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The adoption of e-business technology by SMEs

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Abstract

The paper examines the key factors influencing the adoption of e-business technology by SMEs. To this end, the paper draws on a range of literatures on the diffusion of new information and communication technologies (ICTs), many of which have hitherto been treated as separate. The reasons for this are two-fold. First, e-business technologies are the latest in a line of new ICT technologies. When exploited successfully, ICTs have increased firm competitiveness either by raising the efficiency of internal communication and organisation and/or supply chain relationships, or by facilitating the development of new/improved products and services. Second, it is hypothesised that many of the factors affecting the successful adoption of new technologies are generic in nature. With regards to SMEs specifically, consideration of earlier research may assist us in identifying a set of enablers and barriers to e-business adoption. Hence, by explicitly acknowledging the context and prior history of research in the area, we are able to map out the dimensions of future theoretical and empirical research in e-business adoption by SMEs.

In addition to drawing together factors identified by existing research, the paper highlights the implications of network externalities for the timing of technology investments and the returns that accrue to early and late adopters. It also draws attention to a number of problems associated with the analytical concept of 'the SME' when it is applied to this area. The research proceeds by clearly defining the technological and organisational characteristics of the e-business model and a brief consideration of the trends in adoption in the UK vis-à-vis adoption in the other G7 countries. Together these set up a detailed consideration of the internal and external factors influencing adoption. A qualitative approach, in the form of a detailed case study, is then used to explore the potential usefulness of the factors that have been identified. The results of these findings are then drawn together in the concluding section of the paper.

Keywords

e-business, SMEs, innovation, ICT.

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1. Stages to e-business

E-business is the integration of the internet and related ICTs into the business organisation and has two facets. One is the integration of the supply chain so that production and delivery become a seamless process. The other is the creation of new business models based on open systems of communication between customers, suppliers and partners. Where the integration of the supply chain provides increased efficiency and significant cost advantages through waste minimisation, the development of new products and services are facilitated by new ways of conducting business based on internetworking between organisations and individuals.

It is possible to trace a number of stages through which firms are passing as they progress towards e-business. Each stage is associated with a higher degree of internetworking and sophistication in communication modes, progression from traditional commerce to e-commerce business models requiring ever more radical restructuring of the internal structures. The first stage is the adoption of e-mail. E-mail is a cost effective and fast method of communicating and sending files which can be applied to improve the efficiency of internal communications within an organisation and also external communications with customers and suppliers. The adoption of e-mail for internal communications is closely correlated with the setting up of a local area network (LAN) to link computers within a building. Compared with a wide area network (WAN) that links computers between sites, setting up a LAN is relatively simple and so the costs of implementation are much lower. Both types of networks facilitate electronic communication in the form of e-mail, file sharing and data back-up within an organisation.

The second stage on the path to e-business is the establishment of a web presence. In the past the first company website was often a 'flat ad website'. This is the simplest form of website, consisting of a one or two page document providing background information on the company, its contact address and telephone number. In the past a flat ad website did not always have an e-mail link, although this is now a standard feature. A more sophisticated web presence is provided by a 'brochure website'. This provides details of product/service specifications, price, and availability, and may make use of graphical illustrations of products much in the manner of a mail order catalogue. A brochure website also opens up the possibility of online ordering and payment. Online selling provides a relatively low cost means of reaching a large number of customers. Additionally, the geographical reach of a website is far greater than that of a traditional retail outlet. If a digital commodity is being sold then multiple copies can be distributed across the internet at zero marginal cost. If the commodity cannot be digitised then a means of physical delivery, e.g. overnight carriers, needs to be organised.

As Rosenberg observed some twenty years ago, important epochs in economic history are marked by the emergence of clusters of new, interrelated technologies rather than single technologies (Rosenberg, 1982, p.59). The introduction of online selling invariably requires large-scale changes in information systems supporting outbound

logistics - including stock and inventory control, warehouse management, and delivery planning and control – and marketing and sales. This often requires the introduction of new complementary ICT technologies, new competences and business practices, and a degree of organisational restructuring.

Applying Porter's value chain model to the current discussion, we see that higher degrees of organisational restructuring are associated with each of the stages up to e-business. E-mail is relatively easy to adopt because its introduction affects those internal information systems linked to support activities in the value chain. By contrast, online selling requires a higher degree of organisational restructuring because its introduction affects outbound logistics and marketing, both of which are primary activities in an organisation's value chain. A still higher degree of organisational restructuring is required for businesses making the transition to e-business itself. As noted, e-business involves both the restructuring of supply chains and the reconfiguration of the business-customer interface with the aim of constructing a seamless web between customers and suppliers along the supply chain. This restructuring affects all of the primary activities of the organisation's value chain: in-bound logistics, operations/manufacturing, outbound logistics, marketing and sales, and after sales support. The internet provides a common, interoperable platform for this new business model.

A set of additional elements arise in the e-business model. Interactive websites, incorporating technologies such as dynamic databases and videoconferencing, facilitate multilateral communications between client and provider regarding product design. Extranets enable a business to share part of its information or operations with suppliers, vendors, partners, customers, or other businesses. These can be used to check raw material requirements, investigate stock availability, and check the progress of an order. For many businesses, this represents an important step in the adoption of new working practices with partners. Internally, new ways of working are also being explored by offering employees remote access. Marketing and sales are further transformed by the development of after sales support underpinned by database records of customers and telephone call centres. Finally, e-business requires the introduction of new financial management practices and support systems due to the high degree of complexity, and the need for continuous information collection and monitoring in order to optimise a business' cash flow, in real time.

The different types of communications required for e-business have been highlighted in the literature (e.g. Venkantraman, 1994; Gonzalez, 1998). The internet is an inherently two-way medium that requires the development of new styles of conversation between an organisation and its clients/suppliers. It is still possible for organisations to use the internet to conduct uni-directional interactions, e.g. completing and dispatching forms, sending and receiving messages via e-mail or v-mail. However, what is novel about the internet is the ability to converse with someone while both parties work on an application, see the conversant and transfer documents as the conversation continues. Gonzalez (1998) distinguishes between four types of communication each requiring a higher degree of organisational sophistication: the publication mode, the asymmetrical mode, the symmetrical mode,

and the synchronous virtual environment mode. The publication mode is the traditional uni-directional model of previous ICTs in which the sender formulates a static document that the receiver reads. The asymmetrical mode is a bi-directional, time delayed didactic communication with one participant formulating a written question or statement and the other responding after a time lag. The symmetrical mode differs to the asymmetrical mode in that it has multi-directional communication with numerous feedbacks that takes place in real time and which extends the degree of interactivity. Finally, the synchronous virtual environment mode uses real-time, dynamic, multi-dimensional communication to support key business processes.

There remains enormous scope for extending the use of e-commerce in UK SMEs. We have suggested that the commercial benefits of e-business lie in six areas. First, significant opportunities exist for SMEs to expand their geographical reach. Second, important cost benefits lie in improved efficiency in procurement, production and logistics processes. Third, there is enormous scope for gaining competitive advantage through improved customer communications and management. Customer care websites are now becoming increasingly common. Fourth, the internet reduces barriers to entry for new market entrants and provides an opportunity for small firms to reorientate their supply chain relationships to forge new strategic partnerships. Where proprietary electronic data interchange (EDI)¹ systems were promoted by large organisations as a means of tying in smaller suppliers to their needs, and of securing their market power, open internet-based platforms provide small firms with a far greater degree of strategic manoeuvre and negotiating power. Fifth, the technology facilitates the development of new types of products and new business models for generating revenues in different ways. Sixth, there is the opportunity to transform SMEs into information-driven businesses. The technology offers, for the first time, an affordable means of capturing and processing the information generated through electronic transactions. Through techniques such as data mining, this information can be translated into knowledge about what the company sells and can be linked to how the company operates, resulting in an integrated approach to knowledge management.

