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ABSTRACT

Although large organisations have invested significant amounts of money to integrate their supply chains, the development of supply chain integration among Small to Medium Sized Enterprises (SMEs) is slow-moving. For SMEs, integration is a significant problem due to high costs and technology requirements. Hence, they follow different approach to integrate their supply chains. In authors' previous research, they studied *how* 15 Taiwan's SMEs integrated their Information Systems (IS) with their suppliers through Internet and *what* types of interconnection approaches have they applied. It was found that SMEs have their own ways for integration with the authors identifying in total seven types of interconnections. This research was a small step towards SMEs supply chain integration understanding. Based on this, the authors continue to explore the ways that SMEs integrate their supply chain by revisiting few of these 15 companies, and found out that the case companies are now moving one step forward to fully integrate their supply chains from the procurement of raw material to the distribution of finished goods. This approach is considered as a crucial issue as nowadays the competition among enterprises is about the efficiency of supply chain, which emphasises on tighter cooperation relationship of overall supply-chain process. This paper attempts to explore this area by focusing on the supply chain integration strategy employed by one of the SMEs in Taiwan to (a) to explore *how* SMEs integrate their supply chains; (b) to identify the *benefits* of integrating supply chains; and (c) to help SMEs and researchers to understand this approach better.

Keywords

SMEs, Supply Chain Integration, EAI, E-commerce, Integration.

INTRODUCTION

Integration is frequently cited as being an important issue for organisations now and in the future (Daniel, 2003). Integration problems affect all types of organisations including SMEs, enterprises are seeking ways to integrate their applications at both intra and inter-organisational level. Organisations that consist of incompatible and disparate applications can improve their performance and efficiency by integrating their IS. The incompatible disparate systems are complex and difficult to manage and have caused several problems to the organisations since each individual system stores and handles its own data and it is difficult to communicate with each other. Due to these reasons, large organisations are turning to the adoption of integrated systems as a strategy to improve their competitiveness. For SMEs, integration is a significant problem due to its high cost, technical requirement, limited financial resources and lack of technical knowledge. Hence, SMEs have different approaches towards integration (Chen *et al.*, 2003). Although some SMEs are moving to the adoption of integrated systems, the rate of integration technology adoption is generally low among SMEs (Hughes *et al.*, 2003; Tagliavini *et al.*, 2002).

Today, some SMEs not only seeking ways to integrate the disparate systems within the organisation, but have also moved to extend the whole domain beyond the boundaries of the organisation to include their suppliers, trading partners and customers (Charlesworth *et al.*, 2002; MOEA, 2001). This also has an impact on the supply chain. SMEs might need to integrate their IT infrastructure so as to support the efficiency of their supply chains. By integrating SMEs' systems with their customers and trading partners will give them even grater competitive advantages to compete with the larger companies or their competitors (Chen *et al.*, 2003). The emergence of supply chain integration is therefore undoubtedly a critical component to strengthen competitive advantage of both suppliers and their customers. Nowadays, the competition among enterprises is about the issue of supply chain, which emphasises on tighter cooperation relationship of overall supply-chain process. Archibald *et al.* (1999) suggested that in today's world of competitive business it is no longer companies that compete, but supply chains.

In this paper, the authors: (a) review the literature on supply chain integration, (b) attempt to explore supply chain integration practice in SMEs, (c) analyse and discuss the findings and (d) identify the benefits of integrating supply chain. Hence, provide a better understanding in the area of supply chain integration adoption in SMEs. In doing so, the section 2 of this paper focuses on the theoretical issues of supply chain integration and section 3 describes the methodology. The case study is described in section 4 where as the findings and discussion is reported in section 5.

SUPPLY CHAIN INTEGRATION

Nowadays, the use of technologies help the organisations to better manage their supply chains, as supply chain management applications built on technology platforms have enhanced the ability of organisations to integrate their processes through collaborative information sharing and planning (Charles *et al.*, 2001; Kalakota and Robinson, 2001). For example, the uses of integration technologies like EAI and Web Service to support the integration of supply chains. With supply chain integration that companies anticipate customers' desires and meet their demands. Having too many goods in stock creates unnecessary expenses and risks especially when goods do not sell as fast as expected. When the goods held in inventory for too long, they age and will be easily replaced by newer goods. As a result, those aged goods will be sold at comparatively low prices and the companies will be ended up possibly with loss. However, having too few goods in stock also drags down profits as impatient customers will prefer to give their business elsewhere rather than wait for orders to arrive. For retailers and manufacturers alike, a company's competitive advantage depends in large measure on the adaptability and agility of its supply chain (Dass, 2002).

