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# A Framework for Assessing IT Use in Firm: A Survey of IT Use in Singapore

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**A FRAMEWORK FOR ASSESSING IT USE IN FIRMS:  
A SURVEY OF IT USE IN SINGAPORE**

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**Abstract**

This paper describes an integrated framework for assessing IT use in firms and its application to a survey of IT use in Singapore. The framework attempts to provide a comprehensive assessment of IT use by drawing on previous studies on the technical and organizational aspects of computing. Two broad dimensions of IT are defined: the technology itself, and its application to businesses. Firms are assessed on each dimension in terms of their extent and sophistication of use, and their management policies.

The main findings of the IT use survey are also presented. The framework provides a way to present an overview of IT use in Singapore. It also helps to focus on the areas where government initiatives are most needed for effective utilization of IT in business.

**Introduction**

A shared understanding among researchers and practitioners of what constitutes IT and its use is helpful in making meaningful comparisons between studies, and for deriving useful lessons for practice. However, many surveys and case studies of IT use look only at limited aspects of IT, such as a specific application, project or technology. Even when firms' overall use of IT is the focus of a study, gross surrogate measures such as total IT expenditure or IT capital stock are used (Markus and Soh, 1992; Harris and Katz, 1991; Loveiman, 1988). There is no consistent and comprehensive definition and operationalization of IT across studies. Researchers are aware of the limitations of their measures of IT but are often hampered by data collection or data access constraints.

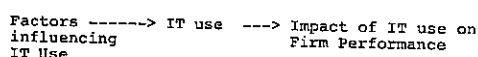
A study of IT use in Singapore, conducted jointly with the National Computer Board, provided the opportunity to attempt the development of a comprehensive and robust framework for assessing IT use. Previous surveys of IT use in Singapore focused on assessing the extent of IT use. In this survey, we also considered the important dimension of depth or sophistication of IT use, and policies and standards that support IT use.

This paper describes our integrated framework for assessing IT use, and presents the findings from its application to the survey on IT use in Singapore. We show how the framework provides insights into patterns of IT usage and highlights issues for future policy deliberation and initiatives.

**A Framework for Assessing IT Use in Firms**

The overall conceptual model for our study is shown in Figure 1. Our aims in developing the model were three-fold: 1) to come up with a rich description of IT use at the firm level, 2) to be able to identify patterns of use that are associated with successful firm performance, and 3) to determine the factors that encourage effective use of IT in firms. This paper, however, focuses only on the conceptual framework for assessing IT use, and excludes the measures of firm performance and the factors associated with IT use.

Figure 1: Conceptual Model



In our survey of the IT literature, we found that there are a variety of definitions of IT. These definitions appear to fall into three categories, depending on whether they emphasize the technical (Scott-Morton, 1991; Yates and Benjamin, 1991), organizational (Davis and Olson, 1985) or social aspects of computing (Kling, 1987; King and Kraemer, 1984). In developing our framework, we attempted a practical compromise that accounts for the technical, business, infrastructural and management dimensions of IT use.

Our framework is presented in Figure 2. We have conceptualized two aspects of IT use: technology adoption, and business application. Each aspect of IT use is assessed in terms of its extent and depth (intensiveness) of use. In addition, we recognize that the potential benefits from technology adoption are greatly increased when there are standards and policies that support integration across systems. Similarly, the application of IT to business processes can also benefit from the existence of standards and policies.

Figure 2: Framework for Assessing IT Use

Measures of IT Use	Dimensions of IT Use	
	Technology Adoption	Business Applications
Scope (extensiveness of use)	1	2
Depth (intensiveness of use)	3	4
Standards and Policies	5	6

Technology Adoption

In assessing the extent and depth of technology adoption (Figure 2, cell no. 1 and 3) we identified a range of hardware and IT tools. Hardware comprised computing and telecommunications equipment. IT tools comprised office automation software, database software, program development languages and tools, telecommunications, and emerging technologies such as artificial intelligence and multi-media. Extent of technology adoption is operationalized as whether the organization uses the particular technology. Depth or intensity of use is more difficult to assess. A number of indicators can be used to give some idea of an organization's depth of technology adoption. These included the number of employees per PC/workstation, the length of time that an organization has used a tool, and a perceptual measure of the level of organizational competence with each tool.