2. Recent trends in the adoption of e-business technologies by UK SMEs

The UK government's 1998 white paper 'Our Competitive Future – Building the Knowledge Driven Economy' (HMSO, 1998) set targets for the numbers of micro enterprises, and small and medium-sized enterprises (SMEs) becoming wired up to the digital marketplace. The targets were specified in terms of the adoption of key e-business technologies. Taking into account the current range of available technologies, this was interpreted as the adoption and use of external e-mail, websites and EDI. Numerically, the target set was for adoption of these underpinning technologies by 1 million micro enterprises and SMEs by the year 2002. When the White paper was published an estimated 350,000 micro enterprises and SMEs possessed these technologies. In 2001 some 1.9 million micro enterprises and SMEs had either adopted e-mail, an EDI system or set up a website (Spectrum/DTI, 2001).

Still, UK SMEs are only beginning to experiment with new e-business solutions.

While 70% of small firms in the UK have some form of internet access (Spectrum/DTI, 2001), this remains limited to the exchange of e-mails or a static company website. Very few UK SMEs firms (or large firms for that matter) use the internet as a fully interactive e-commerce platform. Usage remains confined to the provision of product information and to generic intra- and inter-firm communication. According to sector studies conducted by the Office for National Statistics (ONS) (2001), nearly £57billion of goods and services were sold over the internet in 2000². Putting this into perspective, this represents 2% of total sales in these sectors. The UK experience is in line with the trends in other countries. Indeed it has been suggested that in terms of online trading, the UK ranks equal highest with Canada amongst the G7 countries (Spectrum/DTI, 2001).

The ONS data suggests that there is a positive association between company size and the proportion of UK firms engaged in online trading, defined as both ordering and paying on-line with either customers or suppliers. As in other countries, business-to-business transactions constitute the majority of online trade in the UK. More than four-fifth of total online transactions were between firms, with an estimated value of £47 billion. Again, the volume of transactions carried out electronically represents a small percentage of the total transaction volume in the UK. Inter-firm electronic information flows remain centred on 'traditional' proprietary networking technologies such as EDI via direct lines and value added network (VAN) applications. At present there is a wide range of proprietary e-commerce solutions, including e-commerce interfaces and support applications built upon various enterprise resource planning (ERP) platforms and proprietary database systems.

There is a continued steady increase in nearly all measures of ICT uptake and usage in the UK and the once enormous gap with the USA is closing. A noticeable gap remains, however, with US businesses still more likely to use ICTs across a wide range of business processes. Furthermore, the earlier adoption by US enterprises may well mean that they are using ICTs more intensively than their Canadian, Japanese and European counterparts (ownership measures are a crude indicator of usage since they do not indicate the intensity of use). Comparing the UK experience with that across the G7, UK SMEs are ahead of their counterparts in Japan, France and Italy but lag behind US, Canadian and German enterprises. Indeed, whereas UK enterprises used to be reported as having a lead over their counterparts in European nations such as Germany, this no longer holds. A feature of the data noted by the recent Spectrum/DTI report is the distribution of performances according to the size of enterprises. The spread of performance between the smallest and the largest companies in the UK is greater than for the other reported G7 countries. This is illustrated in Figure 1 below which indicates the percentage of micro, small, medium and large respondents in the USA, Canada, UK, Japan, Germany and France that report the establishment of a company website, external e-mail, EDI installations and online selling systems.

At the national level, UK enterprises are amongst those most likely to have both local area networks (LANs) and wide area networks (WANs). Indeed, the pattern of internal e-mail adoption was found to be closely correlated with that of LANs. Of all respondents contacted, UK respondents had the highest reported use of videoconferencing (22% of all UK respondents). This may reflect both the relative evenness of the geographical spread of population in the UK, and the high proportion of multi-site and multi-national businesses operating in the UK. However the reported incidence of UK enterprises with internet access, websites, external e-mail, EDI and online selling do not compare favourably with competitors in Canada, the USA and Germany. 27% of UK businesses allow their customers to order online compared with 40% of businesses in Germany, 28% in USA and Canada, 20% in Italy and Japan, and 17% in France. Breaking down the figures by company size (Figure 1), the incidence of online provision in small and medium-sized businesses are the same as for large firms in the UK, at 28%. Just 54% of small and 65% of medium-sized enterprises in the UK report they have a marketing website. This compares with 54% and 71% in Canada, and 64% and 66% in the USA. Interestingly, UK SMEs measure favourably compared to their German counterparts, who have a reported provision of 50% and 63% respectively. The overall picture is worse due to the lower provision reported amongst micro and large business organisations in the UK compared to their German counterparts.

Figure 1 here

The empirical studies conducted by ONS and Spectrum/DTI provide a valuable resource for those interested in the current diffusion of e-business ICTs in the UK. However, these reports do not explore in detail the key factors affecting adoption. Additionally, indicators such as EDI penetration are not suited to discussion of e-business diffusion. As highlighted in section 2, e-business is associated with the adoption of systems based on open, internet-based standards. These systems seek to displace older EDI technologies. Second, as stated earlier, ownership is a crude indicator of use because it neither indicates the purpose to which a technology is applied nor its intensity of use. For example, having a web presence does not indicate that an SME has an interactive website that is supporting e-business. Third, we have discussed how the establishment of effective e-business systems requires the integration of marketing, purchasing and human resources. E-business requires more than the adoption of one or more key technologies; it requires the development of an interoperable ICT platform that integrates all three of these key business functions. A key research question is therefore the extent to which UK SMEs have integrated their organisational computer systems. These are just a few of the important research questions that need to be addressed. We will turn our attention to these and other research questions in the remainder of this paper.

In order to expand the discussion of the factors affecting the adoption of e-business ICTs, we shall consider two bodies of relevant literature. The first is the research on adoption that has been developed in the information systems (IS) literature. The second is the body of research that has been developed in the literature on technological innovation. These are examined in sections 4 and 5 respectively.

3. Organisational factors affecting adoption by SMEs

In this section we consider factors affecting the adoption of ICTs that have been highlighted in the information systems literature. This body of research work focuses on internal factors within the business organisation, marrying technical implementation issues with business strategy issues. In principle, one would like to treat information systems as a separate factor of production and then measure the contribution of this factor input to overall profitability. However, this is problematic for two reasons. First, the artefactual aspects of information systems are varied in character; they comprise not only hardware and software elements, ranging from http and TCP/IP protocols to databases to processor chips to cables. Second, information systems have an organisational as well as an artefactual dimension, i.e. a particular information system technology has an associated set of organisational structures and procedures. What is more, different information systems typically have different sets of associated structures and procedures. The upshot is that information systems, unlike labour, do not have a common unit of analysis. Consequently, researchers have sought alternative ways in which to proceed. As yet no commonly agreed method exists in this literature. In different ways, researchers have sought to investigate factors affecting the 'successful implementation' of new ICT systems. The most common indicators used are measures of user satisfaction (typically managers' subjective evaluations), the stock of ICTs (as measured by current stock and/or future acquisitions), evaluations of the degree to which systems accomplish the original set of specified objectives, and subjective estimates (again typically those of managers) of the payoffs of system implementation to the organisation.

