Entrepreneurship and Technological Change in Malaysian SMEs

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Abstract

Entrepreneurial characteristics have been found in the literature as most important factor in bringing technological change at the firm level. However, technological change led by ICTs is very different from earlier technological change. Adoption of ICTs in certain industries requires in-depth knowledge of ICT tools. Hence entrepreneurship alone may not be sufficient for the adoption of ICTs. This study aims at identifying factors that discriminated varying degree of ICT using SMEs in Malaysia. The findings suggest that entrepreneurial characteristics of managing directors coupled with other firm-specific factors significantly discriminated advanced ICT using firms from the rest. The results show that firms with higher skill intensity adopted more advanced ICTs. Also perhaps for the first time, the study found evidence to support the argument that formally trained workers are more useful than on-job trained workers in SMEs. We conclude that one of the ways to encounter the onslaught posed by the globalisation is to focus on the appropriate human resource development policies that can cater to the specific needs of SMEs.

Keywords:

Globalisation, Entrepreneurship, Human Resources, ICTs, SMEs, Developing Countries

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1. INTRODUCTION

The Small and Medium-sized Enterprises (SMEs) play a crucial role in economic development in developed as well as developing countries. In recent years they have occupied a pivotal position in economic development of developing countries. This is primarily due to changing business environment. Vertical integration and business process outsourcing mark the new environment. This has led to sub-contracting of business activities to SMEs. Despite having their crucial position in an economy, they are the most vulnerable for rapid technological change. The rapid technological change that has been witnessed by the last decade of twentieth century has created opportunities as well as threat to the existence of SMEs. It is also perceived by many that new WTO regime might also challenge the very existence of SMEs. Globalisation and liberalised economic policies pursued by nations have exposed SMEs to large domestic enterprises and multinational enterprises (MNEs).

The rapid development and diffusion of information and communication technologies (ICTs) in recent years has drawn attention of social science institutions and researcher. Scholars have expressed very divergent views ranging from extremely negative- creator of mass unemployment (Nilsen, 1980) to positive- demonstrating employment creation capabilities (Freeman and Soete, 1994). Several organizations such as United Nations and European Commission have shown their anxiety regarding pattern of the development and diffusion of ICTs. Consequently, the United Nations Centre for Science and Technology for Development (UNCSTD) constituted a working group in 1995 to investigate reasons for uneven use of ICTs in developing and developed nations. The Working Group considered social, economic, and technological capabilities of countries and found that LDCs were at a very different starting position in the task of building innovative and distinctive technological and physical infrastructure that is prerequisite for adoption and production of ICTs. The Group identified and underlined the importance of experience, skill, and knowledge in the adoption of ICTs (Mansell and When, 1998).

Another high level expert group formed by European Commission in 1995 analysed the social aspects of an information society. The Group describes knowledge, skill, training, education, and learning as essential complementary assets for information societies (Soete, 1997). Furthermore the Group perceives the radical changes in employment structure as a consequence of the adoption of ICTs. The changes in employment structure as perceived by the Group are, creation of new jobs for skilled workers on one hand and loss of some jobs for unskilled workers on the

other at firm level. According to the Group, the adoption of ICTs is unlikely to result in a decline of employment at industry level. The findings of the Group are based on general industrial applications of ICTs and are not specific to SMEs or large enterprises. There are, however, major difference in approaches of adoption of new technologies in SMEs and large firms.

In the theory of technological change, the decision-making process has a bearing on the adoption of new technologies (Pennings, 1987; Lefebvre and Lefebvre, 1992). It is more informal in SMEs than large corporations. For instance, large firms evaluate the pros and cons of new technology through a feasibility study, while the SMEs depend on technology suppliers. Theoretically, the mere adoption of new technologies does not guarantee its potential benefits (Geipel, 1991; Gatignon and Roberston, 1989). This is more relevant in case of ICTs as their adoption is a necessary but not a sufficient condition for increase in productivity, reinforcement of competitiveness, and augmentation in performance (Lefebvre and Lefebvre, 1996; Drew, 2003).

Information and communication technologies are regarded as generic and very pervasive technologies. Their applications cut across sectors of economies. They can be used in almost every activity of an organization. In an industry, they can be used in inventory management, production processes, marketing, and support services. These capabilities of ICTs have potentials to alter business organizations and practices. It is viewed by the proponents of globalisation that these capabilities of ICTs are expected to help SMEs to stand in the global business environment while others perceive that the adoption of ICTs by large corporation would result in erosion of SMEs. The empirical evidence so far suggests that adoption of new technologies by SMEs have helped them to sustain their businesses in globalised business environment (Oyelaran-Oyeyinka, 2007; Lal, 2007; Lal and Paul, 2004; Drew, 2003).

However, the empirical evidence also suggests that the factors that influence the adoption of ICTs in SMEs are not uniform across countries and industries within a country. These factors can be categorised into three groups, namely; country- industry- and firm-specific. Technological development led by ICTs is different from earlier developments in the sense that the adoption of ICT led technologies is not influenced by factors that are internal to the firms alone but is influenced by factors that are external to the firms. These factors are known as country-specific factors represented by technological infrastructure which is dependent on several technological and economic factors. Given a particular level of technological

infrastructure in a country the degree of adoption of ICTs is influenced by skill intensiveness of the sector. For instance the type and intensity of ICT adoption in "high tech" such as electrical and electronics sector is very different from "low tech" sector such as apparel manufacturing. The third types of factors that influence the adoption of ICTs are firm-specific such as market preference, performance, entrepreneurship etc. The empirical evidence suggests that the relationship between the degree of the adoption of ICT led technologies and firm-specific factors is bidirectional.