A competitive firm has to have the ability to acquire the goods and services it needs just when and where it needs them, at a favourable price, and with acceptable payment and delivery terms. A competitive firm needs to directly manage the flow of goods through its distribution networks in a cost-effective manner. Not only large companies, but also SMEs have come to realise that they can achieve this by integrating their supply chains. Implementing supply chain integration can be cost saving for the company in many ways. It can lower the costs of labour, increase flexibility, achieve faster response times and cut down the occurrence of errors on paper based operation, reduce unauthorized buying outside preferred supplier agreements, and reduce stocking, hence achieve competitive advantage (Essig and Arnold, 2001; Lee and Whang, 2001). Automation process also can shorten the cycle time from ordering to distribution, thus resulting in enhanced production ability and increased efficiency. For suppliers, they can also benefit from supply chain integration as this will shorten business transaction cycle, lower capital cost in stocking, lower labour cost, increase efficiency, enhance accuracy and faster handling time and delivery speed (Chen *et al.*, 2003).

Although many efforts have been made by large companies to use integration technologies to support their supply chain integration strategy, there are still problems. Since most of organisations' suppliers are SMEs that (a) their ability and resources are limited; (b) they might want to protect their proprietary process knowledge and competitive advantages from larger companies; and (c) they might wish to have unrestricted control of their own assets. Therefore, integrating systems with their buying organisations seems to be a significant problem for them. The supply chain can not be efficiently integrated without the support and cooperation from the suppliers. Using new technology to support the integration of the supply chains is much harder for SMEs due to their characteristic weaknesses from the larger organisations e.g. lack of financial resources and technology ability (Burns, 2001; Carter and Evan, 2000). The maturity of integration technologies (e.g. EAI and Web Service) and the lack of cases in integration technologies adoption in SMEs have made the problem even worse for SMEs. Hence, slow down the rate of adoption among them.

METHODOLOGY

During they year 2002-2003, the authors conducted primarily qualitative case study in 15 Taiwan SMEs from IT sector to investigate the types of integration/interconnection used by these companies. Based on the results derived from this research, the authors continue to explore how SMEs integrate their supply chain by revisiting few of these case companies again in 2003-2004. In this paper, instead of conducting a multiple case studies on 15 Taiwanese companies, the authors focused on one company only named SAMPO. In the previous research, the authors found that SAMPO has only integrated part of their supply chains e.g. e-purchasing. In the new case study, SAMPO reported that they are trying to fully integrate its supply chain processes from the procurement of raw material to the distribution of finished goods. A single case study research is employed here as this research method generally answers one or more questions which begin with "*how*" or "*why*". The questions are targeted to a limited number of events or conditions and their inter-relationships (Yin, 1989). Moreover, the type of case study research undertaken in this research is an *exploratory* case study as the use of supply chain integration in SMEs is at present the little-know phenomena. According to Yin (1989), in *exploratory* case studies, fieldwork, and data collection may be undertaken prior to definition of the research questions and hypotheses. Therefore, by combining the

previous research with the new research together, the authors believe that SMEs might be able to gain a comprehensive understanding on the area of supply chain integration in SMEs and might be able to learn from practice.

CASE STUDY

Adoption of Supply Chain Connectivity by SMEs Case Study – (2002-2003)

Over the past few years, many large or even some medium sized companies have made major efforts to create electronic connections with their major suppliers. Despite considerable success with suppliers that can afford the up-front investments in computer systems and business applications, these buying organisations face a series of technical difficulties together with an expanding set of day-to-day operational challenges. They need to eliminate paper-based business processes while also addressing the requirements of small and medium-sized suppliers that do not have the wherewithal to manage their own electronic supply chain. Many large and some medium sized manufacturers have yet to launch an electronic supply chain initiative and continue to rely on paper-driven business processes. With the broadly use of the Web and integration technologies in business environments, manufacturers now have a viable set of options for substantially reducing paper-driven business processes from its supply chain and for incorporating all of its suppliers into an electronic supply chain network to increase efficiency.