Turning to the factors affecting successful implementation that have been highlighted in the information systems literature, we follow Yap *et al.* (1992) schema. This clusters the factors that have been reported as affecting the successful adoption of ICTs by SMEs under five major classes: organisational characteristics, organisational action, system characteristics, internal expertise and external expertise.

3.1 Organisational characteristics

As in other literatures, the IS literature notes that company size is related to the probability of ICT adoption with smaller companies less likely to adopt new technologies than their larger counterparts. Smaller organisations typically have less complex organisational structures than larger organisations and, hence, have lower internal requirements for extensive communication technologies. With smaller volumes of information to be communicated and stored, there is less compelling need for ICTs to manage information.

ICT experience and the presence of in-house processing capabilities are well-documented factors affecting ICT adoption. In addition to technical knowledge and competences (Raymond, 1985; Yap *et al.*, 1992; Chapman *et al.*, 2000), the literature has highlighted the importance of application capabilities. The latter category involves a strategic understanding of the market opportunities afforded by new ICTs, their organisational implications, and the ability to successfully implement them in order to leverage competitive advantage (Venkatraman, 1994; Mullins *et al.*, 2001; Tetteh and Burns, 2001). Research on UK SMEs consistently indicates problems in both categories. Spectrum/DTI (2001) highlights UK SMEs' inability to take advantage of the opportunities afforded by e-business ICTs. Tetteh and Burns (2001) suggest that "few SMEs realise that they need a strategic appreciation of the dynamic of the Web and that they will have to develop the capabilities for managing the information infrastructure for an e-business" (2001, p.171). Furthermore, Chapman *et al.* (2000) and Spectrum/DTI (2001) suggest that UK SMEs tend to lack the in-house technical skills necessary to successfully implement e-business strategies. This is despite the wide range of support offered to SMEs (Hamill and Gregory, 1997; Fariselli *et al.*, 1999). In addition to national initiatives, the European Union has been funding a range of initiatives aimed at boosting ICT take up by SMEs. Yet, despite this effort, technology take up has remained much slower in SMEs than in large enterprises (Lebre La Rovere, 1998).

Spectrum/DTI (2000) estimates that some 63% of UK businesses provide formal ICT training for their employees. This compares very favourably with respect to their findings in the other G7 countries (73% in France, 71% in Germany, 61% in Canada and 50% in USA, 47% in Italy, 41% in Japan). However clear differences exist according to firm size, with an estimated 58% of medium-sized firms and just 50% of small firms providing formal training compared with 74% of large firms. This accords with empirical studies by Lange *et al.* (2000) and Mullins *et al.* (2001) who also find a distribution of training according to size. In their study of Scottish SMEs, Lange *et al.* (2000) highlighted a number of factors affecting the upgrading of in-house human capital. First, training was perceived by those managers contacted to be a costly investment. Search costs are high, with managers reporting a bewildering number and variety of training initiatives provided by both public and private sector agencies. This makes it difficult for SMEs to ascertain which provision is most suitable for their needs. However, the study additionally reported that managers view investment in the upgrading of in-house skills as risky. This raises some concerns

with respect to managers' limited expectations on the returns to investment in human capital. Additionally, worries were expressed regarding the dangers of subsequently losing trained staff to other organisations. The basis for this fear of a free rider problem is open to question. Research conducted by Mullins *et al.* (2001) on European SMEs suggested that there may be a recognition problem. Only half the managers they surveyed made a link between the quality of staff skills and the effective exploitation of e-business ICTs. A research issue that needs to be addressed is the degree to which a lack of awareness of the available opportunities, rather than a scarcity of in-house skills and competences, inhibits the automation of key business functions within SMEs.

Three further resource constraints in SMEs are frequently cited in the literature: financial resources, management resources, and time. The scale of many small businesses is such that they are more exposed to cash flow problems, have less resources to devote to the sophisticated management of financial instruments and, since they do not enjoy the economies of scale and market power enjoyed by large organisations, SMEs do not enjoy the preferential interest rates offered by banks to large organisations (Fariselli *et al.*, 1999; Foong, 1999; Premkumar and Roberts, 1999). Ein-Dor and Segev (1981) additionally note that there are considerable economies of scale in computing operations themselves. Hence banks may reasonably expect returns on investment in SMEs to be smaller than for large enterprises. The stronger financial constraints facing smaller organisations is a key factor, it is suggested, explaining why smaller companies tend to be more sensitive to cost and why they have longer replacement cycles. Additionally, binding financial constraints give rise to the possibility of sub-optimal investment decisions when SMEs choose to adopt lower-cost, second-best (or worse) options that do not satisfy users' needs.

In addition to financial constraints, it has frequently been asserted that SMEs face severe time constraints compared to their larger brethren. There are multiple reasons for this. First, the organisational structures of small firms tend to be flatter than in large firms, with management performing multiple organisational tasks. In addition to potential losses of efficiency due to a lack of task and skill specialisation, managers in SMEs have little time to spare to upgrading their own knowledge and competence base (Lange *et al.*, 2000). Second, Ein-Dor and Segev (1978) and Malone (1985) discuss the shorter management timeframes found in SMEs. Tighter timeframes are one consequence of the oft-cited ability of SMEs to respond quickly to changing market conditions. When combined with pressures arising from multi-tasking within flat management structures, managers in SMEs are constrained to the day-to-day running of their businesses with little or no time to devote to forward planning. This helps explain the lack of willingness to resources upgrade either their staff's or their own skills base. Third, experience is a time-related variable. Empirical research conducted by Yap *et al.* (1992) supports Raymond's (1985) suggestion that the successful implementation of new ICTs is positively associated with the duration of an SME's ICT experience. Raymond reasoned that problems relating to ICT implementation require time to be resolved and, hence, measured success will be time dependent. Fourth, time is an inherent influence affecting the path dependency of ICT investments. Previous experience gained through past

investment in older ICTs such as EDI, assists companies in identifying and understanding the organisational and strategic issues raised by investments in e-business ICTs.

Our own view is that the category 'SME' is problematic since it places under one roof companies that differ enormously in nearly all conceivable dimensions, not only in terms of numbers of employee and turnover but also in their business activities (manufacturing and services), degree of international exposure, customer bases, sector characteristics, technological sophistication. *Ex ante* one would expect that, in bridging these very different internal and external forces, a variety of organisation structures could evolve, some of which would more closely resemble categorisations traditionally associated with large businesses than those associated with micro or very small businesses.

3.2 Organisational action

Studies in large organisations have established the importance of top management support in facilitating successful ICT adoption (Cerveny and Sanders, 1986; Earl, 1996; Daft, 1998). In SMEs the focus has fallen on the support of CEOs because most small businesses are managed by an owner that also acts as the CEO. Additionally, as previously noted, SMEs tend to have a flat organisational structure. Within such organisational structures the CEO typically performs multiple roles in the daily running of the business, takes the majority of decisions, and has full control over the organisation's resources (Raymond and Magnenat-Thalmann, 1982; Steinhoff and Burgess, 1986). CEO support is therefore essential for establishing appropriate ICT goals, identifying critical business information needs, and allocating the requisite financial resources. DeLone (1988) and Yap *et al.* (1992) have highlighted the importance of CEO support in the implementation phase. Support in decision taking in on-going implementation is important, not only by indicating serious commitment but also for ensuring effective delegation and staff direction, and for the conduct of progress reviews when necessary. As with previous ICTs, dependence on CEOs support to drive the adoption of internet technologies and the subsequent development of e-business solutions has been highlighted in empirical research conducted by Igbaria *et al.* (1998) and Premkumar and Roberts (1999).