The existence of organizational standards and policies that guide technology adoption can greatly increase the potential benefits from IT. Standards facilitate systems integration through encouraging common systems building blocks. Standards also increase the productivity of system maintenance and development efforts through promoting common development methodology, standard data formats and so on. We categorized the major standards into three groups:

- 1) common system building blocks - eg. common systems development methodology, policy on end-user development of applications,
- 2) telecommunications - eg. compatible protocols among computer systems, existence of a network administrator,
- 3) organizational database - eg. standard data formats, policies on data access, ownership and security.

### Application to Business Processes

Previous studies (Rule and Attewell, 1989) concerned with assessing business use of IT generated lengthy lists of typical business applications (eg. order entry, inventory management, payroll etc.) and asked organizational respondents to indicate which computerized applications they had. We felt that this method was too cumbersome for the purposes of our survey which had to cover all types of firms in the Singapore economy. We decided instead to use Porter's (1985) value chain classification of business activities. There are at least three advantages to using Porter's value chain as the basis for assessing the application of IT in business activities: 1) it is reasonably generic, and has been tested in many different industries, 2) it is well known, and many respondents would have heard of it, 3) it is part of a well accepted theory of strategic advantage, and it has been used to illustrate how the application of IT to the value chain can result in competitive advantage (Porter and Millar, 1985).

The value chain comprises two types of activities: Primary (inbound logistics, operations, distribution, sales/marketing, and services) and Support (infrastructure, human resource, technology development, and procurement). The extent of application of IT to business activities was operationalized as the number of value activities that the business had computerized.

The depth of application of IT to business activities was measured in two ways. Firstly, the number of years that the activity had been computerized. Second, the degree of IT support for transaction processing, performance monitoring, and decision support for each business activity. Firms that use IT for decision support in a larger number of activities are defined as having a greater depth of IT use.

Much of business activity involves communication. Increasingly, with the globalization of trade and production, such communication takes place across national boundaries and time zones. The increased dynamism of the business environment also requires greater speed of communication. As such, electronic communication with business partners is an important aspect of the application of IT use in business. Therefore, the extent of business application of telecommunications measures whether the organization has electronic links with its business partners (eg. suppliers, distributors, customers, government agencies etc.). The depth of business application of telecommunications examines the different types of electronic communications (eg. email, EDI) that a firm uses.

As in the case for technology adoption, policies pertaining to IT use in business are also important in leveraging the benefits from IT. IT planning is of particular significance in ensuring that appropriate business applications of IT are identified and supported. We therefore measured the following key aspects of IT planning: the comprehensiveness of and adherence to IT planning policies, the degree of CEO involvement in IT planning, and the degree of integration of IT and business plans. Closely related to IT planning is the issue of project justification. Increasingly, researchers recognize that traditional cost-benefit approaches to investment justification, previously adequate for transaction processing systems, are no longer appropriate for applications that deliver competitive and qualitative benefits (Keen, 1991). Organizations where the CEO is highly involved in approving major IT projects and in setting IT policies, are more likely to have appropriate IT justification policies.

### Methodology

A large scale survey was conducted jointly with the National Computer Board to assess the extent of IT use in Singapore. The questionnaire was in two parts; the first part was addressed to the CEO and collected information on the business as well as satisfaction with computerization in the firm. The

second part was addressed to the CIO or senior IS manager, and sought details on the technological infrastructure and application profile of the organization. This two-stage approach to the questionnaire was adopted so as to minimize self-reporting bias; with this approach, we avoid the problem of having the IS manager rate the effectiveness of his organization's computerization efforts.

There was extensive pilot testing of the questionnaires. With NCB's help, we were able to pilot test the questionnaires in a variety of firms, both large and small, and from a wide range of sectors, such as the manufacturing, service, and public sectors. Significant changes were made in the format and wording of the questionnaire after each round of pilot testing, until we were satisfied that the questions were unambiguous, and convenient for the respondent.

