed research variables was examined using factor analysis. Table 2 presents the results. The factor analysis indicated that all the factor loadings were
### Table 2. Factor Analysis of Research Variables

<table>
<thead>
<tr>
<th>Items</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Factor 5</th>
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<td>0.736</td>
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</table>

Note: Figures are factor loadings.

greater than the cutoff point of 0.50, as recommended by Nunnally [68]. Except for two measures of IS attributes, the items loaded on their hypothesized variables. In the case of relative advantage and compatibility, the items loaded on the same factor. Both Moore and Benbasat [64] and Benham and Raymond [7] had similar experience in empirical testing of these scales. Although there may be a conceptual difference between relative advantage and compatibility, they are being viewed identically by respondents, or there is a causal relationship between them [64]. Moore and Benbasat [64] give as an example the unlikelihood that respondents would perceive the various advantages of using IS if their use were in fact not compatible with the respondents’ experience or work style. In this study, we combined the items measuring these two closely related variables into a single variable. For subsequent statistical analysis, the score for each composite research variable was the aggregate of a respondent’s scores for items defined to measure that variable.
Data Analysis

Correlation Matrices

The Pearson correlation matrix for likelihood of IS adoption was examined for the extent of multicollinearity problems (see Table 3). The highest squared correlation among the independent variables was 0.19 between the aggregated measure of relative advantage/compatibility of IS and complexity of IS. None of the squared correlations was close to 0.80 to suggest a problem with multicollinearity among the research variables [41]. Similarly, the Pearson correlation matrix for extent of IS adoption was examined (see Table 4). The highest squared correlation among the independent variables was 0.23, between the aggregated measure of relative advantage/compatibility of IS and complexity of IS. Again, there was no evidence of significant multicollinearity among the research variables.

Hypotheses Testing

The individual hypotheses with regard to the decision to adopt IS were tested by using discriminant analysis. Discriminant analysis is a technique to study the differences between two groups with respect to two or more independent variables simultaneously. It is the appropriate statistical technique when the dependent variable is categorical (e.g., adopters or nonadopters) and the independent variables are interval data [41].

The results of the discriminant analysis are presented in Table 5. According to the Wilks' lambda of 0.72 ($\chi^2 = 43.36, df = 8, p = 0.0000$), the overall model was significant. A further indicator of the effectiveness of the discriminant function is the degree of predictive accuracy measured by the percentages of cases (or businesses) classified correctly. The discriminant function correctly classified 75.4 percent of the businesses in the sample, which exceeded the hit ratio of 59.9 percent that would be expected due to chance [41]. The individual correct classification rates for adopters and nonadopters were 78.4 percent and 68.3 percent, respectively. The probabilities for the F-statistics identify the independent variables that are significant discriminators between the two groups. The discriminant loadings or structure correlations show how closely a variable and the discriminant function are related. The discriminant loadings reflect the variance that the independent variables share with the discriminant function and can be used to assess the relative contribution of each independent variable to the discriminant function. Generally, any variables exhibiting discriminant loadings greater than or equal to 0.30 are considered significant [41].

The results supported hypotheses 1a, 2a, 3a, 4a, 5a, 6a, and 7a. The likelihood of IS adoption was significantly associated with CEO characteristics (CEO's innovativeness and CEO's IS knowledge), IS characteristics (relative advantage, compatibility, and complexity of IS), and two attributes of organizational characteristics (business size and employees' IS knowledge). One organizational characteristic (information intensity) and the environmental characteristic (competition) were
not significantly related to the decision to adopt IS (see Table 5).

The hypotheses relating to the extent of IS adoption were tested by partial least squares (PLS), a structural equation modeling technique (see Table 6). This technique is appropriate when the dependent variable is of interval scale [91]. PLS allows simultaneous evaluations of both the measurement model (reliability and validity of variables) and the structural model involving the variables. In this study, we used Lohmoller's [57] PLS program to analyze the data. Jackknifing was used to produce parameter estimates, standard errors, and t-values. A 5 percent level of significance was used for all the statistical tests.

In PLS analysis, the reliability of a variable is evaluated by computing composite reliability while convergent validity is evaluated by the average variance extracted [33]. Acceptable values for composite reliability and average variance extracted are 0.7 and 0.5, respectively [13]. From Table 6, all the variables were reliable and met the condition for convergent validity. Discriminant validity of the variables was evaluated by comparing the average variance extracted for the variable with the squared correlations between it and the other variables. In all cases, the average variance extracted was greater than the squared correlations between variables, indicating that all the variables in the model exhibited discriminant validity.