Research conducted by Palvia and Palvia (2000) has suggested that the age and experience of the owner/CEO is the single most important factor governing successful ICT adoption. However, it is important to note that the median size of businesses included in the study was just 4 employees. It is not surprising to find that the owner is the primary IT user in micro businesses and, consequently, that the personal characteristics of the owner correlate closely with recorded satisfaction levels. In addition to variables such as the age and experience of the owner, the findings of the study suggested that gender is a statistically significant variable. By comparison, empirical research conducted by Igbaria *et al.* (1998) on a sample of firms with between 20 and 100 employees found that gender differences in the use of

spreadsheets, data management packages, programming languages and software packages were not significant when one controls for education, age and the experience of employees. Thus, while male respondents used more computer packages than female respondents, this reflected differences in their organisational functions, experience and training. In contrast to the research conducted by Palvia and Palvia, that conducted by Igarria *et al.* included staff in many different positions/functions rather than just the profiles of the CEO. An interesting counterpoint to this is provided by Spectrum/DTI (2000). It asked managers across the G7 the extent to which they were enthusiastic about ICTs. The study found that the degree of expressed enthusiasm amongst its respondents was not statistically related to either ICT uptake or usage.

Small businesses with a large number of administrative applications have the potential to provide better support for management control, operational control and administration. Raymond (1985) has argued that, as managerial task specialisation is less pronounced in small businesses, a manager must resolve a wide range of decisional and functional problems. Thus, it is expected that a small business manager will have a higher level of satisfaction with an ICT system that addresses a greater number of his/her problems. Raymond found some evidence to support the hypothesis that success is positively related to the number of administrative applications. However, the study conducted by Yap *et al.* (1992) found no evidence to support the hypothesis. Only when distinguishing between different types of administrative applications did they find a positive correlation for one particular class of application: financial and accounting applications.

3.3 Internal and external expertise

Montazemi's (1998) empirical study of 40 SMEs found a positive correlation between ICT success and the presence of a systems analyst. As Montazemi himself noted, the mere presence of a knowledgeable systems analyst does not guarantee successful ICT adoption. The match between a firm's information system and its business strategy requires a detailed action plan that exploits and integrates the analyst's expertise (also see Galliers, 1991, Earl, 1996; Daft, 1998).

A knowledgeable systems analyst may perform a number of important roles within the firm. To begin with, (s)he may act as a 'technology gatekeeper' for the firm. An effective systems analyst facilitates the implementation process by moderating extreme views or positions taken by external consultants, vendors, or colleagues within the SME. A technology gatekeeper additionally plays an important role in shaping realistic expectations within the SME regarding the likely benefits of new ICTs. The system analyst plays an important role as 'translator' between users within the organisation and the technology, providing in-house technical support, user assistance, and perhaps even basic training or instruction. This role positively contributes to the rate of technology assimilation within the organisation. Thirdly, the analyst often has an important role in the codification and transmission of knowledge

within the organisation. User manuals, work procedures and system documentation are typically written and maintained by the systems analyst. Finally, the systems analyst can play an important strategic role in system development since (s)he possesses the technical background to improve and develop the implemented technology.

The diffusion of innovations is a process of social as well as a technical adaptation. For Rogers, innovativeness is the “degree to which an individual... is relatively earlier in adopting new ideas than other members of a social system” (Rogers, 1983, p.245). In common with the introduction of any radically new product, e-business ICTs are currently characterised by a high degree of uncertainty and fluidity. Doubts with respect to market size, combined with high rates of change in the underpinning technologies and rapid rates in experimentation of alternative business models, give rise to a high degree of uncertainty. In the presence of such technological uncertainty, the literature highlights the importance of networks within the information gathering process.

Social networks may be personal or commercial. Research conducted by Johnson and Keuhn (1987) indicates that SMEs rely on their commercial networks much more than on government sources for their information search. These networks may comprise suppliers, research centres and other private/public agencies involved in the transfer of information, industrial associations, competitors, and consultants providing specialised services or know-how (Julien, 1995; Gibb, 1997). The importance of trust as a factor underpinning social networks has been highlighted by a number of authors (e.g. Hill and McGowan, 1996; Charlton *et al.*, 1997; Meldrum and de Berranger, 1999). Trusted external sources may to some extent offset the internal information gathering and processing constraints of SMEs arising from limited time, financial and other resources. Lee (1994) suggests that the extent to which SMEs exploit their social networks is influenced by their internal culture, which can either hinder or encourage the sharing of new knowledge and information. This contrasts with research conducted by Howard (1997). Howard reports that the SMEs in her sample had relatively few external contacts and that they had difficulties in obtaining impartial expert advice. Howard reports that the experiences of SMES in her sample vary according to industrial sector and company size.

Data collected by Yap *et al.* (1992) suggests that, for those SMEs with external consultancy, successful ICT adoption is positively related to the quality of external advice provided by consultants to SMEs. Gable (1991) adds that the manner in which SMEs manage the relationship is a crucial factor determining the benefits of this interaction. He argues that SMEs need to actively focus consultants’ advice and that three issues are crucial for a successful relationship: firm-consultant compatibility, the identification and addressing of specific organisational goals, and the ability to accommodate evolving project objectives. The research conducted by Yap *et al.* finds a positive relationship between successful adoption and the level of vendor support. This suggests that vendors also play an important role in the computerisation of SMEs with small businesses relying on vendors to propose alternative ICT options and to provide after-sales service and training.

4. Industry-level and macro-level factors affecting e-business adoption and exploitation

Much of the discussion relating to firm size and organisational structure is predicated on (what in industrial economics, at least, is seen as) a rather old-fashioned comparative approach – the organisational structure-performance approach - in which a set of idealised structures for SMEs and large organisations are stipulated. Relatively flat owner-led SME organisational structures are said to have advantages in terms of their ability to adapt to market changes when compared to the more complicated and hierarchal bureaucratic structures of large organisations. On the other hand, large organisations are said to enjoy significant advantages in terms of access to financial and human capital resources (Rothwell and Dodgson, 1991; Vossen, 1998). Unfortunately, these ideal types have been found seriously wanting in terms of their ability to explain the actual competitive or innovation performance of a company, or its speed of technological adoption. The comparative approach has fallen out of favour in, for example, industrial economics, as other, potentially more relevant factors, have been highlighted. These include the characteristics of the industrial sector in which the firm operates, its geographical resources, culture and other macro (national) and meso factors, and additionally factors relating to the nature of the technology itself (Hennart, 1982; Rogers, 1983; Casson, 1987; Porter, 1990; Hofstede, 1991; Lundvall, 1992; Freeman and Soete, 1997).