We sampled from the population of firms with 10 employees or more. Firms with less than 10 employees were excluded because the response rate was likely to be very poor. A systematic random sample of 5,326 firms was selected, and the CEO questionnaire mailed to them. The population of firms was stratified to ensure adequate representation from seven major sectors of interest, and a random sample was also selected from the remaining firms in the population. The seven sectors of interest were: manufacturing, trade, transportation, financial services, tourist and leisure services, construction and real estate, and the public sector. A response rate of 28.5% was achieved through the diligent follow up efforts of the NCB. The second stage questionnaire to the CIO was then sent out to responding firms who had indicated that they were computerized. 1,285 CIO questionnaires were sent out, and 682 were returned (53.1% response rate).

The data was coded and entered by NCB's Survey Research Unit. This paper is based on the findings from our first round of analysis. Our aim in that first round was to get an overall picture of IT use in Singapore, and also to perform broad comparison by sector and firm size.

### Findings

#### Characteristics of Respondents

Respondents to the survey were mainly small and medium sized companies with between 10 and 99 employees. Such companies formed 70% of our respondents, but account for 94% of the population. As such, small firms are under-represented in our sample, and larger firms are over-represented. Since larger firms tend to use IT more, our findings on IT use in Singapore are likely to be slightly more favourable than if the sample more closely reflects the size distribution of the population.

84% of the sample firms are privately owned. About half have their operations entirely in Singapore, a quarter have some operations in the region, while the remaining quarter have operations beyond South East Asia. Many of the firms are new, with 53% having commenced their business in 1980 or later.

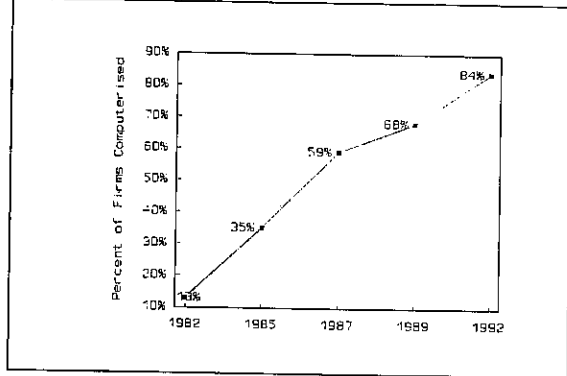
#### Technology Adoption

A gross measure of the extent of technology adoption is whether firms are computerized. A firm is considered to be computerized if it has a computer (PC, mini or mainframe). Using this measure, we find that the rate of diffusion of computerization in Singapore has been rapid (see Figure 3), with 84% of the sampled firms being computerized currently. Most industry sectors have similar levels of computerization, although the financial and public sectors were significantly more computerized (90% and 100% respectively), while the construction sector lagged behind the rest (only 79% of construction firms were computerized). As expected, firm size was a

good predictor of firm computerization (see Figure 4). However, it is noteworthy that the rate of computerization between 1989 and 1992 for small firms (between 10 and 50 employees) was twice that of larger firms.

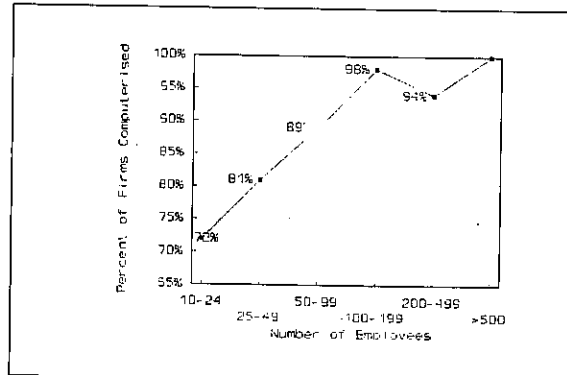
Overall Level of Computerisation

Figure 3



Computerisation by Firm Size

Figure 4



At this point, we should note that the public sector and financial services sector lead in many of the indicators of IT use. The public sectors launched an intensive computerization program under the guidance of NCB in the 1980s. Public sector organizations are also large, and firm size is positively correlated with the extent and depth of IT use. The financial service sector in Singapore, as in other countries, leads in the use of IT because of the information intensiveness and international nature of its operations.

What sort of hardware configuration is in place for firms that are computerized? As expected, PCs are pervasive. A large proportion of the PCs in the sampled firms are not stand-alone, but are part of a local area network (LAN). More than half (52.8%) of the computerized firms do not have mainframes or minicomputers. The primary users of mainframes and minicomputers in Singapore are organizations in the public sector and the financial services sector.

