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RESOURCE CONSTRAINTS RELATED TO EMERGING INTEGRATION TECHNOLOGIES ADOPTION: THE CASE OF SMALL AND MEDIUM SIZED ENTERPRISES

Abstract

While most prior studies on Enterprise Application Integration (EAI) and Web Services adoption have focused on large counterparts, this research recognizes the importance of these technologies, and realizes the difficulties involved in their effective adoption by Small to Medium Sized Enterprises (SMEs). The aim of this paper is to study as to whether the resources constraints (time, finance, and expertise) a real obstacle to emerging integration technologies (EAI and Web Services) adoption in SMEs. The paper initially conceptualizes a model to support the analysis and proposes a research issue for validation. A qualitative multiple case study approach was considered as an appropriate research methodology to test the conceptual model. Findings obtained from the empirical study suggest that: (1) expertise, time and financial constraints is a real obstacle to SMEs' integration technologies adoption, and these constraints are important influential parameters affecting SMEs' adoption decision; and (2) SMEs' resource constraints are closely related to financial and expertise availability, time and expertise flexibility, and manager's attitude on managing time and financial issues. Based on this, the proposed conceptual model is revised. Finally, concluding section of the paper also outlines limitations and provides future research directions.

Keywords: *Enterprise Application Integration (EAI), Small to Medium Sized Enterprises (SMEs), Integration Technologies, Adoption, Factors, Resource Constraints.*

Introduction

After years of different technological acquisitions, companies inevitably end up with disparate systems spread throughout their different units. In this environment, businesses face an integration challenge. As the number of systems grows, such integration became more complex and difficult to manage, as changes to any single application requires changes to all the interconnected applications that shared the information. Without a scalable approach to integration, many organizations find their Information Technology (IT) infrastructures difficult to manage, impeding the implementation of new technologies (Sanchez et al. 2002). To overcome these problems, organizations seek ways to integrate their IT infrastructures, as they believe this might help them to increase their competitiveness by cutting down their overall operational and labor costs, as well as to increase efficiency (Morphy 2003). However, integration is not a simple task, which demands enterprises to continuously invest in their Information Systems (IS), as most organizations continue to struggle with the integration challenge, especially Small to Medium Sized Enterprises. It is expected that there are more barriers to the adoption of integration technologies in SMEs than there are for large businesses (Hughes et al. 2003; Tagliavini et al. 2002). This is partly due to the high capital investment costs and the skilled manpower required to implement and operate integration technologies, and partly due to SMEs' characteristic limitations. Iacovou et al. (1995) report that SMEs differ from large companies in many ways that affect the adoption of integration technologies: (a) the lower levels of resources available for adopting integration technologies (Iacovou et al. 1995; Kuan and Chau 2001); (b) the substantially less sophisticated IS management (Kagan et al. 1990; Tagliavini et al. 2002); (c) the needs for integration and their characteristics; and (d) the quantity and quality of the available environmental information (Pearce et al. 1982).

The normative literature has focused on the identification of factors, such as benefits, barriers and costs, affecting the integration technologies (e.g. Electronic Data Interchange (EDI) and Enterprise Resource Planning (ERP)) adoption in SMEs. However, it is unclear at this stage as to whether EDI and ERP adoption factors mentioned in the literature efficiently explain SMEs' decision-making process related to the emerging integration technologies like EAI and Web Services adoption. This is a new research area with many issues under research, like *why* SMEs are lacking behind large companies in EAI and Web Services adoption, and *whether* SMEs' characteristic limitations is a real obstacle to EAI and Web Services adoption. In this paper, the authors focus on the analysis of the resource constraints affecting the emerging integration technologies adoption decision in SMEs, as these have not been yet perceived as anticipated. In addressing this gap, the paper initially introduces the area of emerging integration technologies (Section 2). Thereafter, the authors conceptualize a model to support the analysis. The research methodology used to test this model is then reported. In Sections 5 and 6, the empirical findings are discussed, with key lessons learnt and extrapolated before offering conclusions.

Emerging Integration Technologies

There are various integration technologies, such as ERP, EDI, EAI, Middleware and Web Services, which might be used to bridge systems together. Since EDI, ERP, and Middleware have been adequately examined in the literature, the focus of this research is therefore on emerging technologies like EAI and Web Services. EAI, it encompasses technologies that enable business processes and data to speak to one another across applications integrating many individual systems into a seamless whole (Linthicum 1999). EAI aimed at modernizing, consolidating, and coordinating the computer applications in an enterprise. Typically, an enterprise has existing legacy applications and databases, and wants to continue to use them while adding or migrating to a new set of applications that exploit the Internet, e-commerce, extranets, and other new technologies. Thus, application integration results in supporting an efficient integration. EAI provides a common framework for integrating incompatible and distributed systems, as well as making it faster and easier to tie together applications, so that they can be integrated into business processes. However, the most common problems with EAI are the high investment costs, and particular complexity and flexibility concerns (Charlesworth and Jones 2003; Zahavi 1999). Some analysts have pointed out that EAI solutions are expensive and have long implementation timeframes (Darin 2002). Nevertheless, EAI and Web Services use a similar concept of a universal integration technology supported by adapters for each application (Kaye 2003). Web Services are not EAI in and of themselves. Rather, Web Services are just another technology that enables EAI, and it can significantly change the traditional point-to-point approach. Similar to other integration technologies like XML, Enterprise Java Beans (EJB) and CORBA, etc., which can be used to support EAI technology, Web Services are another. Web Services allow EAI architects to integrate many back-end systems through the creation of loosely coupled composite applications. Web Services is a technology and set of standards existing in the application service-oriented approach to EAI, which is only one of many approaches.