4.1 Sector and supply chain factors

Examining the data provided by the 2000 Spectrum/DTI report, knowledge-intensive industries rank the highest in their use of key external networking technologies, i.e. company websites, use of external e-mail, EDI and on-line selling systems (see Figure 2). Technology-intensive manufacturing sectors (chemicals, vehicle components, defence and aerospace) and service sectors (advertising, and insurance services) are significantly more likely to make frequent use of external networking applications than are clothing, road haulage, and retail sectors. We observe that life cycle of an industry can have an effect on ICT usage, with usage likely to be higher in new sectors than in mature sectors. Firms in mature industries face particular challenges posed by the introduction of new technologies and practices that displace pre-existing technologies and practices.

Figure 2 here

Decisions to adopt e-business technologies are also influenced by supply chains. An important link may exist between industrial sector and supply chains. An interesting finding of the Spectrum/DTI (2000) report is a pronounced preference for EDI and external e-mail in different industry sectors. Road haulage, clothing, vehicle

components and insurance companies were found to strongly favour EDI systems whereas advertising, chemicals and defence companies have a pronounced use of e-mail for external communications³. Here the work of Bolisani on EDI is of particular interest (Bolisani *et al.*, 1999). EDI permits the communication of structured messages between customers and suppliers using agreed formats, and allows data to be fed directly into an electronic business process. The technical complexity of EDI is such that the costs of installation and maintenance are only justifiable when the technology is employed to underpin long-term, high value relationships.

The diffusion of EDI technologies has largely been associated with the development of tight supply chains that are focused around a leading company with significant market power. This leading company can ensure its business partners conform to its requirements. Moreover, it is not unknown for the leading company to assist smaller SME partners, both financially and/or through technical support, in implementing the requisite systems. In manufacturing and retailing the implementation of EDI has commonly resulted in the development of 'hub-spoke' EDI networks around the leading company (Zwass, 1996). These hub-spoke networks are limited in flexibility; it is very difficult to alter the connected partners, message formats, and transaction procedures. Thus, although EDI was claimed to offer great potential for smaller businesses, the role of SMEs in hub-spoke EDI networks is often marginal. In many cases they are simply embedded in a closed system of relationships, the conditions of entry and action being determined by their larger partners. Indeed, there are instances of SMEs needing to run two different EDI systems on different equipment in order to participate in more than one network.

Picking up on Rosenberg's observation regarding the emergence of clusters of interrelated technologies making up a technology system, Windrum (2001) notes that technological substitutions can occur within system components. The substitution of EDI by open TCP/IP technology is a case in point. The diffusion of EDI has been closely tied with the diffusion of just-in-time production (JIT), electronic point of sale (EPOS), automated billing systems, and electronic inventory technologies. JIT production has been a particularly important factor in manufacturing sectors, its chief benefits lying in the significant reduction of inventory costs. Successful implementation of JIT requires the output of each stage of the production process to be fed into the next stage without undergoing an intermediate storage stage of indefinite length. In addition, the organisation needs to manage the delivery of external inputs from other organisations along the supply chain to ensure inventory stocks are minimised. Automated billing systems and EDI have further increased the strength of the couplings between organisations within supply chains.

The nature of the supply chains found in a particular sector can thus be a key factor affecting technological diffusion. In vehicle components sectors, for example, EDI diffusion has been facilitated by the close supplier relationships demanded by the few, large automobile manufacturers of their first- and second-tier suppliers in order to manage their JIT manufacturing processes. Similarly in the clothing sector, a small number of powerful actors – this large time retailers – have championed EDI technology and pushed it down the supply chain in order to gain greater control over

their supply chains as a prerequisite for the need to control quality and the timing of delivery of their inputs. By contrast, the scale of operations of most small retailers is such that they do not justify investment in EDI-based JIT processes.

Turning to sectors such as advertising, where there are low adoption rates of EDI but high adoption rates of external e-mail, there is not a demand for high volumes of data interchange with one specific consumer or supplier. In addition, suppliers do not tend to make long-term commitments to advertisers but usually offer new campaigns to competitive tender. This makes expenditure on EDI a risky investment. In contrast to EDI, the setting up of e-mail is technically simple and does not require large initial financial investments. Indeed, it is often a standard package delivered by an internet service provider. Sillince *et al.* (1998) found that the most important issue affecting the decision of UK SMEs contacted in their study was whether customers, suppliers and other organisations with which they regularly communicate also have e-mail. Thus, in the absence of monopolistic buyers or monopsonistic suppliers dominating supply chains, adoption decisions are affected by network externalities. Here the perceived value of a network technology – in this case e-mail – increases according to the number of other users who are currently using the same technology. This has been formalised in Matcalfe's Law, which states that the value of a network is proportional to the number of users (Windrum and Swann, 1999).

4.2 Locational factors

It has been proposed that the development and diffusion of internet-based e-business, will be associated with a reshaping of inter-firm and firm-consumer relationships. Such changes are likely to have important implications for the geography of production (of both manufactured goods and services) and consumption. While ICTs may reduce the necessity of geographical proximity, they do not eliminate the existence of agglomeration economies (Pratt, 2000). Wever and Stam (1999) distinguish between classical resources munificence theory and the learning economy approach. In the former it is proposed that some regions have a more favourable resource base than others, e.g. a better educated workforce, more and better knowledge centres, more venture capital companies, more high-quality services. The probability of innovation within a region are therefore related to the range and quality of the resources that are located within it. The learning economy approach views innovation as a process of interaction between customers, suppliers, and knowledge centres. Geographical proximity, together with an institutional framework that encourages interaction, will stimulate the formation of regional clusters of innovative activities (Lundvall, 1992; Nelson, 1993; Storper, 1995; Morgan, 1997).

A distinction is made between two types of agglomeration economies within classical munificence theory (Moulaert and Djellal, 1995; Malmberg *et al.*, 2000). 'Urban economies' arise from urban concentration and include access to a diversified workforce, physical infrastructures, and a range of diversified activities (particularly services). These factors are external to the firm and the industrial sector to which it

belongs. By contrast, 'localisation economies' are internal to the industry and are related to the degree of industrial specialisation within a locality. Specialised inputs, for example, may be natural endowments (e.g. weather, soil conditions) or created endowments (e.g. a skilled workforce). A locality may also contain networks of dedicated suppliers (Keeble and Wilkinson, 1999). These factors form the key elements of a firm's supply chain. Further, close proximity to similar firms (similarly attracted by location-specific advantages) promotes the diffusion of new knowledge and information amongst competing companies. The local nature of information and the geographical bounds of knowledge spill-overs have been highlighted by Antonelli (1988) and von Hippel (1994). Indeed, quantitative and qualitative research (e.g. Jaffé *et al.*, 1993; Audretsch and Feldman, 1996; Saxenian, 1994) support the proposition that the spatial proximity of industrial activities promotes informational externalities.

Turning to those factors that affect ICT adoption most directly, access to a pool of diversified labour, the transmission of new practices for managing relations with clients and suppliers, as well as technical information, and access to suppliers of new technologies and consultants that assist firms in make efficient technology choices, are factors that may outweigh the transaction cost benefits of digital goods highlighted by the weightless economy school. This is supported by empirical research conducted by Funck and Kolawski (1990), Fisher and Johansson (1994), Blaas and Nijkamp (1994), and Karlsson (1995). Not only does this research find a positive association between ICT adoption and population density, the association is found to increase in strength as the technical complexity of ICTs increases. The main factors highlighted in these studies are the proximity to suppliers and other organisations providing information and knowledge about new ICTs, and a qualified workforce for their implementation.