In the research conducted in 2002, the authors studied the industrial automation programme which was executed by the Ministry of Economic Affairs, technology department in Taiwan. Taiwan government has followed a similar way as Singapore where its government supported the industries to promote e-business application ability to increase competitive advantages e.g. the Logistics Enhancement Applications Program in 1997 and the TradeNet Plus programme to develop a complete e-business transaction system in 2001 (MOTI, 2001). The main goals of this program were to establish B2B e-commerce operation capability in IT industry to enhance Taiwan IT industry's core competence and to push forward 2,500 SMEs in IT industry to establish operation capability. Meanwhile, to overcome the problems while promoting e-commerce in IT industry and serve as the reference for promotion in other industries. The case companies were *ACER Inc, MiTAC International Corp, PRIMAX Electronics Ltd, Inventec Corporation, TATUNG Co, MicroStar Inc. (MSI), ADI Corp, SAMPO Technology Corp, Compal Electronics Inc, First International Computer Inc, Arima Computer Corp, Compeq Mfg. Co. Ltd, Twinhead International Corp, Delta Electronic and ASUSTeK Computer Inc.* The case companies' suppliers employed several different types of interconnections to connect with the case companies through Internet. In total 7 types of interconnection were identified including 3 main types A, B and C and their subtypes. The types of connection between the suppliers and the core manufacturers where classified by the authors into three main types, which are Type A (Application to Application i.e. AP-to-AP), Type B (e-commerce (EC) Turnkey) and Type C (Browser). The idea of the first type of connection Application to Application was to use Extensible Mark-up Language (XML) based technology. The concept of the second type of connection EC Turnkey was that the suppliers install Turnkey software, so the main buyers can then push their purchase orders to the suppliers' Turnkey system. The third type of connection Browser was based on that the main buyers set up one to one supplier Web page. All the process information about the sales orders, delivery information and invoices etc can be looked up through Browser. This type of connection is normally used when there is a small amount of orders to the suppliers. Those main types were further classified into subtypes which are A, A+, A-, B, B+, C and C+ depending on their level of automation.

As a result, there were in total of 3948 suppliers have been forced to follow the main manufacturers to adopt the e-commerce management style and the majority of these 3948 suppliers have adopted the type C connection (3375 suppliers) to connect with their main manufacturers (See Figure 1). This indicated that Web based technology is the most popular technology for integrating inter-organisational IS among SMEs (i.e. suppliers) and most SMEs are still not able to achieve high degree of automation so far i.e. fully automated systems without involving any labour works. The reasons for this are: (a) the suppliers are small sized enterprises, their technology ability and application level of B2B e-commerce are limited and the volume of business is smaller (or the product variety of the company is little); (b) most of the raw material productions from the suppliers are not key-production; (c) most of the suppliers produce standard products so they have goods in stock; and (d) the benefit of using this type of connection is conspicuous and it does not affect the beneficial results of case companies' computerisation. Before the case companies integrating their systems with their suppliers, most of the participants have faced problems such as slow response times for orders, frequent occurrences of error and stocking problems. By integrating the purchasing process with the suppliers, those problems have significantly improved. Hence, improved competitiveness (Chen *et al.*, 2003).
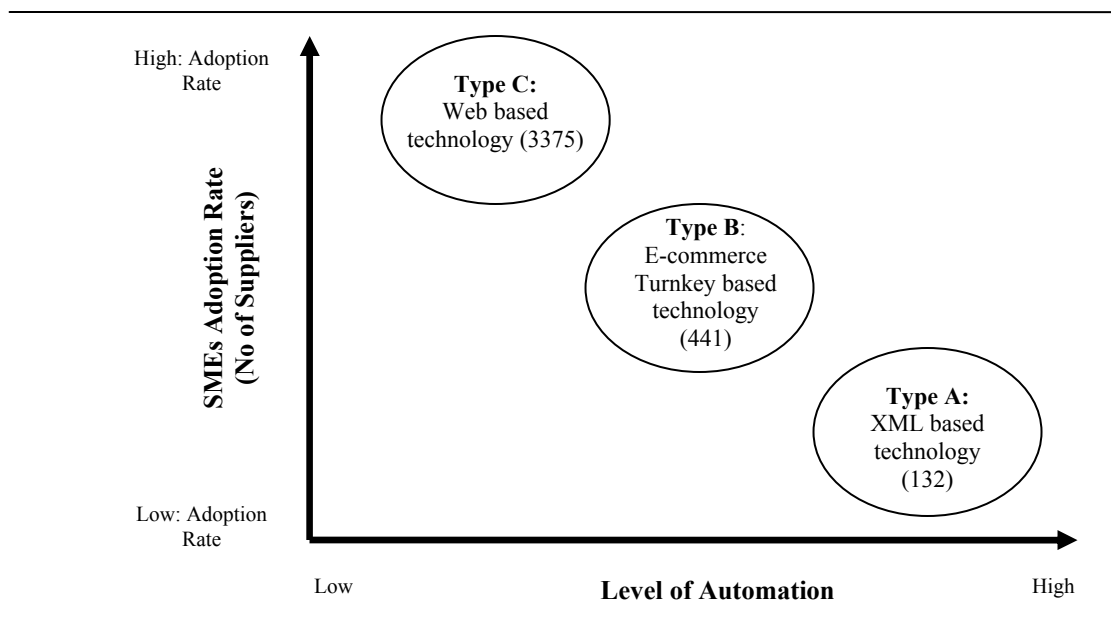
Figure 1. SMEs Adoption Rate and Level of Automation