SMEs and Innovations

It is widely acknowledged that innovation plays a central role in the competitiveness of firms and countries. Innovation is understood to be a key driver of productivity. Innovation helps businesses to improve the way that products and services are made and delivered, or to introduce entirely new ones. Evidence suggests that innovating companies sustain a higher performance and grow faster than non-innovators (Stokes and Wilson 2006). Small and large firms appear to have different roles to play in the innovation process (Acs and Audretsch 1990). The small firm today is seen as playing an important role in the innovation of new products and processes. Larger firms have an advantage in capital-intensive, concentrated industries where substantial resources and converging technologies are present. Smaller firms appear to have the advantage in emerging industries with high levels of innovation. Smaller firms also contribute more innovations than larger firms (Audretsch 1995). Davis (1990) claims that SMEs are often regarded as being more innovative than large ones because of their flexibility and willingness to try new approaches. This notion that small firms contribute relatively more to innovation than larger ones was not always in vogue. In the 1960s, the UK and other European governments encouraged larger companies to form through merger and acquisition, in order to promote the research and development of new products and technologies. It was thought that only large industrial units could afford the high fixed cost of investment in research and development. The monopoly power and economies of scale of large organizations were thought to be necessary to provide the resources needed for the high costs of new technology. In practice, there are advantages and disadvantages for the small and large business involved in innovative activity. In summary small firms have advantages in management, internal communications and marketing, stemming from their flexible and opportunist behavioral patterns, especially influenced by entrepreneurial owner-managers. They have the disadvantages of lack of in-depth resources of qualified people and finance. Larger firms have greater material resources which gives them advantages in attracting the necessary staff and funding the growth and other activities to which successful innovation can lead. Taking these SMEs' disadvantages in innovation into consideration, this paper studies the adoption of emerging innovation in SMEs.

Conceptual Model: Integration Technologies Adoption in SMEs

The review of the literature has shown that a few prior studies have focused on integration technologies in small businesses, as reported by Daniel (2003), Hughes et al. (2003), Iacovou et al. (1995), Kuan and Chau (2001), Ravarini et al. (2000), Tagliavini et al. (2002), and Waarts et al. (2002). Among these studies, the model proposed by Iacovou et al. (1995) presents the most comprehensive research that focuses on the adoption of EDI in small businesses. Iacovou et al. (1995) proposed an adoption framework to address the issue of the major factors that explain the EDI adoption behavior of small organizations and the expected impact of the technology in the small business context, based on a multi-case study. These factors were: (1) perceived benefits, (2) organizational readiness, and (3) external pressures. Several other factors that inhibit EDI adoption in small organizations were also identified by Iacovou et al. (1995) as being: (1) costs, (2) complexity of the technology, (3) the need to change internal systems, (4) lack of technological skills, and (5) lack of system integration. However, these factors were not included in their model, as they claimed that as these factors have generally been identified through studies of large organizations, their applicability to small business is questionable. Based on this EDI model, Heck and Ribbers (1999) proposed a model which explains the adoption and impact of EDI in Dutch SMEs. They found that apart from the factors mentioned by Iacovou et al. (1995), the availability of EDI standards appears to be an important factor that influences the adoption of EDI in SMEs.

Moreover, Iacovou et al. (1995)'s study is very similar to the framework suggested by Tornatzky and Fleischer (1990), which indicates that there are three elements that influence the process by which innovations are adopted: (1) external environmental context, (2) technological context, and (3) organizational context. Chwelos et al. (2001) further validated the model proposed by Iacovou et al. (1995) and used an empirical work to predict EDI adoption. They reported those found from their studies, which included: (1) competitive pressure, (2) dependency on trading partner, (3) enacted trading partner power, (4) industry pressure, (5) financial resources, (6) IT sophistication, and (7) trading partner readiness. Apart from EDI adoption by SMEs, Vidgen et al. (2004) explored the role of Web Services in SMEs through the application of the Venkatraman (1994) business transformation model, using case study strategy. The case identified the potential benefits for SMEs provided by Web Services technology and considered those factors that enabled successful Web Services adoption, which they suggested were: (1) senior management support, (2) knowledge of transfer mechanisms, and (3) employing a suitable technical architecture.

Based on the literature review, it seems that external forces tend to have more impact on small businesses than on large businesses (Welsh and White 1981). Most of the factors that focused on the adoption of integration technologies by SMEs are from the external forces, e.g. governmental support, external pressures, pressure from trading partners, etc.. In many cases, a company may adopt a technology due to the influences exerted by its business partners and/or its competitors, having no relation to the technology and organization itself. Pressures from business partners or competitors have been suggested by many researchers to be an important factor in the adoption of integration technologies (Hart and Saunders 1998; Kuan and Chau 2001; Premkumar et al. 1994). Since SMEs are usually weaker partners in inter-organizational relationships, small

businesses are susceptible to impositions by their larger partners (Saunders and Hart 1993). Therefore, SMEs are under pressure to adopt integration technologies if their business partners request or recommend doing so. Thus, to remain competitive, SMEs have no choice but to adopt integration technologies.

The authors realized that most of the literature on SMEs adopting integration technologies is mainly focused on the adoption of EDI. The literature concerning the adoption of EAI or Web Services by SMEs has remained very limited. Although EAI adoption models for larger organizations are available, currently there is still an absence of models explaining their adoption by SMEs. This is partly due to the fact that EAI and Web Services are only beginning to emerge, and possible uses of these emerging integration technologies by companies of all sizes is still in the early stage (Ray 2006). Shin (2006) claimed that SMEs are particularly slow in adopting EAI. Another reason is due to the issue of whether it is accepted that EAI's and Web Services' implementation is necessary for SMEs (e.g. extra costs and expertise required to implement these technologies) (Hailstone and Perry 2002).