The transition from single to multiple units organisation opens up a range of spatial configurations, as firms are free to relocate activities to regions offering superior quality resources. However these benefits are gained at the expense of increased coordination costs. Regardless of absolute size, a company with multiple sites tends to have more complex internal communications requirements than one based in a single location. Further, companies with international sites require advanced ICT applications in order to manage their communications across long-distances and time zones (Chandler, 1977). This UK's history of foreign direct investment (FDI) has produced large multi-site and multi-national organisations compared with other European nations (Dunning, 1993; Jones, 1994). These organisations have a correspondingly greater complexity of internal communications and are an important explanatory factor behind the differential national uptake of technologies such as internal e-mail, local area networks (LANs), wide area networks (WANs), and intranets⁴ in the UK. The benefits of introducing more efficient internet-based ICTs is the reduction of the communication costs associated with more spatially dispersed organisations.

5. Case Study

Having discussed a broad range of potential enablers and barriers to ICT diffusion, we consider an empirical case study that illustrates how various factors can play themselves out at the local level. As suggested at the outset of the paper, we find many of the factors that affected the diffusion of previous ICTs playing a significant role once more. In addition, the case study highlights the strategies and actions that have been taken in order to deal with the challenges posed by e-business. The SME we shall consider is a printing company located in the North of England employing some 75 staff. It provides a good example of a company that has struggled to catch up with the rapid pace of organisational and technological change that has occurred within its industry. The industry has seen a shift away from the production of highly standardised products made in large print runs to tailored products made in smaller quantities.

New ICTs have played a key role in facilitating this change, not only by making small batches of printed materials economic for the first time but also by facilitating closer client-provider interaction, and improved image quality (notably the introduction of affordable digital colour technology). As in other industries, new ICTs have reduced barriers to entry and radically cut production costs. In highly competitive market conditions, companies have seen prices fall and profit margins squeezed, forcing them to find new ways of adding value to their products. The case study company has sought to follow these trends, shifting its focus away from traditional products to a variety of new goods and services that involve closer contact with clients, shorter printing runs and a greater use of new digital technologies.

The adoption of internet technology has enabled the company to develop an integrated information system in which sales staff have up-to-date data on clients and their sales portfolios via an intranet, while existing clients can monitor the progress of their orders at each stage of the production process via an extranet. In addition to improving the speed of communications with clients, e-mail has facilitated the introduction of colour proofs. The ability to easily and quickly generate colour graphics (prohibitively expensive with previous technologies) has turned design specification into WYSIWYG process. Combined with an ability to send images in jpeg file format over the internet, this has enabled clients to play a far more active role in product/design specification while simultaneously reducing lead time.

The company also offers potential clients the opportunity to inspect its current portfolio of products and services through its public website. This is done in a rather novel way. For each product/service category listed on the website, a case study is provided. Here an initial problem faced by a client is identified after which there follows a description of how this problem was dealt with and a successful solution formulated with the assistance of the printing company. This indicates the extent to which the image presented by the company has shifted away from that of a producer of bulk items to that of a knowledge-intensive services provider offering solutions to clients' problems.

We have argued (in sections 2 and 5) that the successful adoption of internet technologies in part depends on how these are used in conjunction with the other technologies and management practices that form a 'technology cluster'. Despite predictions that the new digital media and communication channels offered by the internet would contribute to the demise of printed materials, ICTs have actually invigorated both the company and the printing industry in general. Interestingly, the case study provides an example of how, as part of a substitution process, internet technology has extended the logic of an older technology to new areas. The nature of printing design - its non-standardised content and rate of product change - had precluded a widespread diffusion of EDI in the printing industry. Yet the potential advantages of JIT production remain. The case study company, for example, has sought to leverage these advantages through its 'Virtual Cupboard' service. Offered to its most valued clients, this service enables clients to reduce their stocks of printed materials to zero by guaranteeing the printing and delivery of any desired quantity of a specific item within 24 hours. This is achieved through the company holding electronic templates of the client's entire portfolio of printed materials.

Management has come a long way in turning what had been a very traditional printing company into a modern business operation. Yet there remains much that needs to be done if it is to catch up with its leading competitors. This is clearly evident, for example, in its transition towards an e-business model. Despite the company's moves to reconfigure communications with clients through its website and extranet, it has not as yet made the move to online sales. Further, the successful implementation of JIT depends on an organisation's ability to manage the delivery of externally sourced inputs in order to ensure that its inventory stocks are in turn minimised.

We were informed by the Managing Director that basic supplies to the printing industry are controlled by a few, very large international companies and so, due to its lack of market power, the company is unable to insist on the JIT delivery of its supplies. Indeed the company is forced to bulk buy their inputs. We were informed that all SMEs in the printing sector face this problem. The upshot is that the company is being squeezed by larger firms on each side of the supply chain, raising its exposure to risk. The company also has a narrow customer base, and is over-reliant on a few major customers. This despite efforts to build up close business relationships with more blue chip customers. Management is still searching for a strategy that will expand the company's client base. Online sales may offer it an important opportunity to reach new customers and broker new long-term relationships.

The strides made towards an e-business model form part of a wider organisational transformation of the company. As noted previously, e-business is predicated upon the integration of a set of interrelated ICTs within a new business structure. The company began with an information system that was partial and comprised set of incompatible legacy systems. Thus, while computer automation was well established in design and administration, designers worked with Apple Macintosh hardware/software that was incompatible with the bespoke system used by

administrative staff. Unfortunately, the company's first forays into internet technology lacked a clear strategic objective, and its first website - a flat ad website that hosted an e-mail account - was not integrated with the other information systems. This e-mail account was hardly ever used for business communications. In part this was due to the fact that only one computer was set up with an e-mail account, in part it reflected the fact that most of its customers did not use e-mail at this time! As the Managing Director noted in our discussions with him, the company jumped on the industry bandwagon. It recognised a need to catch up with rivals, who were starting to set up websites at this time. With little or no thought given to what the internet could actually do for the company or leverage competitive advantage, it followed suit.

The company simply lacked the knowledge needed to develop a coherent strategy. Not only did its existing personnel lack the requisite operational competence to set up and run a computer network, they also lacked an appreciation of what the internet could actually offer the company. These constraints were quickly recognised by the company's management. Management were also keenly aware that there was no 'quick fix'. Financial constraints limited flexibility and its ability to invest in the upgrading of technology and skills, whether via the hiring of new staff or the retraining of existing staff. The company's social network provided little assistance since other SMEs within the industry faced the same problems. Further, the time constraints faced by management means that it could not quickly upgrade its skills/knowledge base. Rather, the upgrading of information system and knowledge base would need to proceed incrementally over time.

Following the discussion developed in this paper, three research questions are of particular interest. First, what strategies did the company formulate in order to overcome these initial barriers? Second, what organisational role did the management team play? And third, what external sources were called upon? We observed (in section 4.2) the emphasis placed on the CEO in motivating the diffusion of new ICTs in SMEs. This stems from two initial assumptions. First, the business is managed by an owner who also acts as the CEO and, second, SMEs have a flat organisational structure in which the CEO performs multiple administrative and organisational roles and has full control over the organisation's resources. Under these conditions, CEO support will be essential for establishing appropriate ICT goals, identifying the business' information needs, and allocating the requisite financial resources.