In this paper we intend to identify and analyse firm-specific factors that discriminated advanced ICT using SMEs from the rest. Given the characteristics of the sample firms, sector-specific factors are unlikely to play any major role in the adoption of ICTs. Since all sample firms are drawn from different locations in Kuala Lumpur, access to technological infrastructure may vary from firms located in one area to another. Hence we will examine the role of technological infrastructure in the diffusion of ICTs. The specific objects of the study are:

- To examine the pattern of the adoption of ICTs in SMEs
- To investigate the role of entrepreneurial characteristics in the adoption of ICTs
- To identify and analyse factors that discriminated advanced ICT using firms from the rest
- To assess the role of institutional environment on the diffusion of ICTs

The remainder of the paper is organised as follows. Theoretical framework is presented in Section 2 whereas data and characteristics of sample firms are discussed in Section 3. In Section 4 we formulate hypotheses. Statistical results are presented and discussed in Section 5 while the findings of the study are summarised in Section 6.

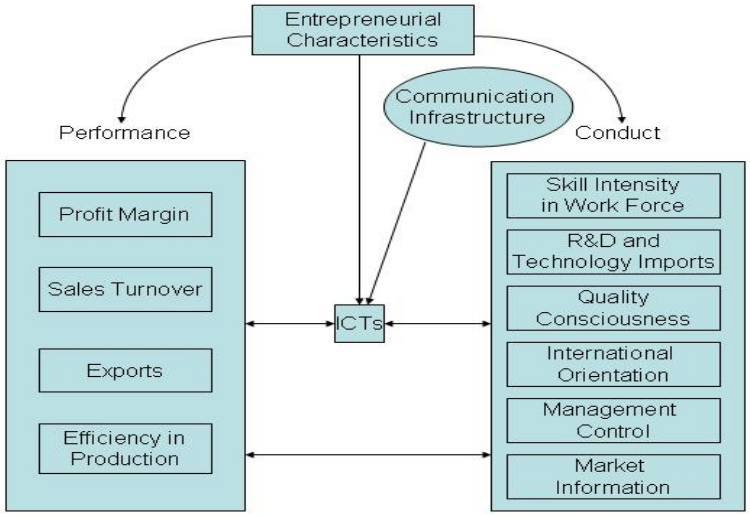
2. THEORETICAL FRAMEWORK

In general technological change can take place from various sources such as adoption of new technologies and innovation activities at the firm level. This study focuses on technological change due to adoption of new technologies and its relationship with entrepreneurial characteristics. Although entrepreneurship or entrepreneurial characteristics are driving forces of innovation as well as adoption of new

technologies, technological innovations are rarely found in small firms. Recent studies such as Lal and Dunnewijk (2008) suggest that small firms managed by persons with entrepreneurial abilities diverted their attention on innovation but their innovation activities were more directed towards organisational and marketing innovation.

As mentioned earlier the diffusion of ICT led technologies is influenced by several factors. These factors range from firm-specific to sector- and country-specific. The aim of the study is to analyse firm-specific factors and factors related to technological infrastructure which are beyond the control of firms. Hence the country- and sector-specific factors are not depicted in the framework. Theoretical framework used in the study is presented in Figure 1.

Figure 1: Theoretical framework



The theoretical framework depicted in Figure 1 cannot be generalised for all types of firms. This is primarily because of differences in decision making processes. In SMEs the decisions are usually taken by the owner or managing director of the firm whereas in large firms they are taken by a group of persons. Consequently decisions in SMEs are heavily influenced by entrepreneurial abilities of the owner. Since the paper analyses role of entrepreneurial characteristics in the adoption of new technologies in SMEs the theoretical framework is more suitable to SMEs rather than large firms.

The variables included in the study have been broadly grouped into conduct and performance factors. Performance indicators are represented by profit margins, sales turnover, exports, and efficiency in production processes as a result of the adoption of new technologies whereas conduct variables include skill intensity of

workforce, R&D and technology imports, quality consciousness of management, international orientation, better management control, and access to latest market information. Communication infrastructure has been kept as a separate category of factors because of its pivotal role in the diffusion of ICTs. Communication infrastructure includes type of communication, i.e. digital or analogue medium, speed and cost of communication, quality and reliability of communication medium, and Internet infrastructure such as speed and cost of access to Internet servers.

It can be seen from Figure 1 that the relationship of entrepreneurial characteristics with other factors is unidirectional suggesting that entrepreneurial abilities of the owner influence other variables and the reverse is not true. Theoretical framework also suggests that availability of communication infrastructure is not in the hands of owner and is totally external factor that influences the extent of the adoption of ICTs. On the other hand the degree of adoption of ICTs and other factors, i.e. conduct and performance mutually reinforce each other.