Supply Chain Integration Approach Adopted by SMEs Case Study – (2003-2004)

After the implementation of e-procurement in 2002, the case companies were still facing problems such as: (a) difficult to manage the Logistic Service Provider (LSP) (for transportation) as there are too many of them and they all have different ways of handling things; (b) most of the files handling jobs are still performed manually, therefore, errors occur frequently; and (c) the case companies were not able to gain information instantly and the accuracy of the information received/sent is usually incomplete. Due to these problems, those companies are now moving one step forward to integrate their financing, shipment, inventory and hub with banks, direct suppliers, forwarders, LSP and Application Service Provider (ASP) through Internet to integrate the cash flow and e-logistic within supply chain. The proposed supply chains integration solution by the case companies is supported by the Council for Economic Planning and Development (CEPD) in Taiwan. CEPD in Taiwan has completed a draft "Framework and Action Plan for the Development of Logistics/Distribution Services" aimed at enlivening the market mechanism, strengthening the transportation infrastructure, integrating customs clearance operations, promoting digitised and standardised operations, and providing assistance and incentive measures to boost the development of high-value-added logistics services. The new program has encompassed wholesale, retail, transportation, and warehousing (excluding passenger transportation services) services (MOEA, 2003b). In doing so, the case companies hope that they will be able to exchange real-time information faster with their suppliers, LSP and customers to increase business efficiency as well as to achieve higher level of information transparency and process automation. Although the case companies and their suppliers, banks, LSP, ASP and forwarders are still working on their supply chain integrations, the results are looking promising.

The companies that the authors have visited which are *Inventec Corporation, TATUNG Co, SAMPO Technology Corp, and ASUSTeK Computer Inc.* The authors found that each of them has different architecture towards supply chain integration, but the common goal is to integrate the supply chain (from procurement to distribution). In this paper, the authors will only report one case study conducted in SAMPO Technology Corporation in 2003. SAMPO Technology Corporation is the subgroup of SAMPO producing CRT monitors, LCD monitors, and other high-end technology products. SAMPO was founded over 67 years ago in 1936 as a small family business. Since then, it has grown to incorporate over 20 companies and affiliates, 3 of which are publicly listed companies and a workforce of over 10,000 people across the globe. For the inter-organisational integration, SAMPO adopted Business-to-Business Integration (B2Bi) protocol to interconnect with its direct suppliers, ASP/Hub, direct customers, LSP and overseas sites and banks through the Internet (i.e. system-to-system connection), and the interconnection between SAMPO and its direct suppliers has already been established in 2002. The role of B2Bi platform here means the process of transforming legacy data into B2B protocol standard (in this case SAMPO uses Rosetta Net PIPs/Standard). The forwarders used Web based technology to interconnect with SAMPO through the Internet (i.e. system-to-Web connection). Basically, all the interconnections used here are based on the types of interconnection for e-purchasing