Once the reliability and validity of the variables were established, the structural model could be assessed to see if it supported the hypotheses. The percentage of variance explained ($R^2$) was 43 percent, implying a satisfactory and substantive model [30]. Three of the standardized path coefficients were significant at the 5 percent level. The results supported hypotheses 6b, 7b, and 8b. The extent of IS adoption was significantly associated with all three organizational characteristics (business size,
Table 4. Correlation Matrix for Extent of IS Adoption (Adopters Only)

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)  CEO's innovativeness</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2)  CEO's IS knowledge</td>
<td></td>
<td>0.154</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3)  Rel. adv./compatibility</td>
<td></td>
<td></td>
<td>-0.010</td>
<td>-0.171</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(4)  Complexity</td>
<td></td>
<td></td>
<td></td>
<td>-0.009</td>
<td>0.006</td>
<td>0.480**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5)  Business size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.155</td>
<td>0.083</td>
<td>-0.153</td>
<td>-0.024</td>
<td>1.000</td>
</tr>
<tr>
<td>(6)  Employees' IS knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.010</td>
<td>0.167</td>
<td>0.130</td>
<td>0.315**</td>
<td>0.116</td>
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<tr>
<td>(7)  Information intensity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.111</td>
<td>-0.003</td>
<td>0.128</td>
</tr>
<tr>
<td>(8)  Competition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.043</td>
<td>0.020</td>
</tr>
<tr>
<td>(9)  Extent of IS adoption</td>
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<td></td>
<td></td>
<td>0.167</td>
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</table>

* p < 0.05; ** p < 0.01.

Table 5. Discriminant Analysis for Likelihood of IS Adoption

<table>
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<tr>
<th>Variables</th>
<th>F-value</th>
<th>Significance</th>
<th>Discriminant loadings</th>
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</thead>
<tbody>
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<td><strong>CEO characteristics</strong></td>
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<td></td>
</tr>
<tr>
<td>CEO's innovativeness</td>
<td>6.38</td>
<td>0.013*</td>
<td>0.347</td>
</tr>
<tr>
<td>CEO's IS knowledge</td>
<td>12.92</td>
<td>0.001**</td>
<td>0.494</td>
</tr>
<tr>
<td><strong>IS characteristics</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Relative advantage/compatibility</td>
<td>13.31</td>
<td>0.000**</td>
<td>0.502</td>
</tr>
<tr>
<td>Complexity</td>
<td>6.24</td>
<td>0.014*</td>
<td>0.343</td>
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<td><strong>Organizational characteristics</strong></td>
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<tr>
<td>Business size</td>
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<td>Employees' IS knowledge</td>
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<td>0.001**</td>
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<tr>
<td>Information intensity</td>
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<td><strong>Environmental characteristic</strong></td>
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</tr>
<tr>
<td>Competition</td>
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<td>-0.146</td>
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</table>

* p < 0.05; ** p < 0.01.
Table 6. PLS Analysis for Extent of IS Adoption (Adopters Only)

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<td>reliability</td>
<td>variance</td>
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<td>1.00</td>
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<tr>
<td>CEO's IS knowledge</td>
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<td>0.72</td>
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<tr>
<td><strong>IS characteristics</strong></td>
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<tr>
<td>Relative advantage/compatibility</td>
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<tr>
<td>Business size</td>
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<td>1.00</td>
</tr>
<tr>
<td>Employees' IS knowledge</td>
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<tr>
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<td><strong>Environmental characteristics</strong></td>
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<td>0.60</td>
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<tr>
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</tbody>
</table>

*p < 0.05; **p < 0.01; \( R^2 = 0.43 \).

employees' IS knowledge, and information intensity). CEO characteristics, IS characteristics, and environmental characteristics were not significantly related to the extent of IS adoption.

Discussion

Likelihood of IS Adoption

The data analysis shows that IS characteristics have a major effect on the decision to adopt. Small businesses with more positive attitude toward IS characteristics are more likely to adopt IS. This result provides support for Rogers's [78] innovation theory in the small business context. Three essential attributes of the innovation that affect the formation of attitude are relative advantage, compatibility, and complexity. If the innovation is viewed as better than the existing manual system, is consistent with the needs of the adopting business, and is easy to use and understand, then there is a greater chance that a favorable attitude toward the innovation will be formed. In the context of IS adoption by small businesses, those businesses with CEOs who perceive of IS as beneficial, compatible, and relatively easy to use will be more likely to adopt them.

Another major group of factors affecting the decision to adopt IS consists of the
characteristics of the decision maker. The decision maker's characteristics, specifically CEO's innovativeness and CEO's IS knowledge, are positively associated with the decision to adopt IS in small businesses. IS are complex technological innovations that require large outlays of financial resources for a small business with scarce resources. If the IS implementation is not successful, a small business that is heavily dependent on the IS can suffer irreparable damages from which it may not be able to recover. Hence, IS adoption that involves a substantial investment is a risky venture for a small business, and only a small business with an innovative CEO will be willing to take the risk. Risk taking is an important characteristic of a technology champion [44].