Globalization forces many enterprises to change the way they do business. To compete in global markets, SMEs need to develop new business strategies and deploy new technologies (e.g. Web Services and EAI). However, Storey (1994) argued that the size of small businesses creates a special condition, which can be referred to as resource poverty, that distinguishes them from their larger counterparts and requires some different management approaches. Thus, it is vital to identify the nature of SMEs to assess what makes them distinct from other types of organization (e.g. large organizations), as the nature of SMEs might be a real obstacle to their adoption of integration technologies. SMEs comprise a significant part of the economy and are characterized by high firm failure rates (Storey 1994). Storey and Cressy (1995) reported that about 11% of small businesses fail to survive in any given year, a failure rate six times higher for smaller than for larger businesses. This is due to the fact that SMEs usually: (1) have little ability to influence market price by altering their output (Kirby 2003); (2) have small market shares, so are unable to erect barriers to enter their industry (Deakins and Freel 2003); and (3) cannot easily raise prices and tend to be heavily dependent on a small number of customers (Storey 1994).

Small businesses cannot usually afford to pay for the kind of accounting and book-keeping services they need, nor can their new employees be adequately tested and trained in advance (Welsh and White 1981). Small businesses are also under increasing pressure to employ IS to maintain their competitive positions. At the same time, there are more barriers to IS implementation in small businesses than there are for large businesses, due to the high capital investment and skilled manpower involved in implementing and operating IS (Thong 2001). Welsh and White (1981) also pointed out that resource constraints (time, finance and expertise) in small businesses are based on the concept of resource-based theory. Resource-based theory is often used to explain the adoption and use of IS/IT in SMEs. According to it, firms are characterized as being collectors of resources or capabilities. A firm's resources may include both tangible and intangible assets, including capabilities, organizational processes, information, and knowledge, that are all controlled by a firm to enable it to conceive and implement strategies that improve its efficiency and effectiveness (Barney 1991). Resource-based theory emphasizes an understanding of the internal capabilities that enable organizations to secure competitive positions, and the importance of internal resources in a company (Barney 1991; Caldeira and Ward 2003). In this research, resources-based theory is applied to explain the importance of the natural resources of a company, in terms of the integration of its technologies adoption decision (e.g. time, finance, and expertise constraints).

- **Time constraints** refer to the limited amount of time available for activities beyond the normal job responsibilities of individuals in small businesses.
- **Financial constraints** refer to the limited amount of finance available for activities beyond the normal operations of small businesses. In this case, financial resources are related to those available to pay for the integration technologies' installation costs and for the implementation of any subsequent enhancements, as well as for ongoing expenses during usage.
- **Expertise constraints** refer to the limited amount of expertise within small businesses to carry out activities beyond designated job responsibilities. In this case, technological resources refer to the level of sophistication of IT usage and IT management in an organization.

According to Welsh and White (1981) that: (1) SMEs have to control their cash flows carefully, as they do not have unlimited funds for their IS project, (2) SMEs tend to choose the cheapest system, which may be inadequate for their purposes, (3) SMEs usually underestimate the amount of time and effort required for adopting integration technologies, and (4) SMEs normally engage consultants and IT vendors to develop and support their IS (Thong 2001). Levy et al. (2001) report that large firms use IS/IT to add value rather than simply to reduce costs. SMEs' exploitation of IS tends to mimic the early use in large firms – cost reduction. However, SMEs may use IS to co-ordinate internal activities, to add value through collaboration, particularly with customers, and occasionally to innovate (Levy et al. 2001). For example, SMEs might prefer to outsource most of their activities, whereas large companies might prefer to outsource only those activities which are not directly related to their business strategies, or even to manage these activities totally on their own. Resources such as time, finance, and expertise, all necessary for planning, represent the most critical difficulties for small businesses (Cohn and Lindberg 1972). Thong (2001) reports that small businesses tend to have insufficient knowledge to implement IS successfully, thus, SMEs might need to seek external expertise (e.g. IT vendors, etc.). For this reason, Kagan et al. (1990) and

Tagliavini et al. (2002) claim that SMEs usually have substantially less management over their sophisticated IS, and this might affect the way that they approach integration technologies.

In addition, according to Attewell's (1992) technology diffusion theory, the role of external entities (e.g. consultants and IT vendors) as knowledge providers in lowering the knowledge barrier or knowledge deficiency on the part of potential IS adopters. Small businesses tend to delay in-house IS implementation as they have insufficient knowledge to implement IS successfully (Thong 2001). Shin (2006) added that the utilization and application of IT among SMEs have been slow due to their weak infrastructure for IT diffusion, which includes diverse standardization, weak logistic support, legal structure, low transparency in accounting systems, and unrecorded transactions. For these reasons, some researchers have found that small businesses generally face greater risks in IS implementation and the use of IT than large businesses (Cragg and King 1993; Cragg and Zinatelli 1995; Iacovou et al. 1995). Thus, managers in SMEs have been characterized as having reservations about the adoption and use of IS (Chang and Powell 1998; Thong 2001). However, these reservations have not always obviated the benefits and successes such organizations can achieve from IS. In the early days, SMEs tended to use IS as tools to automate their standard administrative functions, e.g. accounting, budgeting and inventory control, etc.. There has been a growing literature addressing the issues of using IS for a competitive advantage amongst SMEs (Pollard and Hayne 1998). According to Lin et al. (1993), the increasing interest in the strategic use of IS by SMEs is based on three factors: (1) the increased adoption of IS and its effective use by competitors, (2) a decrease in the cost of IS so that it is accessible to SMEs, and (3) the ability for IS to allow SMEs to mask their size from their external partners. Hughes et al. (2003) also claim that under the right conditions, SMEs could be successful innovators of new technology. These conditions include: (1) low costs, (2) relevance of and flexibility to business needs, and (3) previous experience with technology, while high costs, lack of relevance and flexibility and lack of previous experience with technology are proven factors that restrict the adoption of traditional inter-organizational systems amongst SMEs. For these reasons, the authors suggest that some SMEs have turned to the adoption of integration technologies as a new strategy to improve their competitiveness (Chen et al. 2003).