The picture within the case study company is not quite so simple however. To begin with, the business is a limited company headed by two Managing Directors of equal status. The company organisational structure is hierarchical. Under the two MDs there is an operations manager, a sales manager, a financial accounts manager, a production manager and (more recently) an IT manager. This organisational structure closely fits Williamson's classic description of the large, centralised and functionally departmentalised company (Williamson, 1975). This supports our contention that the category of SME is problematic because it places under one roof companies that differ greatly in their size and business activity. A question mark is also raised against the 'heroic' role of the CEO. It was not a single individual but rather a management team that spearheaded change within this company. This management team initially

comprised one of the MDs, the Marketing Manager and the Production Manager. Again, discussions of management teams driving technological and organisational change are common within the large firm literature but not the SME literature, further highlighting the problems associated with the SME category.

A significant turning point was the attendance of an 'IT Planning Workshop' by the MD and the Marketing Manager. Run by the Manchester Metropolitan University (MMU) with the aid of EU funding, the workshop was targeted at small businesses. It provided the MD with an opportunity to examine issues surrounding the company's legacy information systems and ways in which the internet can lever competitive advantage. The Marketing Manager was able to consider the business opportunities provided by e-business and gained a clearer understanding of the basic mechanics of the internet.

Following this external consultation, the IT management team identified two key initiatives. The first was the need to align the company's IS strategy with its overall business strategy. In order to realise this, the company would need to develop a single IT platform that integrates its various activities. The second initiative involved the upgrading of its knowledge base. A key aspect of this initiative involved the creation of a new post; that of an IT manager. The responsibilities of the new post would include the daily running of the new system, strategy formulation, keeping the company abreast of new technology, and staff training. These twin initiatives formed the core of a policy document, produced by the management team, outlining the benefits of e-business, an assessment of the avenues open to the company, and the management team's recommended option. The document was presented to the rest of the company's management in an internal seminar.

Through the setting up of an open standards platform, it was possible to integrate some of the existing ICT investments. A contract was set up with an IT solutions provider to install an open TCP/IP network with requisite new hardware and software. At the same time, e-mail access was widely distributed across all computers within the company. In addition to improving internal communication, e-mail could now be used to send proofs to clients and gain approval for contracts. More of the company's clients were starting to set up their own e-mail accounts so the benefits of developing e-mail communications increased significantly. The aims of the IS strategy were clearly defined by the IT management team: the new system needs to be flexible and ensure the effective flow of information and data between commercial, sales and production departments. The new system is central to the company's business strategy, which aims to increase profits through improving internal efficiency and raising the quality of customer service.

The management team began to role out its plans by first hiring an external solutions provider to install an administrative intranet. This provides all staff with up-to-date sales and production information. Following the attendance of a second (short course) on e-business by the MD, the company employed an IT manager. In addition to strategic and operational responsibilities, the IT manager is responsible for

providing low- and medium-level training to company staff. With the IT manager on board, and seeking to learn from their mistakes, the IT management team proceeded to radically overhaul the company website. Again with the aid of external source, this time a web design company, the management team developed a second generation website which ties the intranet with an extranet and a completely revamped front end in order to improve communication between the company and its clients. The password-protected extranet provides existing clients direct access to the company. Meanwhile, the public website provides potential clients the opportunity to inspect its current range of products and services.

6. Conclusions

Two key findings arise from the research discussed in this paper, each of which is of particular note for those working in the innovation and IS fields. First, the benefits of information and communication technologies such as e-mail and websites depend on the size of their network externalities, i.e. the installed base of other firms and consumers who also adopt these technologies. In this respect they differ to previous generations of computer technologies whose benefits lay in reducing firms' internal transaction costs. This raises important strategic issues relating to the timing of new ICT investments. If a firm invests too early, i.e. existing and potential customers and firms have not adopted the technology or will not adopt it within the payback period, then network externalities will be low and the competitive advantage of technology adoption will approach zero. If the firm adopts too late, then it faces the danger of falling so far behind its competitors that it can no longer recover. We have noted that the appropriate timing of ICT investments are likely to differ according to the industrial sector and the particular supply chain structures within which a firm is located. The network externality issue appears to fundamentally recast existing discussions of first- and second-mover advantages of technology adoption.

The second issue raised in the paper concerns the existence of commonality, in particular the recurrence of internal and external factors affecting the adoption of technologies within SMEs. All too often researchers have noted surprise at finding factors, that were known to affect the adoption of previous technologies (ICT and otherwise), also had an influence on the adoption of a new technology. By short circuiting yet another reinvention of the wheel, it should be possible to give greater direction and speed up future empirical research on the adoption of e-business technologies by SMEs. To this end, the paper has drawn together research on adoption conducted in a range of (previously separate) disciplinary fields in order to identifying a set of potentially important variables. The possible explanatory value of these variables in future quantitative research has been highlighted with the aid of exploratory qualitative research in the form of a detailed SME case study.

Turning, first of all, to the internal factors affecting e-business adoption, our research once again illustrates the important constraints imposed on SMEs by limited time, knowledge, and financial resources. As highlighted in previous research, knowledge

constraints take two forms. One form concerns the ability to implement and run an e-business information system. The other concerns the ability to appreciate its strategic worth and the capacity to apply the new technology in new ways in order to lever competitive advantage over competitors. Crudely speaking, improving the former is related to the quality of the workforce while the latter is related to the quality of management. The case study company sought to overcome its constrained resource base through the incremental improvement of its knowledge base, the piecemeal improvement of its information system, and a restructuring of the organisation. This involved the upgrading of existing managerial and staff skills together with the target hiring of new staff, including the creation of a new IT managerial position.

With respect to previous literature on organisational action, we identified a number of problems associated with the 'SME' category when applied to the case study. First, the organisational structure of the company was not the classical 'flat' structure described in the small firms literature. It is far closer to the U-form structure with centralised and functionally departmentalised identified in large firms by Williamson (1975). Second, and probably related to the first finding, change is not being driven by a CEO but by a small management team, formed through a coalition of interests, that worked closely together to form an IS strategy that underpins the company's business strategy, and is now seeking to implement this IS strategy. This raises a serious question mark against the 'heroic CEO' description encountered in the small firms and SME literature. Future research should consider, for example, more sophisticated analyses developed by managerial theories of the firm. Strategy is often the consensus that is reached through negotiations between managers holding (sometimes very) different views and interests. Subsequent implementation involves a further round of negotiations between management and the other members of the organisation, possibly leading to strategy revision. We raise these issues as being of potential interest for future research.

As the case study highlights, the process of strategy formulation and implementation may be far from smooth in practice. An initial lack of knowledge amongst the management team prevented the formation of a clear and coherent IS strategy. The management team was not aware of the potential to integrate all of its IS functions within an open internet-based platform. Nor did it understand the implications of network externalities. As a result, the first company website was separate and incompatible with the other IS systems while its implementation of e-mail failed because it moved earlier than its customers and the other firms within its supply chain. Problems were compounded by the fact that an e-mail account was only set up on one of the company's machines and staff were not provided with training. Existing theoretical and empirical research on technology adoption draws attention to the importance of external expertise, notably the roles played by suppliers and external consultancy as key sources of new knowledge and information, in such circumstances. This is supported by the case study. This particular company drew upon the services provided by two private sector service companies and a public sector institute, to improve its IS system and its knowledge base. In terms of the latter, important contributions from external sources were made in improving the managerial competence (essential for effective strategy formulation) and for identifying methods for improving workforce competence (essential for effective

strategy implementation).