In addition, small businesses with CEOs and employees who are more knowledgeable about IS are more likely to adopt them. This finding is consistent with Attewell's [3] theory of lowering knowledge barriers. To the extent that the small business can lower its knowledge inadequacies, it will facilitate the path to IS adoption. Dewar and Dutton [22] found that extensive knowledge of the innovation is important for the adoption of technical process innovation. Lack of knowledge of the IS adoption process and insufficient awareness of the potential benefits may inhibit small businesses from adopting IS [80]. To address this, small businesses may supplement their inadequate IS knowledge by engaging external IS experts such as consulting firms and IT vendors [83]. The external IT experts can act as Attewell's [3] "supply-side organizations," helping to lower the innovation risk of the small businesses.

Not surprisingly, business size—anther organizational characteristic—is the most significant discriminator between adopters and nonadopters of IS among small businesses. Even among small businesses with limited resources, businesses that are bigger are more likely to adopt IS. As small businesses are characterized by severe constraints on resources such as finance and in-house technical expertise, adoption of IS represents a disproportionately large financial risk [14, 16, 89]. Only those businesses that have adequate financial and organizational resources would consider adoption of IS a viable undertaking. Hence, having adequate resources is a necessary first step toward the decision to adopt IS. This is consistent with findings from other studies in the technological innovation literature (e.g., [47, 56]).

Finally, the remaining organizational characteristic of information intensity and the environmental characteristic of competition do not have any significant direct effect on the decision of small businesses to adopt IS. This suggests that businesses that adopt IS do not do so because of their environment. The competitiveness of environment does not really provide any direct "push" for small businesses to adopt IS. However, there is some evidence that information intensity and competition may have indirect effects on IS adoption through the characteristics of IS. Both information intensity and competition are positively correlated with relative advantage and compatibility of IS. Thus, information intensity and competition may influence the perception of small businesses toward the IS characteristics, resulting in the decision to adopt IS. Additional research needs to be conducted before more concrete conclusions can be drawn.
Extent of IS adoption

The main result here is that, of the four types of characteristics, only organizational characteristics have significant effects on the extent of IS adoption. The most significant organizational characteristic that determines the extent of IS adoption is business size. This is not surprising, as larger businesses tend to adopt more IS than smaller businesses owing to their needs. Larger businesses also have more resources available. Interestingly, business size is not correlated with any of the other independent variables.

After controlling for the effect of business size, the next most significant organizational characteristic that determines the extent of IS adoption is employees’ IS knowledge. Small businesses that have employees with greater IS knowledge are likely to use IS more extensively. This finding is again consistent with Attewell’s [3] conceptualization of innovation diffusion as a process of lowering knowledge barriers. Since most small businesses do not have a formal internal IT department, they usually computerize with the aid of external IT experts such as consultants or IT vendors. Attewell [3] suggests that the relationship between the innovation suppliers and the adopting businesses will go beyond selling and will become structured around the task of reducing knowledge hurdles. When the small business accumulates more IS knowledge through learning by using, it will lower its IS knowledge barriers and be more confident in adopting other IS. Widespread, routinized, and effective use of the technological innovation is needed before additional adoption takes place [32].

The third organizational characteristic that affects the extent of IS adoption is information intensity. The greater the information intensity of the product or service that the small business is involved in, the greater the extent of IS adoption. This provides some support for the information-processing theory. Galbraith [37] found that, when businesses take on uncertain tasks, such as scanning and processing complex information about new innovations, they have to manage the increase in information load with various design strategies. Similarly, a small business dealing with a product or service with high information intensity can make more extensive use of IS to meet its information-processing needs.

Contrary to the hypotheses, characteristics of the decision maker (CEO innovativeness and CEO’s IS knowledge), the IS innovation (relative advantage, compatibility, and complexity), and the environment (competition) have no significant effect on the extent of IS adoption in small businesses. While CEO characteristics and IS characteristics may influence the initial decision to adopt IS, they do not affect the extent of IS adoption subsequently. This suggests that Attewell’s [3] theory of lowering knowledge barriers takes precedence over the decision maker’s characteristics and perception of the IS characteristics after the initial decision to adopt IS. In the case of competition, it appears to have no direct “push” for small businesses to increase the extent of IS adoption. However, competition may have an indirect effect on the extent of IS adoption through information intensity. Competition is positively correlated with information intensity. Further study of this relationship is needed.
Conclusion

Using theories from the technological innovation literature, this paper developed and tested an integrated model of IS adoption in small businesses. In general, the results provide support for the model. Of the four contexts identified in the model, three (CEO characteristics, IS characteristics, and organizational characteristics) are of primary importance in determining the decision to adopt IS. Small businesses that possess (1) innovative and IS knowledgeable CEOs, (2) positive attitude toward the relative advantage, compatibility, and complexity of the IS, and (3) larger businesses and businesses with more IS knowledgeable employees are more likely to adopt IS. While information intensity and competition have no direct effects on the decision to adopt IS, they may have indirect effects on the decision to adopt IS through their effects on perceived characteristics of IS. However, of the four contexts, only organizational characteristics (specifically business size, employees' IS knowledge, and information intensity) have been shown to be determinants of the extent of IS adoption.