identified by the authors in 2002 case study. In doing so, standard information exchange mechanism and common platform is formed and the flow of information and goods for shipping is integrated. As a result, an intelligent commercial vehicle operation (CVO) environment is established and an intelligent enterprise-to-shipping-operator environment is developed. Hence, result in increased logistics efficiency. In addition, SAMPO also installed a FXML gateway to interconnect with its cooperated banks through the Internet for payment automation (i.e. e-payment). The main difference between the e-payment interconnection from others is the security issue. Therefore, encryption was used for payment transaction. By integrating the payment system with banks can save transaction times and reduce labour power. Hence, increase operation efficiency and achieve real-time payment. The e-financing model is shown in Figure 2.
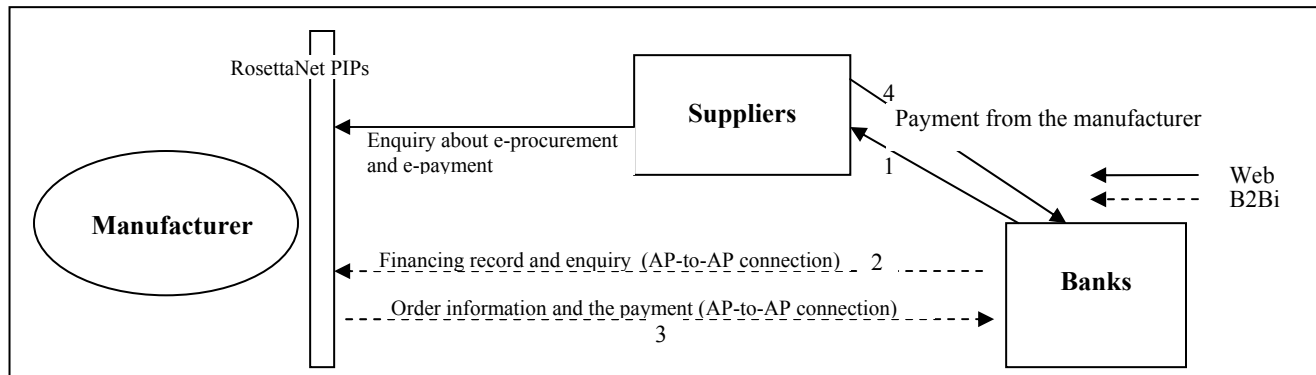

Figure 2. E-financing model for SAMPO
(Sources: SAMPO Technology Corp and (MOEA, 2003a))

For the intra-organisational integration, SAMPO adopted Enterprise Resource Planning (ERP) integrated software solution and EAI technology. ERP is used here to manage the company's resources and to integrate all business functions such as planning, inventory/materials management, and more. EAI technology is adopted here for data transformation, data integration, transport and messaging. According to Themistocleous and Irani (2000), EAI is achieved at three integration layers namely *transportation layer, transformation layer* and *process automation layer*. Source and target applications are integrated by exchanging their application elements, which include *data*, *objects* and *processes* when EAI is used. Here, the case company uses EAI to transfer the data elements from source application to the integration infrastructure and from the latter to the target application. So the flow is data elements are transferred from source application to the target through the integration infrastructure using the *transportation layer*. Meanwhile, data elements are translated from source application structure to target application format using the *translation layer* as translation is needed to transform data into compatible format for target application. Then, data elements that are used for the integration of processes or the integrity of information are transferred to *process automation layer*. The supply chain integration system architecture is shown in Figure 3.
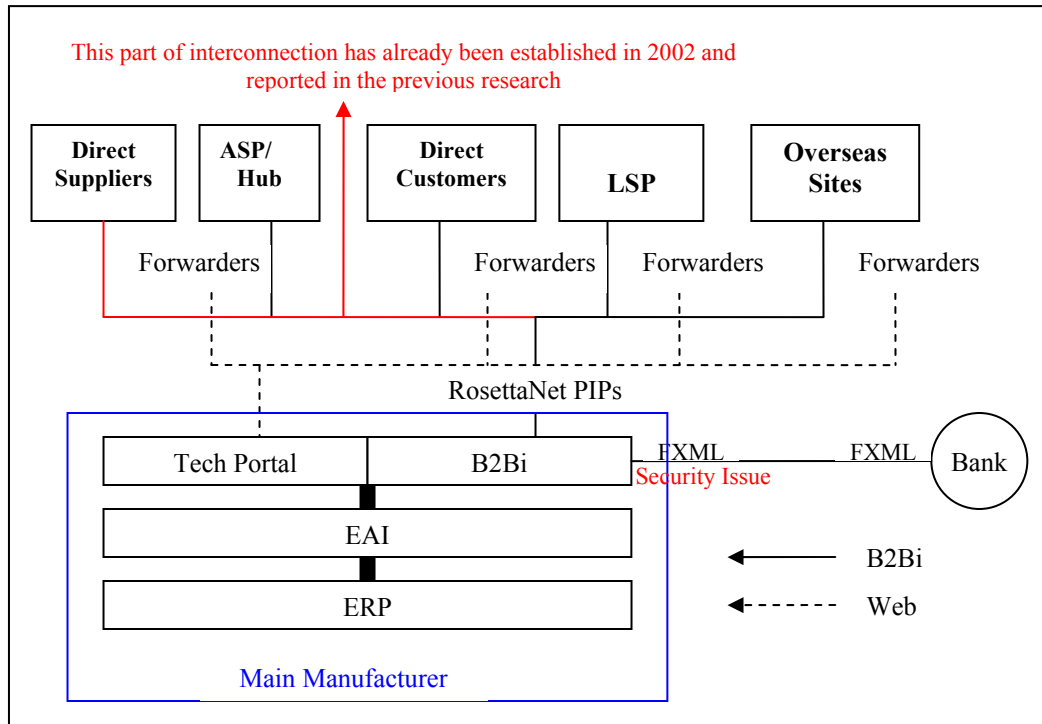
Figure 3. SAMPO's supply chain integration architecture
(Sources: SAMPO Technology Corp and (MOEA, 2003a))