Thus, a better understanding of the ways in which SMEs adopt and implement integration technologies is necessary because previous research in the area is limited, due to the rapidly changing economics of using IT, and the resulting increased adoption by smaller enterprises (Caldeira and Ward 2003). Moreover, it appears that the nature of SMEs, in terms of external and internal resources (e.g. time, finance and expertise), impacts on the way that they approach integration technologies. Kirby (2003) and Storey (1994) are among those others who claim that SMEs cannot afford to fail due to their limited resources. Thus, the following Research Issue (RI) arises for further investigation:

RI. Whether the resource constraints (expertise, time and financial constraints) a real obstacle to SMEs' EAI and Web Services adoption?

In an attempt to study the proposed research issue together with the factors identified from the literature, a conceptual model is proposed in Figure 1. This model is novel, as this model is one of the first attempts to explore and understand the adoption of the emerging integration technologies factors, taking into account SMEs' resource constraints (financial, expertise, and time). In the conceptual model illustrated in Figure 1, the authors present different influential factors related to integration technologies adoption in SMEs (adoption factors) and the resource constraints that need to take into consideration when studying emerging integration technologies adoption in SMEs. In doing so, the research issues will be validated in the case study.

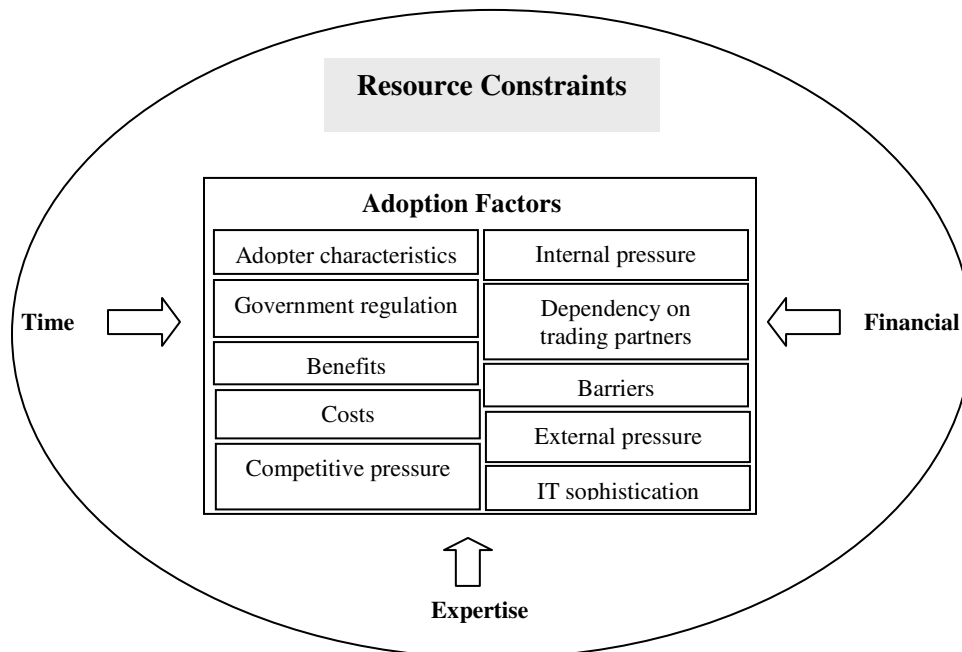


Figure 1. Conceptual Model for Emerging Integration Technologies Adoption in SMEs

Research Methodology

The authors have used an empirical research methodology proposed by Themistocleous (2002) to study the integration technologies adoption in SMEs. This methodology is based on three development stages namely: (1) research design; (2) case study data collection, and (3) case study data analysis. At the first stage of research design, the authors study the literature to develop an understanding of the research area under investigation and to identify a research need. From the literature review, the research issue was highlighted for a more focused study. Based on the research issue and need, it was decided that the research design would utilize the multiple case study strategy suggested by Yin (1994) through the employment of qualitative research methods. Such an approach can be used to: (1) investigate little-known phenomena as if understanding and analyzing factors affecting integration technologies in SMEs, (2) examine in depth complex processes (integration technologies decision-making), (3) examine the phenomenon in its natural setting, and (4) learn from practice.

Multiple case study strategy was employed to explore and understand the factors associated with integration technologies adoption in SMEs. In doing so, various data collection methods such as interviews and observation were used. The bias that is considered a danger in using a qualitative research approach was overcome in this research through data triangulation. The use of multiple data collection methods makes the triangulation possible, providing stronger substantiation of theory. For the purpose of this paper, four types of triangulation were used, namely: (1) data, (2) theory, (3) methodological, and (4) interdisciplinary triangulation (Denzin 1978; Janesick 2000). The authors interviewed two different types of SMEs (macro, small and medium). Face-to-face, structured, semi-structured, and unstructured interviews were conducted to different interviewees (i.e. managers, Management Information Systems (MIS) managers, employees etc.), and lasted one and a half hours each.

SMEs in some countries are classified as micro, small, or medium enterprises (European Commission 2003). The three parameters generally applied by most countries, singly or in combination, are: (1) capital investment in plant and machinery, (2) the number of employees, and (3) the volume of production or turnover of business. The definition may vary among countries or institutions, based on the differences in economic levels or the wealth of the countries (Gibson 2001; Storey 1994). Since the case studies were conducted in Taiwan, SMEs definition given by Taiwan Economy Affairs Commission is adopted. This classifies SMEs as using a sales turnover is less than US\$5 millions (Gibson 2001). In this research, three companies from the IT manufacturing industry have been studied to explore the research issue. Due to confidentiality reasons, the companies' names cannot be revealed in this paper. Therefore, we use Companies A, B, and C to represent the case companies (non-adopter, adopter, and planning to adopt).