Among computerized firms, the extent of technology adoption can also be assessed in terms of usage of what we term IT tools. We identified three broad categories of IT tools: 1) office automation, 2) telecommunications, and 3) new technologies. Table 1 lists the individual tools within each of

these three categories as well as the percentage of firms that use each tool. All firms have some form of office automation, especially PC software (97%), and databases (67%). The adoption of decision support systems (14%) is however still low.

Table 1: Extent of Use of IT Tools

Usage of IT Tools/Systems	% of Firms
<b>Office Automation Tools:</b>	
PC software packages	97%
Desktop publishing	31%
Decision Support Systems	14%
CASE Tools	11%
4th GL	22%
Databases	67%
<b>Telecommunications:</b>	
E-Mail	31%
EDI	25%
External databases	20%
<b>Technologies:</b>	
CAD/CAM	22%
CIM	3%
ES/AI	4%
Smart Cards	2%
Multimedia	5%

In the telecommunications area, only a minority of firms have e-mail (31%), EDI (25%), and access to external databases (20%). One exception to this overall picture of the extent of adoption of telecommunication tools is the transportation sector. 64% of transportation firms use EDI. This is because of the government's implementation of Tradenet, a trade-document clearing system. Technology adoption is also very low for new technologies such as CASE, CIM, CAD/CAM and AI. CAD/CAM fares the best in this group of technologies, as it is used in about a quarter of computerized manufacturing, construction and trading firms.

One set of measures of the depth of technology adoption relates to ratios of employees to IT resource. We found that among computerized firms, on the average, there was one PC/workstation to 3.8 employees, and an average annual IT expenditure of S\$1,350 per employee. Table 2 shows that there is significant variation in the depth of IT use across sectors, with the public

Table 2: Average Intensity of IT Resources per Employee

Sector	# Employees per PC/Workstation/Terminal	Average 1991 IT Expenditure per Employee
Overall	3.8	\$1,350
Manufacturing	5.6	\$1,422
Trade	2.9	\$2,951
Transportation	4.1	\$2,812
Financial Services	2.9	\$1,798
Tourist & Leisure	10.6	\$872
Construction	5.8	\$1707
Public Sector	2.2	\$917

and financial service sectors employees having the most access to PCs/workstations. Interestingly, these are not the sectors that spend the most on IT per employee. In fact, it is the trade and transportation that lead the other sectors in terms of IT expenditure per employee. This may be explained by the fact that average firm size in these sectors tend to be small, while the overall extent and depth of computerization is comparable to other sectors (excluding the public and financial services sectors). Such firms therefore have a smaller base over which to spread their IT expenditure (which often has a high proportion of a fixed overheads).

The other set of measures of the depth of technology adoption relate to organizations' experience and competence with IT tools. Organizations have the most experience with PC tools (an average of 5 years), followed by databases (4.5 years) and fourth generation languages (4 years). Interestingly, the average firm experience with new technologies such as CAD/CAM, CIM, and AI is not significantly lower than that for other more established technologies such as email and EDI. Firms had an average of 2-3 years experience with these technologies. In this case, the averages are somewhat deceptive, as the spread in distribution in terms of number of years in use is greater for email and EDI than for CAD/CAM, CIM and AI. On the average, firms rated their competence with most technologies between 4 and 5, on a seven point scale, where 1 is low, and 7 is high. The average level of competence for AI, smartcards, and multimedia however, was below 4. (See Table 3).

Table 3: Depth of Use of IT Tools

IT Tools	Ave Yrs of Use	Ave. Competence Level (1-7)
<b>Office Automation Tools:</b>		
PC software packages	5.0	5.1
Desktop publishing	2.9	4.4
Decision Support Systems	3.6	4.2
CASE tools	2.7	4.3
4th GL	4.1	5.0
Databases	4.5	4.9
<b>Telecommunications:</b>		
E-Mail	3.2	4.8
EDI	2.5	4.4
External databases	2.9	4.5
<b>Technologies:</b>		
CAD/CAM	3.6	5.1
CIM	3.3	4.8
ES/AI	2.3	3.7
Smart Cards	2.1	3.8
Multimedia	2.2	3.7

Standards and policies relating to technology adoption were categorized into three groups: common system building blocks, telecommunications, and organizational databases. The overall ratings of comprehensiveness of standards and policies in these categories are low, with a range of 2.7 to 3.0 (on a scale of 1 to 7). As in other measures, the financial services and public sectors have higher ratings, but even so, their average ratings hover around 4, the midpoint on our 7 point scale.