Before the implementation of supply chain integration, the delivery process was more complicated and time consuming as many of these processes were done manually. For example, when companies need to deliver goods to their customers by LSP that they need to fill in purchase orders first, then the LSP will come and pick up the goods. After receiving the goods from the ordering companies that usually LSP will put labels on the goods to facilitate the process as ordering companies will constantly check with LSP to see whether the goods have arrived on time. After this, LSP will key in the goods information into their database for suppliers' enquiries. Meanwhile, if companies want to trace the goods that they need either to contact LSP by telephone or in person. Then LSP will check with the drivers to see where the goods are. As a result, the information obtained might not be 100% accurate all the times and information can not be obtained in real-time. This might affect the collaboration relationship between LSP and their customers. This situation has now improved ever since the case company start integrating its supply chain. The case company has performed a preliminary efficiency analysis to examine the performance of integrating its supply chain. In doing so, some improvements are being specified by the case company as follows:

- The period of stock stored in the warehouse has reduced approximately from 60 days to 45 days.
- The management of distribution has shortened approximately from 24 hours to 3 minutes.
- The ratio of finalising production on time has improved approximately from 75% to 90%.
- The average time on payment operation has cut approximately from 2 hours to 10 minutes.

Other benefits included:
- Reduced errors occurrence and operation time.
- The capital costs have significantly reduced by automating process.
- Since the period of stock stored in the warehouse has reduced, this has also lowered the risk.
- The case company is able to obtain and exchange real-time information now.
- Strengthen the ability of revolving the capital.
- Increased collaboration among customers, LSP, banks and suppliers. Hence, building a closer relationship.
- Increased competitive advantage.

Apart from the improvements mentioned above, there are also problems and difficulties during the development of supply chain integration such as:

- Some LSP claimed that since the pricing standard of ASP is unclear, this might increase their capital costs on integration.
- The lack of IT application ability and the knowledge on RosettaNet standard of LSP, SAMPO has spent a significant time on helping them in building B2B e-commerce platform.
- Many LSP need to change their backend systems as well as to enhance the B2B system functionalities upon the implementation of integration.
- There are also concerns over security on e-payment and the Internet. SAMPO is addressing this issue by using the security measures like encryption to protect its data so that members of the supply chain can only see information that is relevant to them.