The relationship between skill intensity and the intensity of ICTs use has been shown as bidirectional in Figure 1. However, it may not be easy to capture this relationship in labour intensive sector such as apparel manufacturing. This is because the users of ICTs constitute a small fraction of total employment. Hence skill intensity in labour intensive sectors may not differ among different levels of ICT using firms. Moreover ICT tools in "low tech" sectors are packaged and they do not necessitate high skilled person for their use. Whereas there is a very strong bidirectional relationship between skill intensity and the degree of ICTs use in "high tech" sector firms as ICT tools are reprogrammable and consequently highly skilled persons are required for their effective utilisation. For instance, in order to use same assembly line for manufacturing of printed circuit boards (PCBs) of different electronic gadgets, one needs to reprogramme most of the control devices of the assembly line. Moreover skill requirement increases with the complexity of ICT tools and hence the bidirectional relationship is justified in "high tech" sectors.

The relationship between the intensity of ICT use with other conduct variables such as R&D and technology import, quality consciousness, international orientation, better management control, and access to latest market information is considered to be bidirectional. Import of technologies is facilitated to a great extent by the use of ICTs. For instance in order to buy manufacturing technology equipment, one can collect a lot of information through Internet about their availability and specifications. This information is very useful in taking a right decision. Higher the technological

complexities of manufacturing equipment more advanced ICTs are needed to view their design and specification. Similarly ICTs used in production processes contribute to better and consistent quality of products. And in order to produce international quality of products one needs to adopt more advanced flexible technologies in production processes.

The intensity of ICT adoption and the extent of international orientation reinforce each other because more advanced ICTs allow to transfer of encrypted information such as complex and confidential product designs whereas one does not require complex ICTs for the transfer of simple text. The relationship between ICT adoption and other conduct variables namely: better management control and access to latest market information is considered bidirectional because they reinforce each other. For instance, simple Internet search might provide information related to latest market trend and product specifications and to produce such products a firm might need more advanced ICT led production technologies. Similar is the case with the other variable, i.e., better management control.

The bidirectional relationship between extent of ICT adoption and performance variables is quite obvious. Better performance means the firm has more financial resources to invest in new technologies. And the adoption of more advanced technologies is expected to result in better performance. However, the role of entrepreneur is very critical in identifying the appropriate technology. Mere acquisition of new technologies may not result in better performance. Appropriateness of new technologies and fulfilment of other necessary conditions are essential for successful use of new technologies and better performance. Hence the role of entrepreneur takes a pivotal position in this process. Adoption of ICTs may not always lead to increase in the factors like sales turnover, profit margins, or higher exports. Many times firms have to adopt new technologies just to survive in the market which is done by augmenting productivity through the use of advanced ICTs in production processes. But the general relationship between performance and the degree of the adoption of ICTs remains true.

3. DATA AND CHARACTERISTICS OF SAMPLE FIRMS

The study is based on primary data collected from SMEs[2] located in and around Kuala Lumpur. A semi-structured questionnaire was used to collect data on various aspects of SMEs. Description of the variables used in the study is presented in Appendix Table 1. The survey was conducted during October 2004 and March 2005. Questionnaires were distributed and personally administered to 100 respondents drawn from different industries. In all there were 67 usable returns, yielding an overall response rate of 67 per cent. Questionnaires were distributed to firm representatives personally to ensure response from only senior managers such as Chief Operating Officers (CEO), General Managers or anyone who held high positions. Finally interviews were also conducted to clarify information collected where and when necessary to ascertain that data and information collected are accurate and reliable. Sample firms belonged to several sectors. The largest percentage (35.82 per cent) of firms came from hardware and machinery sector followed by chemical and pharmaceuticals accounting for 14.93 per cent of sample firms. Wood industry emerged as the third largest sector contributing 11.94 per cent of firms. The other sectors that are represented by sample firms are: electrical and electronic goods manufacturing, fashion and textiles, and food and beverages.

Comparing simply by number of sample SMEs with total small firms in Malaysia, one may wonder whether sample firms are representative of SMEs in Malaysia. However, in view of the fact that sample firms come from in and around Kuala Lumpur they may be treated as representative of Malaysian SMEs as firms located in other parts of the country are likely to follow similar trend with respect to the adoption of new technologies. We would like to give some idea of total SMEs in Malaysia. In 2003, SME companies formed nearly 92% of the total 689,160 companies registered in Malaysia and contributed 29.1% of total manufacturing output, 26.1% of value-added. This means that in 2003, SME provided about a third of the total employment (32.5%) in the country (MITI Statistics, 2003). At present, about 40% of the SME in the manufacturing sector are in the resource based sector. Several important sectors in the SMEs include the wood and wood products industry which accounts for about 12.8%, food, beverages and tobacco (10%), paper and paper

[2] There is no standard definition of SMEs in Malaysia. We have used the definition of Small and Medium Industries (SMI) Association of Malaysia. Their classification is as follows: (a) small-scale company is a company with an annual sales turnover of less than RM10 million and not more than 50 full-time employees, and (b) medium-scale company is a company with an annual sales turnover between RM10 million to RM25 million and with 51 to 150 full-time employees.

products (9.9%), and rubber and plastic industry (7.4%), machinery and equipment (9.4%) and textiles, apparel and leather (8.8%).