Case Study

Taiwan has moved from a labor-intensive based economy to a knowledge-based economy which focuses more on products and services (i.e. innovation). Therefore, it is assumed that most SMEs in Taiwan have adopted more advanced technologies (e.g. EAI or Web Services) than SMEs from other countries. To test the proposed conceptual framework, the authors studied three SMEs companies (adopter, non-adopter and planning to adopt) in Taiwan.

Company A (Small Company - Non-Adopter)

Background to Organization

Company A had been dedicating itself to be a Computer Integration Manufacturing (CIM) leading company in IC and the TFT-LCD fabrication-related field. Company A's mission is to provide the customers with total CIM solution, with solid teamwork implementation, professional domain know-how, and on-time delivery, to create the value and profit together. The company currently has 70 employees worldwide and an annual turnover of US\$0.3 millions. Company A's main business areas include software development, computer integration manufacturing, and manufacturing execution systems.

Resource Constraints Related to Non-Adoption Decision

The non-integrated nature of Company A has caused some problems and inconveniences to the organization. The authors found that most of these problems are from the management perspective, and are related to the company's financial, expertise, and time limitations.

Company A's manger claims that there is no problem for their business activities. However, the authors realized that there are some problems after interviewing the employees from the organization. In other words, what the manager said was different from the employee responses. The employee said that: *"When the manager says 'no problem', he is trying to hide the serious problem behind"*. After interviewing the employees from Company A, the authors found that the company's working process is very slow, and there are some customers complaining that engineers cannot respond quickly to their requests. Since Company A does not have a standard operation procedure, the employees found it hard to deal with each project as they need to learn every new project from the beginning (i.e. they do not have a flowchart to follow). The interviewees also mentioned that they spend a lot of times on restarting a new case/project; therefore overtime working is required almost every day. For this reason, the employees' turnover rates (especially for those technical people) are high in the company, and most of them leave to join other companies (most of which are Company A's customers or partners). Because of this, as reported by the interviewees, most of the staff in Company A do not like to learn new things. The interviewees said that: *"Most of the time, we are forced to learn new things which we don't really want to. The main reasons are that we don't know when we are going to leave the company, and this will add more work load to our everyday job. We already work overtime almost everyday"*. These are part of the reasons why Company A does not adopt any integration technologies, since most of the employees are looking for a chance to migrate to other companies, e.g. large companies. Most of these large organizations provide better compensation to employees. Thus, they can attract better employees to their companies. As for Company A, it is hard to recruit strong technical-based employees as these employees will rather go for the large organizations. *"We do know too busy is our big problem, but since most of our employees have the engineer's background, we don't know too much about management"*. According to Company A, their first priority is to make profits so as to survive, and they are only meeting micro-profit era in the IC and TFT-LCD industry. However, they do realize that the high technology market changes fast and is a very competitive market. If they cannot step on, they might be replaced soon or later by other competitors in this highly competitive market. However, the manager reported that *"there is nothing much we can do now, as most of the employees here in the company are pretty much occupied with many things. Integration technologies adoption can be time-consuming, and will not be our first priority at the moment"*.

With the non-integrated infrastructure, Company A often faces the following problems: (1) insufficient decision making, (2) important information is often missing, and (3) data cannot be retrieved from employees' and customers' requests. For example, there is often a delay in confirming order information and sending information dealing with product availability. In many cases, the management cannot take sufficient decisions regarding the replacement of products. Thus, this inability leads to customer and employee complaints and dissatisfactions. Company A understands that the non-integrated nature of systems cost the organization money and time. This is attributed to the organization having to spend high amounts of money to support and maintain them all. Additionally, the inability of Company A to serve customers efficiently has incurred extra costs to the company as it leads to loss of sales. As suggested by one of the interviewees *"no money, no improvement, and no improvement becomes no sales"*.

Moreover, most of the company information and data are processed in a very traditional way. Most of the Purchasing Orders are still handled by paper, fax and telephone. One of the interviewee from the sales department said that: *“We often deal the purchasing order through the paper work. When a business deal is made, we need to record the purchasing order document in writing, and this must be done within the company. Thus, we need to come back to the company to do this and often end up leaving the office late”*. The statement demonstrates that with a non-integrated IT infrastructure, this often results in time delays in delivering information (i.e. cannot obtain real-time information), as much work needs to be carried out manually. This often causes delays in decision-making, thus resulting in an inflexible management style. For instance, data from one system have to be printed out and then re-entered in a different format to the main system. Although there are problems waiting to be solved, Company A has no intention at all to adopt any types of new integration technologies to overcome these technical problems. The reasons for these are: (1) the business processes are rather simple in the company, and hence the manager from Company A suggested that there is no need to invest in integration technologies at the moment; and (2) the prior failure experience in adopting ERP systems which resulted in time-wasting and money lost has delayed Company B’s decisions in further adopting integration technologies to support its IS. The manager claimed that the reasons for this failure were: (1) most employees failed to learn and use the ERP system properly, and (2) the ERP system provider chosen had a financial crisis, thus Company A was forced to terminate the contract. Due to the limited resources within the company, Company A is not yet able to resume ERP system, as it cannot afford to fail again and they do not have suitable engineers with appropriate skills to manage the ERP system. These limitations also restrict Company A from taking decisions to adopt any other types of integration technologies to support its IS or data integration. In this highly competitive hi-technology market, a quick return on investment is essential, especially for a company size like Company A, and this is the only way to survive.