The results of this study have implications for IS adoption in small businesses. First, the study highlights the importance of having innovative and IS-knowledgeable CEOs. A small business managed by a CEO who understands the benefits of IS adoption and is willing to invest scarce resources in the IS project will be able to take advantage of the promised benefits of IS adoption, including improved organizational efficiency and effectiveness. Second, the IS must offer a better alternative to existing practices in the small business. If the IS are not perceived as beneficial to the small business, there is no reason to adopt them. The IS must also be compatible with existing norms and needs of the potential adopter; otherwise it will be difficult to integrate the use of the IS into the business or there is no reason to use the IS. Further, the IS must be easy to use and to understand. If the IS are too complicated and difficult to comprehend, even if they are adopted, they will discourage the employees of the small businesses and fall into disuse. Third, the small businesses must possess adequate financial resources and IS-knowledgeable employees to effect a successful IS adoption. Even among small businesses, the larger businesses will tend to have more resources and slack capacity. A small business that has IS knowledgeable employees will lower the knowledge barrier in understanding and using the IS. Hence, small businesses that have more resources will have better chances of succeeding in IS adoption. Finally, among the IS adopters, those small businesses that have greater information-processing needs will tend to adopt more IS. This greater need for information processing will have to be supplemented by adequate resources and IS-knowledgeable employees that are more likely to be available in larger businesses.

This study has implications for research as well. To the best of our knowledge, this is one of the first rigorous studies that examined IS adoption in small business from a theoretical and empirical perspective. The model was developed out of an integration of various perspectives using the technological innovation literature as a reference discipline. The model was then empirically tested using multivariate statistical techniques compared with the majority of previous research on small businesses using
bivariate correlation analysis. Future research can build on and extend the proposed integrated model of IS adoption in small businesses by including other potential variables from the different contexts. The effect of competition on IS adoption in small businesses is another area that needs further research. This study has found that competition has no direct effect but may have an indirect effect on IS adoption. More research is needed to elucidate the relationship between competition and IS adoption in small businesses.

Finally, let us discuss some limitations of this study. First, it is not possible to directly measure the perception of the CEO at the time of IS adoption. This is ameliorated to some extent by asking the CEO for his or her perceptions prior to IS adoption. However, we cannot be completely certain that the respondent can backtrack in his or her mind without being influenced by the experience of IS adoption to the state of the firm before adoption. Second, because of the cross-sectional nature of the study, direction of causality can only be inferred. Longitudinal studies need to be conducted to determine the causal links more explicitly. Third, operationalization of extent of IS adoption could have been strengthened if the amount of IS investment were measured. Finally, this study has investigated a subset of the variables found to be important in the technological innovation literature, albeit those that are more pertinent to the context of small businesses. Other variables that may be potential determinants of IS adoption in small businesses include other characteristics of the innovation such as peer influence and trialability. Future research can examine these possibilities. Notwithstanding these limitations, this study has proposed and tested an integrated model of IS adoption in small businesses based on the technological innovation literature and identified some important determinants of IS adoption in small businesses.

Acknowledgment: This study was part of my Ph.D. research supervised by Chee-Sing Yap.

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**APPENDIX A: Software Application Table**

For each computer applications *in use* in your company, please put a tick against the application.

<table>
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<tr>
<th>Application</th>
<th>In use</th>
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<tbody>
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<td>Accounting</td>
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</tr>
<tr>
<td>Inventory control</td>
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<tr>
<td>Sales</td>
<td></td>
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<tr>
<td>Purchasing</td>
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<tr>
<td>Personnel and payroll</td>
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<tr>
<td>CAD/CAM</td>
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<tr>
<td>EDI</td>
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<tr>
<td>MRP</td>
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<td>Others (please specify)</td>
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</table>

**APPENDIX B: Scoring Procedure for CEO’s IS Knowledge**

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<th>Types of experience</th>
<th>Score</th>
</tr>
</thead>
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<tr>
<td>i</td>
<td>2</td>
</tr>
<tr>
<td>ii</td>
<td>2</td>
</tr>
</tbody>
</table>
(i) Attended computer classes; (ii) use a computer at home; (iii) use a computer at work; (iv) have formal qualifications in the use and operation of a computer; (v) none.