3.1 Technological profile of sample firms

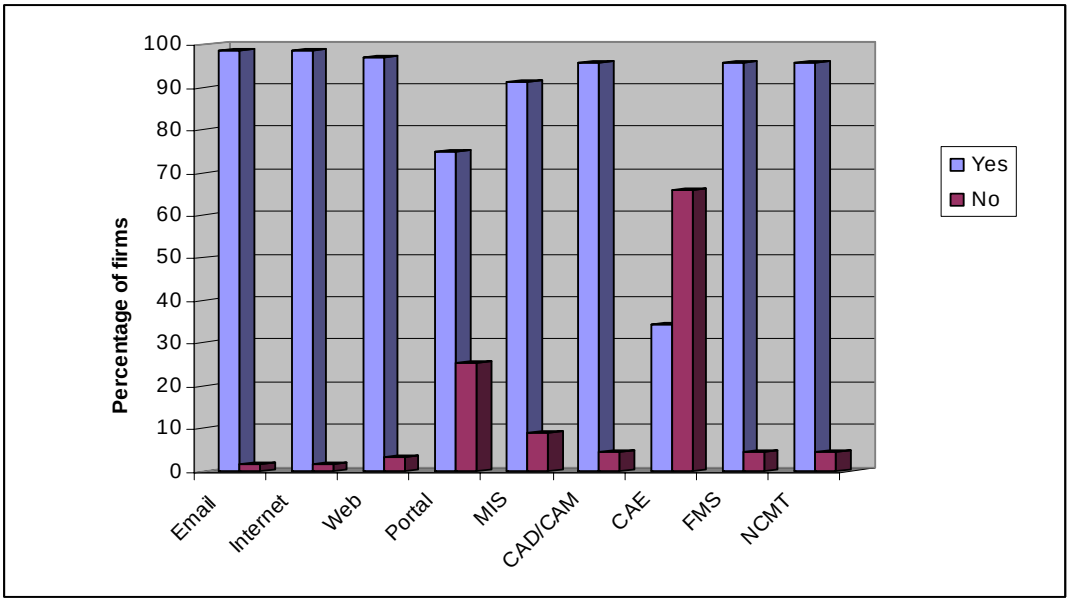
Types of new technologies considered in this study are by and large led by ICTs. Broadly, they can be classified into production and non-production processes. Non-production processes include marketing, coordination of business activities with local and foreign partners and within firms. Such technologies considered in this study are: email, Internet, web enabled technologies, Portal, Management Information System (MIS). Production technologies[3] that are included in this study are: CAD/CAM, CAE, FMS, and CNC[4] machine tools. Intensity of the adoption of these technologies by sample firms is presented in Figure 2.

All the firms, except one, used email and the Internet. The firm that did not use either email or the Internet was ice making firm. Given the nature of the product profile of firm, new technologies were not very relevant for the firm. Ninety-seven per cent of firms had their presence in cyber space. A fairly large percentage (74.6 per cent) of firms had portals for on-line business application processing. Most of these firms used shared portals. Ninety-one per cent of sample firms used MIS but it was limited to in-house management applications. More than 95 per cent of firms used new production technologies except CAE. Merely 34.3 per cent of the firms had adopted CAE. Low usage of CAE could be attributed to its applicability to the sectors to which sample firms belong to. It may be mentioned that CAE is more useful in engineering application.

[3] Computer Aided Design/Computer Aided Manufacturing (CAD/CAM); Computer Aided Engineering (CAE)' Flexible Manufacturing System (FMS); Computer Numerical Control (CNC)

[4] CNC and Numerical Control Machine Tools (NCMT) have been used interchangeably.

Figure 2: Adoption of ICTs in sample SMEs



3.2 Levels of ICT Adoption

ICT intensity is categorised into three levels; namely: low, moderate, and advanced. This categorisation was based on the usage of ICT tools and purposes. Low level ICT adoption refers to basic usage of e-mail, Internet and management information system. These tools are mainly used for communication purposes. Moderate level ICT adoption refers to the usage of ICT tools in the product or process design and also throughout the manufacturing processes. Examples of moderate level adoption include the usage of CAD/CAM, CAE, FMS, and CNC. Advanced level of ICT adoption refers to usage of more advanced ICT applications that include the usage of web enabled services and portal for supply chain and marketing purposes.

The distribution of firms according to the intensity of ICT adoption suggests that only 4 firms had low adoption of ICT (6 per cent), 19.4 per cent were moderate users of ICTs whereas 74.0 per cent of firms were advanced users of ICTs. Interviews conducted later and content analysis of web sites revealed that although 50 respondents had web enabled services, most of these web contents provided basic information regarding firm's product and services, distribution and feedback. These websites also lacked important features such as online purchases, real time communication and interaction.

3.3 Entrepreneurship and the degree of ICT adoption

Entrepreneurship consists of measurable and no-measurable components. Hence it is virtually impossible to exactly quantify entrepreneurship. One of the proxies which have been used in the literature is academic background and knowledge base of an individual. In this study we have used academic background as a proxy of entrepreneurship of owners/managing directors (MDs) of SMEs. Table 1 presents the distribution of firms according to the academic qualifications of owners/MDs. Although low level of ICT using firms were just four, fifty per cent of them were managed by persons with primary or secondary level of education whereas not a single moderate or advanced ICT using firm was being managed by persons with such qualifications. A comparison of the academic background of moderate and advanced ICT using firms suggests that MDs of the latter were more qualified. For instance, 38.46 per cent of moderate ICT using firms were being managed by MBA MDs while percentage of advanced ICT using firms managed by person with such qualification was 50 per cent.