Company B (Micro Company - Non-Adopter: Planning to Adopt)

Background to Organization

Company B. is a trade company, founded in 1980s, with the capital of US\$600,000 dollars, and currently has 15 employees worldwide. It is thus considered as a micro-sized company according to the definition reported in the research methodology section. Company B is an equipment supplier specializing in high technology components, and devices for most manufacturers in Taiwan semiconductor industry, such as Delta and Inventec. Its main products include electronic semiconductor devices and heat-treatment, and most of these equipments are imported from European companies such as ABB, Naberthern, IXYS, and SMSC Corporations. Company B has been growing rapidly in Asia market, and is planning to set up branches in Thailand, China, Vietnam, and Indonesia in the near future. To do so, Company B believes that intra- and inter-organizational integration is important, as this can help them to automate its business process, thus resulting in improved efficiency and competitive advantages. Company B, is a SME that has begun to see integration technologies as a way of gaining competitive advantage, rather than simply a tool to support its business operations.

Resource Constraints Related to Non-Adoption/Adoption Decision

Company B consists of many applications and systems from different customers, and these non-integrated systems and applications have caused problems and inconveniences, as reported by the MIS manager that most of their key customers asked them to setup a platform that is compatible to their systems. Therefore, Company B needs to develop different systems to meet different customers’ requirements. This is time-consuming, as they need to employ someone with technical background to maintain each of their customers’ system. The MIS manager said that: *“An example from one of our partners, Silicon Application Company (SAC), it employed extra 23 employees just to maintain its 23 different customers’ systems. For this reason, I believe that adapting to an integrated IT infrastructure is crucial, however we have no control (i.e. powerless) over our suppliers and customers, and cannot force them to use the same systems as we do”*. Company B realized the need to integrate its IT infrastructure as a way to gain a better control over its subsidiaries, customers and suppliers. However, it is hard to perform such task, due to its lack of financial costs and expertise, as reported by the manager: *“Integration Technology is still a long way to go because there are many companies developing their own systems, e.g. Web services, RosettaNet, and ebXML, and it is hard to integrate all these disparate systems. Despite all the difficulties to integrate these disparate systems, there is still a need to do so. This is why we are integrating our internal systems at the moment, because we see this is a preparation for our future inter-organizational integration”*.

Semiconductor was a fast growing industry in Taiwan in 1980s, thus with many business opportunities. However, these business opportunities have decreased dramatically in the past few years due to the semiconductor industrial migration, with many of the manufacturers moved their factories to other Asia countries like China, Vietnam, Malaysia and Thailand. In this case, Company B has lost many of its customers (i.e. loss competitive advantages), and has begun to realize that there is an urgent need to seek for business opportunities outside Taiwan, as well as to build-up a closer relationship with its existing customers (i.e. to provide a better service to its customers). To do this, the manager in Company B recognized the importance

of adopting integration technologies to support its intra and inter-organizational IS. Thus, Company B has setup an internationalized business plan three years ago regarding the adoption of integration technologies to support its intra and inter-organizational business processes. The plan was first to integrate its internal systems, then its external systems. However, this plan did not succeed due to the costs concern over the integration solutions available in the market at that time, e.g. mySAP and Oracle ERP are too expensive.

Company B has been introduced to a new software package from SAP Business One (B1). SAP B1 is a simple and off-the-shelf integration software designed based on Web Services platform (i.e. Web Services technology), which provides cheaper, easier, and quicker adoption process for SMEs. SAP B1 provides integration abilities that cover finance, sales, purchase, warehouse, distribution, production, invoice management, customer relation management, and human resources management, thus resulting in quicker decision-making process and increased efficiency. The MIS manager from Company B reported the reasons of adopting such software, which are: (1) SAP is a well-known integration technology provider, (2) many IT companies adopt software from SAP, (3) reasonable and affordable price for small businesses, and (4) SAP B1 provides a platform which supports EAI and Web Services technologies. The MIS manager reported that *“we can only afford to adopt SAP B1 for intra-organizational integration (i.e. ERP) at the moment due to the limited resources (e.g. costs, times and knowledge etc.), but will consider inter-organizational integration in the future when the budget is allowed”*. The manager also said that: *“We were going to adopt mySAP, but decided not to since it suits large organizations better than small business. However, SAP B1 is different, it is in a reasonable price, and it provides us with a platform that supports EAI or Web Services technologies, which can be used to help our inter-organizational integration in the future. We are currently the second user of SAP B1 in Taiwan”*.

Company C (Medium-Sized Company - Adopter)

Background to Organization

Company C designs and manufactures the Hi-Ti brand of digital photo printers, using dye-sublimation technology to offer both consumer and commercial print solutions. Company C currently has 650 employees worldwide, and has an annual turnover of US\$1.5 millions. Thus, it is considered as a small to medium-sized company according to the definition mentioned in Section 5. Company C was established in Taiwan in 2001, with cutting edge research and development teams, specializing in optical and chemical knowledge related to digital photography, which has been central to their ability to create high quality, digital photo printers. In that time, Company C has seen a rapid growth, with branches in the UK, USA, Netherlands, Middle East, India, Russia and China, trading across the globe.

Resource Constraints Related to Adoption Decision

In each subsidiary, applications were customized in a unique way to suit needs. Company C has five subsidiaries around the world, and they all have different IT infrastructure and install different applications and systems. The MIS manager reported that *“we prefer to buy off-the-shelf software (i.e. ready-made software), and to further develop these software to suit their needs, as this way is much cost saving”*. Thus, obtaining data from custom systems is difficult, as the majority of these systems have incompatible and heterogeneous data structures and formats. In most subsidiaries, many systems store data for the same entity, which results in data redundancy. The reason for this is that applications cannot share common data or objects due to integration problems. The non-integrated infrastructure leads managers to inefficient decisions, important information is often missing, and/or data cannot be retrieved from applications. For example, there is often a delay in confirming order information and sending information dealing with product availability. Therefore, in many cases, the management cannot take accurate decisions regarding the replacement of products. This inability thus leads to loss of sales and low customer satisfaction, and thus customers often turn to competitors. Company C also realized that the non-integrated nature of systems cost the organization money and time. This is attributed to the organization having to spend large amounts of money to support and maintain all these systems.