The research has identified the potential importance of sector specific, and location specific factors in technology diffusion. The issues faced by an old firm in a mature industry are likely to be quite different to a start-up company in a new (high-tech) sector. With respect to our case study company, the issues it faces are concerned with the implications of substituting old technologies and associated knowledge and organisation practices with new, more efficient ones. Innovations such as digital printing and e-business models, are not sourced within the industry but are usually either introduced by suppliers or adapted using examples drawn from outside the industry. Such innovations are particularly difficult to deal with because they destroy existing competences. SMEs such as the case study company are therefore unable to draw upon social networks within the industry to gain information and knowledge because their contacts face the same set of problems. Finally, while it difficult to establish the significance of locational factors without recourse to a comparative study, we observe that all of the private and public consultants used by the case study company are based in the local regional and that it has been able to recruit new, higher skilled staff (including its IT manager) locally.

To summarise, the research has highlighted a number of key factors that are likely to influence the adoption of e-business technologies in SMEs. Drawn together from a variety of research traditions, these enable one to map out the dimensions of future theoretical and empirical research. In addition, we have highlighted the importance of network externalities in determining the timing of technology investments and recasts discussions of first- and second-mover advantages of technology adoption. These we shall explore in our future research in the area.

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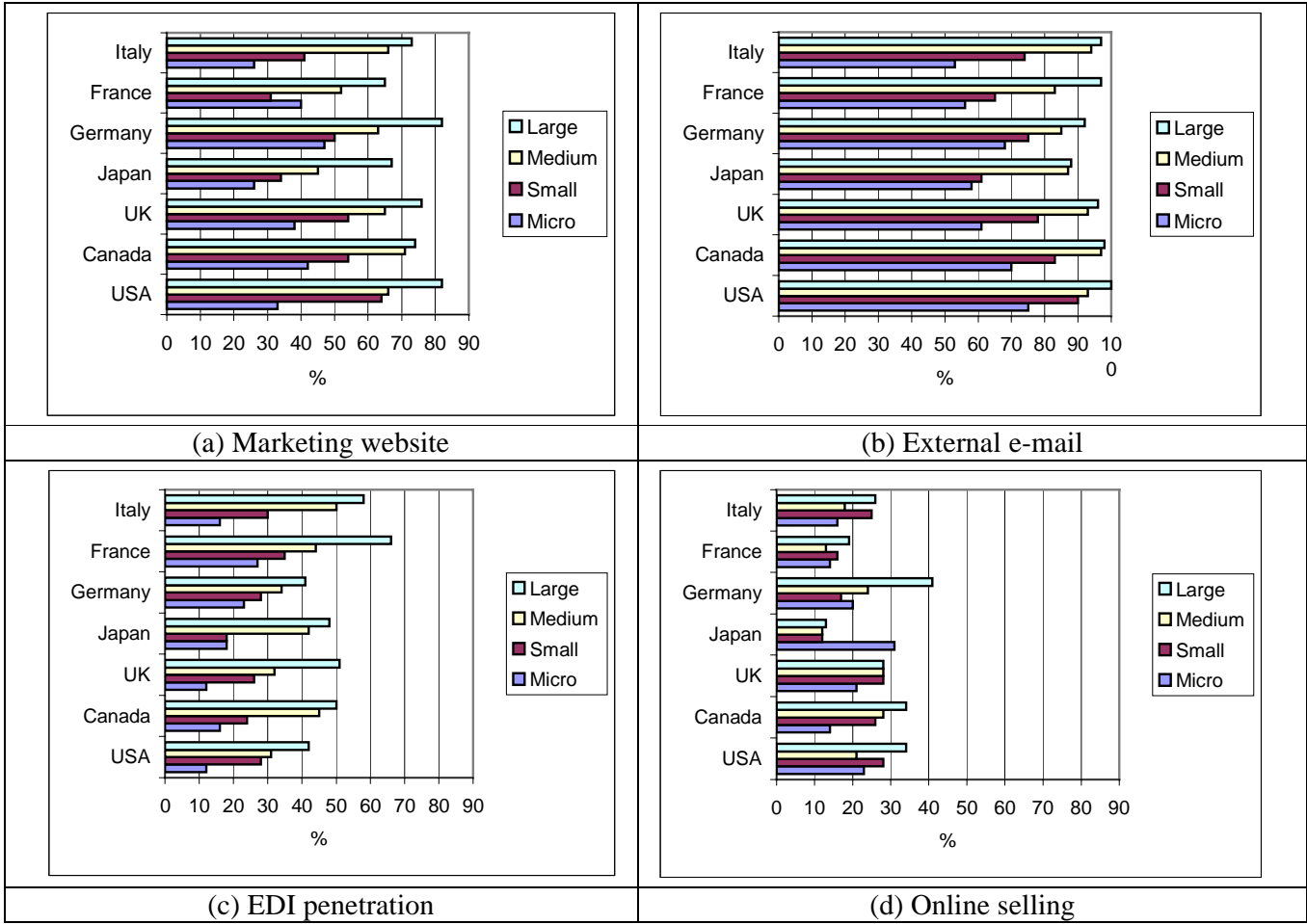


Figure 1. G7 comparison of micro, small, medium and large businesses using e-business ICTs (weighted by business size), %.
source: Spectrum/DTI, 2000.

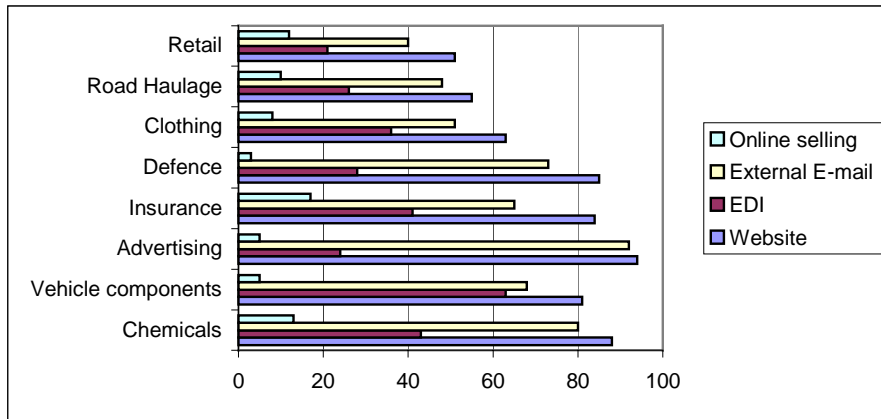


Figure 2. Percentage of UK companies frequently using e-business ICTs by sector
source: Spectrum/DTI, 2000.

¹ EDI permits the communication of structured messages between customers and suppliers using agreed formats, and allows data to be fed directly into an electronic business process.

² The ONS survey had 9000 businesses respondents with 10 or more employees.

³ The study found that EDI was used by 63% of all respondents in the UK vehicle components sector, by 43% in chemicals, 41% in insurance, 36% in clothing, 28% in defence, 26% in road haulage, 24% in advertising and 21% in retail. External e-mail was used by 94% of UK respondents in the advertising sector, by 88% in chemicals, 85% in defence, 84% in insurance, 81% vehicle components, 63% in clothing, 55% in road haulage, and 51% in retail.

⁴ An intranet is a service running on a company LAN or WAN which uses internet (TCP/IP) standards and web file formats to distribute and display information to an organisation's employees. Intranets require considerable financial and human resources to implement and support.