Table 1: MDs education and level of ICT adoption

Education	Level of ICT use			Total
	Low	Moderate	Advanced	
Primary	1 (25.0)			1 (1.54)
Secondary	1 (25.0)			1 (1.54)
Diploma	1 (25.0)			1 (1.54)
B. Engineering		3 (23.08)	2 (4.17)	5 (7.69)
B. Admin/Com		3 (23.08)	10 (20.83)	13 (20.00)
B. Science		1 (7.69)	7 (14.58)	8 (12.31)
MA/MBA	1 (25.0)	5 (38.46)	24 (50.00)	30 (46.15)
M. Engineering		1 (7.69)		1 (1.54)
M. Science			5 (10.42)	5 (7.69)
Total	4 [6.15]	13 [20.00]	48 [73.85]	65

Note: Figures in the parentheses are column percentages while in square brackets are row percentage

It can be seen from Table 1 that four firms had low adoption of ICTs and educational levels of owners' of all such firms were also low, ranging from primary to diploma levels. On the other hand, the educational attainment or qualifications of owners of firms in the moderate and advanced levels of ICT using firms was much more higher, with at least tertiary level education. It is widely accepted that knowledge intensive or technologically driven industries require highly qualified managers to understand and be able to make informed decisions regarding the various

ICT tools and applications in the quest for efficiency and effectiveness. This is reflected in the figures presented in Table 1. MDs of 39.58 per cent of advanced ICT using firms had at least a bachelor's degree in engineering, administration/commerce or science. In addition, 60.42 per cent of the MDs in this cluster of firms were masters degree holders.

3.4 Age of MDs and intensity of ICT adoption

Distribution of sample firms by age of owners/MDs and the level of ICT adoption is presented in Table 2. It can be seen from the table that low level of ICT using firms were being managed by older persons compared to moderate and advanced ICT using firms. It is quite possible that MDs of low ICT using firms were less technology savvy and hence they were not sure about the potential benefits of ICTs and did not favour for modern tools. On the other hand, younger MDs, being more familiar with potential benefits, adopted more advanced ICT tools.

Table 2: MD's Age and ICT adoption

MDs' age group	Level of ICT use			Total
	Low	Moderate	Advanced	
<35		2 (15.38)	8 (16.33)	10 (15.15)
35 – 39		4 (30.77)	6 (12.24)	10 (15.15)
40 – 44		3 (23.08)	11 (22.45)	14 (21.21)
45 – 49	1 (25.0)	2 (15.38)	12 (24.49)	15 (22.73)
50 – 54	1 (25.0)	1 (7.69)	8 (16.33)	10 (15.15)
55 – 59	1 (25.0)		4 (8.16)	5 (7.58)
60 +	1 (25.0)	1 (7.69)		2 (3.03)
Total	4	13	49	66

Note: Figures in the parentheses are column percentage

It can be seen from Table 2 that all MDs of the low level ICT using firms were over 45 years old whereas 84.5 per cent of MDs in the moderate level ICT using firms were less than 50 years old and 75.5 per cent of MDs of advanced level ICTs using firms were less than 50 years old.

3.5 Adoption of ICTs and skill biased-ness

Distribution of firms according to the intensity of ICT use and skill intensity of workforce is presented in Table 3. The table shows that level of ICT adoption is positively associated with the skill intensity of sample firms. This is reflected by the

fact that roughly half of the workforce (45.81 per cent) in low level of ICT using firms did not have formal training. On the other hand percentage of such workers in moderate and advanced level of ICT using firms was just 1.60 per cent and 0.62 per cent respectively. Not only that the percentage of technically trained workers in low level of ICT using firms was just 9.69 per cent whereas the percentage of such employees in moderate and advanced ICT using firms was 27.68 and 24.48 per cent respectively. This suggests a positive relationship between the level of ICT adoption and skill intensity of workforce.

Table 3: Skill intensity of workforce and the degree of ICT adoption

Workers (in %)	Level of ICT use			Total
	Low	Moderate	Advanced	
Eng. Graduates	13.22	19.54	18.16	18.27
PG/Graduate	4.85	8.00	8.19	8.06
Diploma	15.86	27.68	24.48	24.80
Tech. Training	9.69	22.60	27.58	26.20
UG	10.57	22.58	20.97	20.61
Others	45.81	1.60	0.62	2.06
Total	100	100	100	100

4. MEASUREMENT OF VARIABLES AND HYPOTHESES

As depicted in the theoretical framework, the relationship between the extent of ICT adoption with entrepreneurial characteristics and telecommunication infrastructure is unidirectional while with other variables it is bidirectional. Therefore instead of testing the hypotheses that a particular variable influences the adoption of ICTs, we would identify factors that discriminated firms according to the intensity of their ICT use. As mentioned earlier that the variables have been grouped into four categories, namely; entrepreneurship, technological infrastructure, conduct, and performance. We will formulate hypotheses related to groups rather than individual variable.