Company C recognized that integration is a significant parameter that influences the success of e-business applications and supports it in achieving a competitive advantage. Although Company C has a vision that it needs to automate its business process and integrate the heterogeneous data structures and formats, it has only managed to adopt EDI partially to communicate with their partners, suppliers and customers (mainly for purchasing, i.e. orders), as well as the ERP system from DATA SYSTEM (ERP vendor) to manage its internal business processes. The main reason for this is due to the high costs associated with the adoption of integration technologies, e.g. EAI or EDI. Company C reported that even though it has adopted EDI to solve its integration problem, it still requires altering target and source applications all the time when there are any changes. Additionally, EDI has a high cost, and the nature of EDI standards in use (UN/EDIFACT) is complicated, which adds complexity. This is why Company C is slowly moving to EDI over Internet technology, but this part has not been completely implemented. Company C has also adopted ERP systems to support its intra-organizational integration. However,

it claimed that ERP systems have failed to fully support Company C's intra and inter-organizational integration, since they co-exist alongside other applications and the version of ERP systems Company C used is the simplified version. Company C's ERP systems do not support real-time capabilities and there are many compatibility, problems among ERP systems, and as they do not support of all these systems under an e-business architecture that requires real-time data, this is an obstacle. Therefore, the organization believes that the way forward is to develop an integrated IT infrastructure by redesigning its IT infrastructure, and phasing out all redundant systems and data. Also, there is a need for rapid transformation from closed internal processes to open externalized processes. However, this target can be achieved through the development of an integrated, adaptive and consistent IT infrastructure across the company.

Nevertheless, this is not an easy task for a company with limited resources like Company C. Company C states that it does not have enough budgets to implement integration technologies at a moment, although they know it is essential, as the non-integrated IT infrastructure has caused them many problems: (1) high cost of maintenance, (2) not manageable, (3) not flexible, (4) results in insufficient decision-making, and (5) leads to low customer and partner satisfaction. EDI is as far as it goes, but Company C hopes to fully automate its IS in the future to increase its efficiency. The technical person from the MIS department said that: *"In my company, the decision-making process is autocracy. The boss is the one who makes the decision, and all he wants is to cut down the costs as much as possible. Our management is not as systematic as large organizations' do. I suggest that if the company continues to grow, we will probably need to consider adopting EAI or Web Services in the future if the budget is allowed"*.

Findings And Discussions

How SMEs' Resource Constraints Relate to their Adoption Decision? (Testing Research Issue (RI))

All types of companies today seek to become more agile and responsive, and to maximize their existing IT investments. To do this, they need to share information and functionality in individual applications and turn them into an enterprise-wide resource. Thus, integration of enterprise applications and data to simplify and automate business processes has become an important for many organizations. Nonetheless, as stated in earlier, the unique characteristics of small businesses are exemplified in the condition known as resource poverty, where small businesses operate under severe time constraints, financial constraints, and expertise constraints. Whipp and Rosenfeld (1989) and Caldeira and Ward (2003) also emphasize the internal and external resources to analyze the IS/IT implementation in SMEs. They state that the internal resources include: (1) financial resources, (2) human resources, (3) management perspectives and attitudes, (4) IS/IT competences, (5) organizational structure, (6) power relationships, and (7) user attitudes. The external resources cover: (1) external expertise (e.g. vendors' support or consultant effectiveness), (2) technology available, and (3) business environment (e.g. clients, and suppliers, pressure to adopt IS/IT). The empirical data complement the viewpoint reported in the literature and indicate that the limited finance, time and expertise resources have inhibited case companies' integration technologies' adoption. For this reason, Company A has not yet adopted any type of integration technology to support their IS, and it is only able to integrate its internal IS. Although Company C has adopted EDI technology, EDI itself has many drawbacks and cannot fully support organizations to integrate their intra and inter-organizational systems. Thus, Company C has not managed to overcome all of its integration problems. Based on the empirical data, the authors found that the IT abilities are relatively low in SMEs, and having less financial support compared to those in large organizations, they thus (1) tend to go for off-the-shelf software packages, and (2) the easy-to-understand and relatively long-experienced enterprise applications are preferred by SMEs than hard-to-understand and brand-new applications. Also, case companies pointed out that failure is not allowed, as the main goal for them is to survive, thus they cannot afford to fail. In this kind of situation, factors like costs, benefits and IS complexity tend to be more relevant to describe the SMEs' adoption process. Despite the barriers mentioned above, the MIS manager from Company C believed that education will help employees understand the reasons for adopting integrated solutions, and thus, reduce resistance to change. Training can also help employees adapt to use a system, as they will advance their knowledge and learn how to handle and operate an integrated solution.

Moreover, the empirical data also demonstrate that the financial constraint seems to be the biggest concern to Companies A, B, and C, and this concern tends to delay their integration technologies' adoption. The case companies reported that they will not adopt integration technologies unless the benefits of adopting such technologies are made obvious. Additionally, Companies B and C claimed that employees' resistant to change was another serious barrier to their integration technologies adoption, as reported by those companies' MIS managers that most of its employees found it difficult to understand all the technical terms and issues because different terms are used in the different software company (e.g. 'Bill' is used in IBM financial system, whereas 'Invoice' is used in SAP financial system etc.). A lot of employees fear that they will not be able to operate in an integrated environment, as they are short of hard skills. Nonetheless, the empirical evidence also illustrates that the lack of sufficient integrated technologies' knowledge of most SME managers has caused delay in their integration technologies' adoption decision-making, since they are the major decision makers as well as the key persons in the survival of the business (Rizzoni 1991; Thong and Yap 1994). In contrast to Companies A and C, the manager in