FINDINGS AND DISCUSSION

From the case study, it shows that SMEs are moving to the adoption of integrated systems as a way to improve efficiency by interconnecting their systems with their suppliers, LSP, customers and banks to fully automate the supply chain process. Hence, increase competitive advantages. In doing so, many types of interconnections have been established such as Web based interconnection, XML based interconnection and e-commerce turnkey based technology. These types of interconnections were then used to integrate/interconnect the cash flow and logistic flow of the supply chain, which was discussed in the second case study (2003-2004). Among these adopted interconnection methods that there were only approximately 10% of manufacturers (i.e. case companies), supplier and LSP that were able to achieve system-to-system interconnection/integration. The majority (around 90%) of them were only able to achieve system-to-Web connection. This is partly due to the differences in IT application ability between the manufacturers, the suppliers and LSP, and partly due to SMEs' characteristics weaknesses e.g. lack of know-how and finance. According to Burns (2001) and Deakins and Freel (2003), SMEs in general have the characteristics of shortage in finance and weak financial structure. They can not raise capital in the same way as large companies do. In a situation where business slows down and inability to do financial planning, SMEs will face insufficient working capital and it is hard for SMEs to obtain loans from financial institutions (Deakins and Freel, 2003). As a result, these might have an influence on the overall supply chain integration performance. However, since SAMPO and its suppliers were supported by Taiwan government financially and technologically to integrate their supply chains. The authors expected that the situation might be worse for SMEs without any financial or technical supports. Therefore, it was found that the government played an important role in assisting SMEs to achieve supply chain integration. Another point needs to be addressed is, since SAMPO and its suppliers are from IT sector, their IT application abilities are expected to be more advanced than SMEs from other sectors. The authors expect that the development of supply chain integration by SMEs from other sectors might face even more problems and difficulties. Therefore, IT sophistication is found to be one of the crucial factors affecting the adoption of supply chain integration in SMEs.

Moreover, with the implementation of supply chain integration presents the share of technical challenges including change. From the case study, the authors found that supply chain integration brings major changes in the way companies communicate with each other, from planning to purchase to ordering. For the success of supply chain integration, organisations must be willing to collaborate data with its suppliers and customers over the Internet, dynamically exchanging information regarding inventory, production schedules, forecasts and promotion plans. Most organisations or even their suppliers are still reluctant to share information like production schedules, fearing that they will somehow fall into the hands of their competitors. Companies fear that sharing too much information will harm their business. Hence, lose comparative competitive advantages to competitors. For example, suppliers might need to lower prices for own products through transparency of own production prices for the clients. Besides, some smaller companies (e.g. suppliers) did not like being forced to join an electronic supply chain. The smaller companies are pressurised to automate or lose their businesses by big customers. The decision to take on the costs and headaches of automation is not their own, and the benefits of automation may accrue largely to their business partners and not to the smaller companies. Since supply chain is a coordinated activity, the whole chain would suffer if one link were slow to provide the right information at the right time.

Furthermore, according to Themistocleous and Irani (2001), they have identified some benefits upon the implementation of Application Integration. Chen *et al.*(2003) also have reported some benefits of using integration technologies in SMEs. However, the benefits of integrating supply chain in SMEs have not been widely investigated. The adoption of supply chain integration in SMEs can be seen as either a way to provide efficiency savings, or as a strategic response either driven by necessity or due to competitive pressure. A major barrier to the use of integration technology to support the integration of supply chain in SMEs is the lack of technical knowledge and ability of SMEs e.g. suppliers, LSP. The cost is another crucial barrier. Nevertheless, these barriers can not diminish the importance of integrating supply chain as many benefits can be obtained through supply chain integration. Therefore, in this paper, the authors have identified many benefits upon the