One probable explanation for the low ratings of technology adoption standards and policies is the recent adoption of computerization by many firms. Standards and policies are usually developed only at later stages of technology adoption. Many firms may not yet appreciate the importance of these standards and policies. Table 4 summarises the major findings by sectors.

Table 4: Comprehensiveness of Technology Standards and Policies

Sectors	Technology Standards & Policies		
	Common Systems Building Blocks	Telecommunications	Organization Database
Overall	2.7	2.8	3.0
Mfg	2.6	2.7	3.0
Trade	2.6	2.5	2.8
Transport	3.0	3.3	3.6
Financial Services	3.6	3.5	4.0
Tourist & Leisure	2.2	2.1	2.8
Construction	2.3	2.2	2.4
Public Sector	4.0	4.5	4.4

#### Application of IT to Business

A firm's investment in hardware produces value only when combined with applications. A firm's portfolio of applications therefore gives some indication of the value that it receives from its IT investments. Our approach to measuring firms' portfolio of IT applications was to use Porter's (1985) value chain. Although we are still at an early stage in our data analysis, the data collected on business applications has provided some interesting insights.

In assessing the extent of computerization of business activity for the sample as a whole, we find that no firm had computerized all the activities in its value chain. In fact, very few (12%) had computerized even all their primary activities (operations, inbound logistics, distribution, sales & marketing, service). This finding is surprising given that there were a significant number of large firms with more than 500 employees in our sample (about 10% of the sample). We would expect that the potential benefits from computerization, particularly of their primary activities, would be high for large firms. Among the support activities, most firms (88%) had computerized their accounting activities, and about half had also computerized their general administration and human resource activities.

Two measures were used to assess the depth of computerization of business activity: number of years the activity had been computerized, and the type of application (transaction processing, performance monitoring, and decision support). The average number of years of computerization for each business activity is fairly consistent; being between 4 to 5 years. This is likely to be different in the more developed countries such as the U.S., where certain traditional areas such as accounting may have been computerized for decades, while more front-room activities such as sales may have been computerized only within the last ten years or so. Many

Singapore companies however, are less than ten years old, and the IT revolution and low cost computing solutions were already established when they began to computerize. Hence, we expect to see that Singapore firms computerized their business activities in relatively quick succession. Perhaps because the business activities have been recently computerized, the level of sophistication of use is generally not high. In all business activities, the applications are still largely focused on transaction processing, and significantly less on planning and decision support (see Table 5).

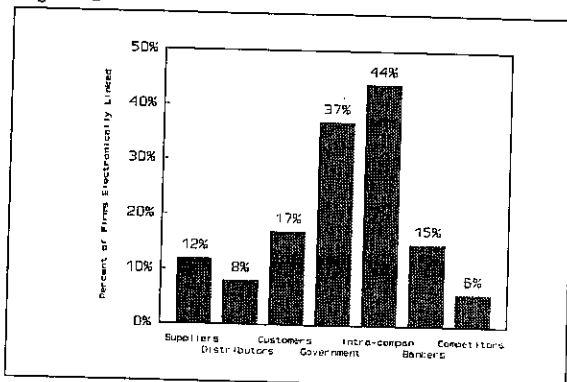
Table 5: Depth of Computerization of Business Activities

IT Applications in Business Activities	Use in processing transactions	Use in performance monitoring	Use in planning & decisions
Primary Activities:	Scale of 1 (Low Usage) to 7 (High Usage)		
Operations	5.3	5.0	3.7
Inbound Logistics	5.2	5.0	4.0
Distribution	5.2	5.1	4.2
Sales and Marketing	5.1	5.0	4.1
After-Sales Service	4.8	4.8	4.2
Support Activities:			
Procurement/Purchasing	5.1	5.0	4.1
Product Development	4.8	4.4	3.8
Human Resource Dev	4.9	4.6	4.0
Finance and Accounting	5.6	5.5	4.6
General Administration	4.9	4.6	3.8