Company B is intended to integrate their intra- and inter-organizational systems. In order to meet this goal, Company B is currently working on integrating its intra-organizational systems, and is preparing to integrate its inter-organizational systems by considering EAI and Web Services technologies in the near future. Therefore, this indicates that the decision on whether to adopt an integration technology is heavily depended on SMEs managers' perceptions, knowledge and intentions (i.e. highly depends on adopter or organizational characteristics). According to Thong and Yap (1994), the impact of the manager/Chief Executive Officer (CEO) is even stronger in small businesses. For these reasons, factors like *IT sophistication*, *adopter characteristics*, *barriers*, and *dependency on trading partners* tend to be appropriate to use to describe SMEs' adoption decision. Thus, the evidence discussed here in this section provides the answer to the Research Issue (RI): *SMEs' resource constraints can be an obstacle to their EAI or Web Services adoption, and these constraints can influence their adoption process and decision.*

Revised Conceptual Model for Emerging Integration Technologies Adoption

Based on the empirical findings, the authors found that firstly the financial constraints are closely related to SME *manager's attitude* (i.e. willingness/unwillingness) to invest on integration technologies, and the *availability* of the budgets that can be used to implement integration technologies. Secondly, expertise constraints are closely related to the *availability* and *flexibility* of the skilled people (i.e. know-how), i.e. whether the company is able to employ skilled people or to provide training to people for implementing integration technologies. Thirdly, time constraints are closely related to SME *manager's attitude* and *flexibility* on time management for integration technologies adoption, i.e. whether SME manager is willing/or able to spend times on implementing integration technologies, and whether the employees within the organization can spare times for integration technologies implementation. For these reasons, *manager's attitude*, *flexibility*, and *availability* are incorporated to the proposed conceptual model to efficiently explain the integration technologies adoption in SMEs. Thus, the revised conceptual model is formed and is shown in Figure 2.

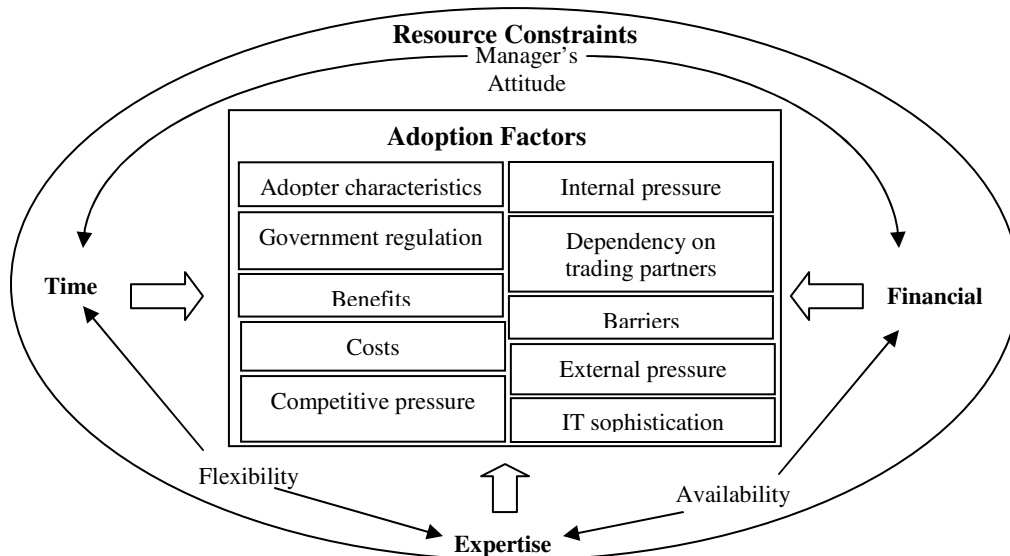


Figure 2. Revised Conceptual Model for Emerging Integration Technologies Adoption in SMEs

Conclusions

While most prior studies on EAI and Web Services adoption have focused on large corporations, this research recognizes the importance of the emerging integration technologies, and the difficulties involved in their effective adoption by SMEs. As reported in the literature, some Web Service applications maybe strategically used by SMEs in ways that are potentially generalizable to other SMEs but are probably not generalizable to large organizations (Ray and Ray 2006). Other research into Web Services has revealed strategic uses of Web Services by large organizations may not be easy for SMEs to employ. Although many influential factors have been reported in the literature related to EDI and ERP adoption, the literature on EAI and Web Services adoption remain limited with many researchers seeking answer to it. It is unclear at this stage why SMEs are lacking behind large companies in EAI and Web Services adoption, and whether SMEs' characteristic limitations is a real obstacle to EAI and Web Services adoption. Thus, research issue arises which was investigated in this research. Based on this, a novel conceptual model was introduced, which highlighted the important resource constraints that need to be

taken into account when studying EAI and Web Services adoption in SMEs. In doing so, this study forms following two important conclusions: (1) expertise constraints, time constraints and financial constraints are a real obstacle to SMEs' EAI and Web Services adoption, and (2) these constraints are important influential parameters affecting SMEs' adoption decision. Moreover, the authors suggest that the future research on emerging integration technologies (EAI or Web Services) adoption in SMEs should focus more on the management perspective than on the technological perspective, as SMEs' adoption decision is heavily depend on their resource availability, flexibility and manager's attitude.

One of the limitations of this research is that the outcomes presented herein are based on real life case study. Thus, the data and the observations derived from these cases might not be generalized. Nonetheless, it is not the intention of this paper to offer prescriptive guidelines for integration technologies adoption but rather to describe case study perspectives that allow others to relate their experiences to those reported. Hence, this paper offers a broader understanding of the phenomenon of emerging integration technologies adoption in SMEs.

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