4.1 Hypothesis I

The hypothesis is related to the entrepreneurial characteristics of owner/managing director with the degree of the adoption of ICTs. Entrepreneurship has been represented by two variables, namely: academic qualification of MDs; and their age. We consider that these two variables are the appropriate proxy of entrepreneurship with respect to the adoption of ICTs. Before we proceed further we would like to mention the methodology of measurement of these variables. Age was collected in

years while qualitative information (Table 1) about academic background of MD was collected and converted into three-point scale, namely: MDs who did not have bachelor's degree were assigned lowest rank, i.e. 1; graduate MDs were assigned higher rank, i.e. 2; and highest rank 3 was assigned to MDs who had professional and masters degrees. These quantitative values were used in the statistical analysis.

These two variables were considered as representative of entrepreneurship as MDs with sound academic background are in a better position to understand and identify ICT tools useful for their business. Age has been considered as representative of entrepreneurship as young MDs are expected to be more risk taking than old ones. Literature on the subject suggests that entrepreneurial abilities positively contribute to adoption of new technologies (Lal, 1999; Oyelaran-Oyeyinka et al., 2007). We also expect that entrepreneurial characteristics are likely to be significantly different in various levels of ICT using firms.

4.2 Hypothesis II

The role of technological infrastructure in the adoption of ICTs is hypothesised in this sub-section. Technological infrastructure needed for the effective use of ICTs includes several factors such as cost and speed of communication, availability and accessibility of different technologies such as dedicated digital lines, satellite based technologies, wireless connectivity, and Internet speed etc. Communication speed has been used in this study as a measure of technological infrastructure. The variable was measured on a five-point scale ranging from "not a constraint" to "severe constraint".

It is very obvious that speed of communication is very important for certain types of ICTs particularly those that are used in non-production activities such as marketing, coordination of activities with other national and international business partners. But speed of communication may be irrelevant for in house use of ICTs such as ICT led production technologies. There have been several studies that have examined the impact of communication infrastructure on the diffusion of ICTs (Hargittai, 1999). A positive relationship has been found between the diffusion of ICTs and the communication infrastructure. Most of these studies have been at the national level rather than firm level. Having no a priori knowledge of impact of communication speed on the diffusion of ICTs at the firm level we hypothesise a similar relationship as that of national level studies. We expect a positive relationship because in general firms adopt ICTs for non-production activities first, for which

speed of communication matters, and then percolate down to production processes. Hence the speed of communication matters for all levels of ICT using firms.

4.3 Hypothesis III

Third hypothesis is related to variables that represent conduct of a firm. The representative variables that are considered in the study are: skill intensity of workforce, quality consciousness of the management, brand name, formal training of workers, better management control, and international linkages. Skill intensity of firm was measured by the ratio of sum number of engineering graduates and graduate/postgraduates to the total number of full time employees. The other variables are opinion variables and were measured on a five-point scale ranging from "not important" to "highly important". The opinion was sought on the role of conduct variables in the adoption of new technologies.

Some scholars might question this categorisation, particularly skill intensity, as part of conduct of firms. In the given context it is justified because MDs who are aware of utility of ICTs will also understand that effectiveness of new technologies can be realised with the acquisition of appropriate technology coupled with skill of users of such technologies. Hence enterprising MDs are expected to hire more qualified person for effective use of such technologies.

Although technological change led by ICTs is regarded as skill-biased, the empirical findings are mixed (Doms et al., 1997; Lal, 2008a). Application of ICTs in science based sector such as electrical and electronic goods manufacturing require high skilled persons for ICTs used in the sector while low tech sector does not necessitate having highly skilled persons for ICT tools used in such sectors. Given the industrial classification of sample firms (Section 3), we expect that skill intensity in advanced ICT using firms was higher than the rest. We expect similar relationship of other conduct variables with the intensity of ICT adoption.

4.4 Hypothesis IV

Fourth hypothesis is related to the performance indicators of firms and the adoption of ICTs. Performance has been represented by improvement is sales turnover, improved delivery schedule, and efficiency in production processes. Firms were very reluctant to share actual data of sales turnover. Hence we measured performance by asking the impact of ICT adoption on the sales turnover. This was measured on a five point scale

ranging from “no impact” to “very strong”. The other performance indicators were also measured the same way as that of sales turnover.

Several scholars have investigated the relationship between the performance and the adoption of ICTs (Baily, 1986; Brynjolfsson, 1992; Lal, 1999). Although different indicators have been used by different authors, all the studies after mid 1990s have found a positive relationship between the performance of firms and the intensity of ICT adoption. Delivery schedule is particularly likely to be improved by the adoption of technologies such as Just in Time (JIT). Hence we also hypothesise that MDs of advanced ICT using firms assigned higher score to performance indicators.