The extent of business use of telecommunications is measured as the number of types of business partners a firm is electronically linked with. Not surprisingly, the most common forms of telecommunication linkage were intra-company (44%), and with government agencies (37%). The high extent of linkage with the government is due largely to the successful implementation of Tradenet (King and Konsynski, 1990), a trade document clearing system. The effects of this system on electronic links is seen most clearly in the transportation and financial services sector, where over 70% of the firms have electronic links with the government. The extent of vertical linkages with suppliers, distributors and customers is also of interest as the IT literature has shown that such links are often the source of competitive advantage (Porter and Millar, 1985; MacFarlan, 1984). In Singapore, the extent of such vertical links are low (see Figure 5). This is an area that we will be monitoring in the next few years, in particular because the Singapore government's latest IT plan, IT2000, lays heavy emphasis on island-wide networking.

Electronic Links with Business Partners

Figure 5



The type of electronic linkage with business partners is considered in our assessment of the depth of business use of electronic communications. Conceptually, electronic communication with business partners may be structured (EDI, on-line terminal transactions) or unstructured (email, database access) in nature. For structured communications, we found that 90% of firms did not have EDI and on-line terminal links with their suppliers, distributors, customers, bankers and competitors. Firms were most likely to have on-line terminal links with related firms (19% of sampled firms), and the public sector (17%). Similarly, they were also most likely to have EDI links with the public sector (15%), and with related companies (9%). Very similar patterns of usage were observed for unstructured electronic links such as email and database access. Email is used by a relatively larger proportion of firms (24%) for communication with related companies.

Policies and processes that enable the effective application of IT to business include IT planning, justification of IT projects and the role of the CEO in policy setting. In the area of IT planning, we found that 36% of the sampled firms had policies or guidelines for strategic IT planning, but that the level of comprehensiveness and compliance with the policy was only moderate (a rating of about 4.5 for both comprehensiveness of and compliance with the policies, based on the IT manager's rating on a 7-point scale). The average level of CEO participation in IT planning (a self-reported rating, also on a 7-point scale), and the integration of IT and business plans were also moderate. The overall picture for IT planning therefore indicates that the concept of strategic IT planning has a foothold in a significant number of Singapore firms, and that prescribed processes such as CEO involvement and integration with business plans are being used to a moderate extent. In the closely related area of IT project justification, we found that a larger number of firms (45%) had policies or guidelines, but the level of comprehensiveness and compliance with the policies, as well as CEO participation in project approval is still moderate.

As in previous measures, a much higher proportion of organizations in the public sector (more than 70%) and financial services sector (55% and 64% respectively) have policies on IT planning and IT project justification. The levels of comprehensiveness and compliance with the policies are also higher (averaging between 5.0 and 5.9).

An Overview of IT Use in Singapore

An overview of IT use in Singapore is provided by summarizing the various measures of IT use for each of the cells in our conceptual framework (see Table 6). The framework is presented in somewhat more detail than in Figure 2 in order to reflect the different ratings for categories within the two broad dimensions of technology adoption and business application. It would be ideal if there were accepted benchmarks for assessing whether IT use in each of the cells is low, moderate or high. However, our search of internationally published IT surveys show that the few benchmarks that exist are oriented towards hardware, for example, the average number of MIPS. In the absence of suitable benchmarks, our assessment takes into consideration normative standards and practices as espoused in the literature and IT textbooks, our perception of IT use in the more advanced countries, and local circumstances. The ratings shown in Table 6 should not be interpreted as value judgements; that is, a low rating need not necessarily be adverse. Value judgements can only be made in the light of contextual factors such as the stage of a country's economic, social and political development, its pool of manpower skills, and its previous experience with IT. With these in mind, the following two paragraphs summarize the reasons for the ratings for technology adoption and the application of IT to business activities respectively.