implementation of supply chain integration in SMEs. To help enterprises and researchers better understand these benefits, the identified benefits from the case studies are summarised and classified in Figure 4. In the diagram, the authors split the benefits into two layers. The first layer indicates the main benefits and the second layer shows the benefits derived from the main benefits (i.e. consequences). For example, adopting supply chain integration can help SMEs to standardise production which can result in improved quality control, improved efficiency and shortened production time.
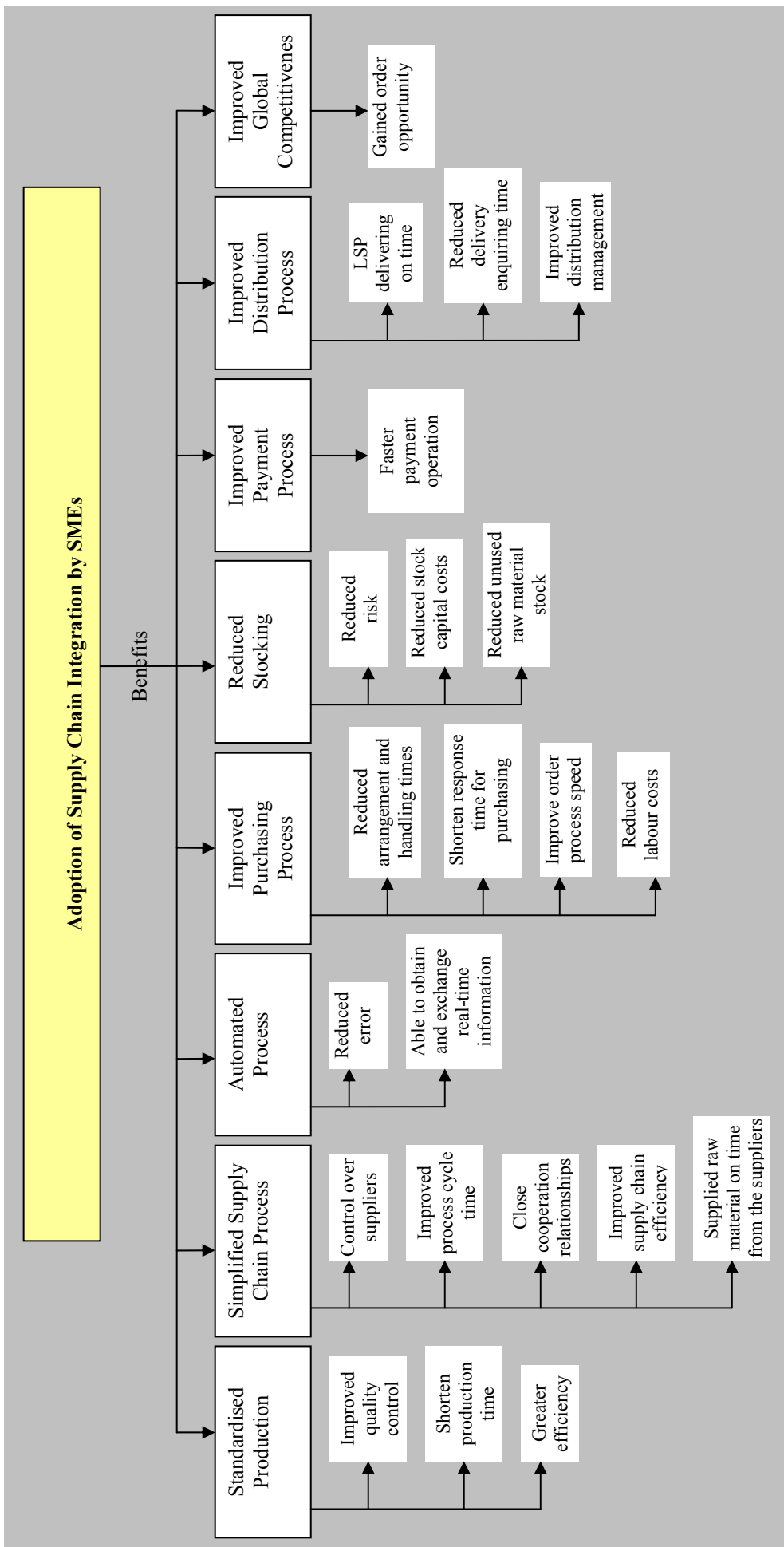
Figure 4. Summary of the adoption of supply chain integration benefits

CONCLUSION

Supply chain integration is an important issue for organisations since, it allows them to take competitive advantage and improve their business processes. In this paper, the integration of the supply chains of Taiwan's SMEs is explored using case study strategy. In doing so, the various types of integrated connection between the buyers and their suppliers, LSP, customers and banks have been studied in this paper as well as the overall effect to the firms. The findings of the analysis indicate that although the integrated connections have been established between the suppliers, LSP, banks and manufacturers, most of the suppliers or LSP have only achieved a system-to-Web integration ability. There were only around 10% of SMEs (suppliers or LSP) were able to achieve system-to-system integration. This indicates that the majority of SMEs are still relied mostly on the Web based technology partly due to their limited resources and technology knowledge. Partly due to the reason that Web based integration technology is simpler and cheaper to perform compared to a system-to-system based integration technology.

By adopting supply chain integration, the local suppliers and LSP have not only improved their technology abilities and application level of B2B e-commerce, but also the manufacturers' international competence has enhanced and the procurement from important international buyers has too increased. This is due to a faster and more efficient business transaction and communication between the buyers, LSP and the sellers always according to the analysis made in this paper. By using a common integration/interconnection standard the suppliers, LSP and buyers were able to share the data and services. Empirical evidences also suggest that SMEs gain significant advantages when integrating their intra and inter organisational supply chains. These advantages were being identified and summarised in this paper to help researchers and organisations to better understand supply chain integration.

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