5. STATISTICAL RESULTS AND DISCUSSIONS

5.1 Statistical Results

The data were analysed in a multivariate framework. Results are presented in Table 4. A forward stepwise discriminant analysis was preferred over other multivariate models such as ordinary least square (OLS) and ordered probit. This is because discriminant analysis does not pre-assume causal relationship between the group identification variable and others. As depicted in theoretical framework, it is assumed that several factors reinforce causal relationship. Hence discriminant analysis was considered as the most appropriate technique to be used in this study. The procedure begins by selecting the individual variable that provides the greatest univariate discrimination (in terms of groups mean difference of F). It then pairs the first variable with each of the remaining variables to find out the combination that produces the greatest discrimination. The variable that contributes to the best pair is selected. In the third step, the procedure goes on to combine the first two with each of remaining variables to form triplets. The best triplet determines the third variable to be entered, and so on. It stops the procedure when groups mean difference F is less or equal to 1. Table 4 presents the summary of the stepwise procedure and the variables selected with their relative contribution to the discrimination

Table 4: Discriminant analysis results

Variable	Mean and SD values			Wilks' Lambda	F-Value	Sig.
	Low	Moderate	Advance			
MD_EDU	1.50 (1.00)	2.46 (0.52)	2.60 (0.49)	.796	7.940	.001
MD_AGE	59.00 (14.65)	42.85 (8.96)	44.44 (8.01)	.843	5.768	.005
EFF_PROD	2.75 (0.50)	3.31 (0.63)	3.63 (0.67)	.885	4.026	.023
MNGMNT	3.00 (0.82)	3.62 (0.51)	3.69 (0.59)	.924	2.535	.087
COM_SPD	3.00 (0.82)	1.54 (0.66)	1.92 (0.45)	.721	12.014	.000
TRN_FRML	2.25 (1.50)	3.62 (0.51)	3.63 (0.53)	.765	9.507	.000
SKILL	0.10 (0.199)	0.28 (0.082)	0.30 (0.10)	.828	6.449	.003
B_NAME	2.00 (1.83)	2.69 (1.49)	3.12 (1.03)	.933	2.229	.116
INT_LNK	1.50 (1.73)	2.69 (1.38)	3.10 (0.99)	.883	4.107	.021
SALES+	3.25 (0.96)	3.85 (0.38)	3.54 (0.58)	.935	2.171	.123
PRD_QUAL	3.25 (1.71)	3.38 (0.51)	3.56 (0.50)	.975	.796	.456
DEL_SCH	3.50 (0.58)	3.62 (0.51)	3.48 (0.71)	.993	.210	.811

Note: Figures in parentheses are standard deviations

In addition to measuring level of significance of variables presented in Table 4 we estimated the discriminating power of the function in terms of the variables included in the analysis. The discriminant function can be written as:

$F=f(E, TI, Co,P) +\varepsilon$ ----------(Eq1)

Where E→ Entrepreneurial characteristics, TI→ Technological Infrastructure indicators, Co→ Variables representing conduct of firms, and P→ Performance variables, and ε is error term.

Based on the function shown in Eq1, a composite score was generated to test the validity of the function. Generated scores were compared with the actual group membership, assigned according to the level of ICT use, of firms. The actual and predicted group memberships are presented in Table 5.

Table 5: Classification results

Actual membership	Predicted group membership			Total
	Low	Moderate	Advance	
Low	3 (75.0 %)		1 (25.0 %)	4
Moderate		9 (69.2 %)	4 (30.8 %)	13
Advance		7 (14.6 %)	41 (85.4 %)	48
Total	3	16	46	65

Note: Total classification power of the function is 81.5 %; Figures in parentheses are row percentages

Results presented in Table 5 show that the discriminant function is able to classify 75 per cent of low level of ICT using firms correctly while it could classify moderate level of ICT using firms with 69.2 per cent accuracy. As far as advanced level of ICT using firms are concerned, the function could classify 85.4 per cent of firms accurately. The total classification power of the function is 81.5 per cent which can be regarded as high discriminating power.

5.2 Discussion

It can be seen from the results presented in Table 4 that variables representing entrepreneurship emerged significant in discriminating different levels of ICTs using firms. The level of significance of both the variables, i.e. age and academic background of MDs is 1 per cent. Results are according to our expectations and in line with the existing empirical evidence. MDs' educational background has not always been a major determinant of the adoption of ICTs (Oyelaran-Oyeyinka and Lal, 2006). The authors found that sector-specificity has a bearing on the educational background of MDs. In this study sector-specificity might have disappeared due to negligible presence of "low tech" sectors. Consequently MDs' educational background has emerged an important factor in determining the intensity of ICT use. The significant contribution of age of MDs in discriminating varying levels of ICT using firms is according to our expectation. Apparently advanced ICTs were being used by firms that are managed by young and professionally qualified persons who understand and are capable of reaping the benefits of new technologies. On the other hand older MDs lack this entrepreneurial ability and hence did not go in for advanced ICTs.

Emergence of speed of communication as one of most significant factors that discriminated varying levels of ICT adoption is according to our expectations. Here it is important to mention that provision of high speed communication network is

beyond the scope of SMEs. It has to be provided by external agencies such as private telecom companies or public sector companies. It may be wrong to argue that cost of high speed communication is so low that it is within reach of every SME. Given the volume of ICT activities that require communication network, many times high speed communication is economically not viable for firm. Such firms then prefer low speed communication network and consequently speed becomes a constraint for them. Or alternatively government is unable to provide high speed communication due to high costs associated with that.