Table 6: Summary of IT Use in Singapore

Dimensions of Measures of IT Use	Technology	Adoption	Business Applications	
	Hardware	IT Tools	Business Activities	Business Partners
Scope	High	Low to High	Moderate	Low to Moderate
Depth	High	Low to Moderate	Moderate	Low to Moderate
Standards & Policies	Low to Moderate		Moderate	

The scope and depth of hardware adoption is rated as high given that 84% of sampled firms are computerized, and that on the average, there is one PC to every 3.8 employees. These are figures that would compare well even to advanced countries. In the area of adoption of IT tools, we found that the extent of use of office automation tools was high, with the majority of computerized firms having such tools. The depth of use of office automation tools we judge to be moderate. Firms' average of 4 to 5 years experience with OA tools is high considering that more than half the firms are less than 10 years old, and the government-led computerization effort in Singapore began only in 1980. However, on the average, these firms only rated themselves between 4 and 5 on a seven point scale of competence. The extent and depth of adoption for telecommunication tools and emerging technologies is low. Less than a third of the firms sampled have any electronic links with external parties, and most of the emerging technologies are adopted by less than 10% of the firms. On the whole, Singapore firms score low (between 2.7 to 3.0 on a 7 point scale) when it comes to the comprehensiveness of and compliance with technology standards and policies.

We found that the scope and depth of the computerization of business activities was moderate in Singapore. Basic backroom activities, such as accounting and human resource have been computerized by most firms, but very few have computerized all their primary activities of operations, inbound logistics, distribution, and sales and marketing. While the average number of years each activity has been computerized is relatively high (4 to 5 years), most of the applications are still focused on basic transaction processing, and very few firms utilize IT significantly support or even management control. Links with related companies (eg. subsidiaries, headquarters) and with government organizations are moderate (44% and 37% of firms respectively), while links with all other business partners are very low (less than 10% of firms). Finally, firms appear to fare better in the area of management practices and policies for the business uses of IT, than in the more technical domain, with the average rating for comprehensiveness and compliance with policies for the application of IT to business uses being about 4.5. Compared to the normative standards propounded in the literature and in textbooks - that all firms should have policies for IT use, and fully implement them - these ratings may be considered low.

#### Conclusion

The picture depicted in Table 6 provides insights into patterns of IT use in Singapore and shows areas for future policy deliberations and initiatives. Singapore's reputation for progressive use of IT has been built around key strategic applications that are government driven, innovative, and well-managed. However, the overall level of sophistication of IT use in business organizations is still relatively low. Doubtless, much of this is due to the fact that many of the firms are relatively young, and their computerization efforts have not yet matured. While more IT use is not necessarily always better, we feel that there are at least two areas of IT use that should be encouraged, for reasons discussed below.

A key area for development is the extent and depth of electronic linkages with business partners; vertical links along the production/distribution chain in particular are very low. This is an area where there is considerable potential for contribution to industrial competitiveness as electronic markets and closer interfirm coordination can hold down transaction costs and increase firms' ability to respond quickly to market signals (Malone et al., 1987). Significant numbers of electronic links exist largely where the government has taken the initiative, as in the case of Tradenet, which accounts for the 64% of transportation firms having EDI links.

Another area in need of development, as highlighted by applying the framework to the data, is the management of IT. We note that more than half the firms sampled do not have policies to guide the adoption of IT, and to maximize the returns from its application to critical business areas. Even among those that do have such policies, their self-assessed level of comprehensiveness and compliance with such policies is moderate at best. It is likely that the managers, in giving their ratings, were influenced by the general level of practice in their industry. If we had been able to assess each company's IT management policies and standards against the general level in more developed countries or against the normative standards in the literature, we may well have assigned lower ratings. Development of better IT management practices therefore need to be addressed, particularly as technology becomes increasingly complex. A cautionary tale is evident in advanced countries such as the United States, which have a longer history of IT use. Many researchers and practitioners find it difficult to attribute business gains to IT investments (Baily, 1986, Thachenkary, 1991), and there is a growing consensus that apart from measurement problems, there is a real need for better understanding and management practices to fit appropriate patterns of IT use to different type of businesses (Markus and Soh, 1992).

We are still at the early stages of our analysis of the data, and we are continuing with the aim of discovering more insights regarding successful patterns of IT use, and formulating specific policy recommendations for government initiatives. The power of such a framework and database increases with longitudinal data collection, which will allow greater confidence in stating causal relationships, and in the identification of key trends in IT use.

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