Four out of the six variables representing conduct of firms emerged significant in discriminating three groups of firms. The level of significance of importance of formal training and skill intensity was 1 per cent while role of international linkages emerged significant at the level of 5 per cent. Unique contribution of the study lies in its ability in capturing the role of learning modes and opportunities in the adoption of new technologies. Results presented in Table 4 suggest that formal training has been assigned more importance than preferred learning modes in SME such as learning by doing, and on-job training. Advanced ICT using firms might have given more importance to international linkages due to globalisation and competitive environment prevalent in Malaysia. Although exports intensity of sample firms was very low, firms might have given importance to international linkages for keeping informed about developments in manufacturing technologies and transfer of new product designs etc. The level of significance of "better management control" variable was 10 per cent. This is according to our expectation. Firms that were using LAN or Intranet might have realised that such technologies provided better control of management functions.

Results are surprising with respect to one performance variable, i.e. increase in sales turnover. "Increase in sales turnover" being insignificant in discriminating three types of firm does not mean that use of ICTs does not improve sales turnover. It can be seen from Table 4 that mean value of opinion of MDs of all types of firms is between 3.25 to 3.85 suggesting that MDs of firms cutting across varying degrees of ICT adoption opined that adoption of ICTs contribute moderately in improving sales turnover. Since there is very little variation in the numerical value of this variable, statistical technique has not been able to discriminate firms based on this variable. Another interpretation could be that firms may not have adopted ICTs only to improve sales turnover. They might have adopted ICTs to survive and remain competitive in the era of globalisation. Delivery schedule being insignificant could be attributed to similar response of all the three group of firms which is evident from

Table 4. The other performance variable, i.e. "efficiency in production processes" emerged significant at 5 per cent level of significance. The results are as we expected. Firms that were using ICTs in production processes might have encountered efficiency gains due to adoption of ICTs.

6. SUMMARY AND CONCLUSIONS

Findings of the study are based on primary data collected from sixty-seven SMEs located in and around Kuala Lumpur. The survey was conducted during October 2004 and March 2005. Keeping bidirectional nature of relationship between the adoption of ICTs and entrepreneurial, conduct, and performance variables, we applied multivariate analysis which does not pre-assume unidirectional relationship of dependent and explanatory variables. Consequently stepwise discriminant analysis was used for data analysis. Sample firms were grouped into three categories based on their intensity of ICT adoption, namely: low; moderate; and advanced.

Results suggest that entrepreneurial abilities of managing directors emerged highly significant factor that discriminated three groups of ICT using firms. The other variables that discriminated advanced ICT using firms from the rest can be grouped into three categories, namely: technological infrastructure, conduct of firms, and performance. Findings suggest that variables representing all four categories emerged significant in discriminating varying levels of ICT using firms. The performance variable labelled "contributions of ICTs in increasing sales turnover", measured on a five point scale ranging from "no impact" to "very strong", did not differ significantly among three categories of firms. One of the interpretations for insignificance of performance variable could be that firms might have adopted more advanced ICTs not because of its contributions to increase in sales turnover but to remain competitive in the globalised world. It is needless to mention that Malaysian SMEs are fully exposed to multinational firms and they face stiff competition from them.

One of the unique findings of the study is that managing directors of advanced ICT using firms assigned higher importance to formally trained workers than learning by doing or on-job trained workers, which are the preferred mode of skill upgradation in SMEs. This could be attributed to the nature of industrial applications of ICTs. As argued by several scholars technological change led by ICTs is different from earlier ones in many ways. ICTs are not only pervasive but also obsolescence rate of ICT tools is very high. Hence highly skilled and formally trained workers might be more suitable for efficient and effective use of ICTs particularly in science based sectors.

Programmability aspect of ICTs also necessitates formally trained workers. The arguments may not be valid for applications of ICTs in low tech sector.

The findings related to entrepreneurial abilities are not new. Entrepreneurship plays a major role in any technological change carried out at the firm level. The uniqueness of the study lies in capturing the role of formal training of workers for successful use of ICTs. By doing so, SMEs can be successful in maintaining their market share and succeed in facing onslaught posed by globalisation in the form of global competitiveness.

Based on the findings of the sturdy we recommend that Malaysian government needs to focus on human resource development policies and cost effective communication infrastructure policies. Government needs to provide high speed telecommunication network at globally competitive rate. Human resource development institutions can be strengthened so that they are capable of providing job-oriented formal training. A provision of such opportunities is expected to contribute in efficiency and high productivity of workers which in turn will help small firms to remain competitive in the era of globalisation.

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Appendix Table 1: Description of variables

Variables	Description
MD_EDU	Academic background of managing directors: Qualitative information was collected but converted into three categories for statistical analysis
MD_AGE	Age of managing directors in years
EFF_PROD	Opinion variable, i.e., does adoption of ICTs induce efficiency in production processes?
MNGMNT	Opinion variable, i.e., does adoption of ICTs enable better management control?
COM_SPD	Speed of communication, Opinion variable, i.e., does speed of communication a constraint?
TRN_FRML	Opinion variable, i.e., role formal training in effective use of ICTs
SKILL	Skill intensity
B_NAME	Opinion variable, i.e., role of brand name on competitiveness of firm
INT_LNK	Opinion variable, i.e., does adoption of ICTs augment international linkages?
SALES+	Opinion variable, i.e., does adoption of ICTs increase sales turnover?
PRD_QUAL	Opinion variable, i.e., role of ICTs in contributing in the product quality
DEL_SCH	Opinion variable, i.e., does adoption of ICTs help in meeting delivery schedules?

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