Performance of Integrated Supply Chains - an International Case Study in High Tech Manufacturing -

David C.L. Kuo, Martin Smits
Center for Research on Information Systems Management
School of Economics, Tilburg University,
P.O. box 90153, 5000 LE Tilburg, Netherlands, m.t.smits@kub.nl

ABSTRACT. *The aim of this study is to identify factors that improve the performance of integrated supply chains (SCs). We developed the 'extended strategic alignment model' based on the literature on next generation supply chains, supply chain management, and the role of IT and business architectures. The model was used to do in depth analysis of the Unitech worldwide SC for high-tech hand-held scanning devices. During 1995-2002, the business architecture, power relations, and IT architectures in the SC changed considerably. We found a high increase of overall SC performance, intensifying relationships with local Taiwanese and European companies, and continuous IT developments. There was no SC wide planning of IT infrastructures and no IT-driven strategy to improve SC performance. No shared SC performance measures are used; in fact, in each company SC performance is measured from a perspective limited to one or two tiers in the SC. Originally, the Taiwanese company had a dominant position in the SC. Over the years, downstream companies increased their power position, without any of them having a clear control system for the integrated SC.*

Key words: Supply Chain; Supply Chain Performance; Strategic Alignment.

1. Introduction

In 1994, Ring and Van de Ven [27] wrote 'an unprecedented number of business firms in many industries have entered into a variety of inter-organizational relationships to improve their competitive advantages'. In 2000, after discovering the inadequacy of traditional relationships across the value chain, many organizations were establishing new forms of inter-organizational systems with their suppliers and customers in an effort to improve total channel performance [4].

In the past decades, IT and globalization have lead to new organizational forms, dynamic business networks, and 'next generation supply chains' also known as 'integrated supply chains' [26]. The battleground for organizations has shifted focus from competition between individual companies to competition between business networks, and from individual company performance to supply chain performance, with emphasis on continuous improvement across the extended chain [15].

The main research question in this paper is 'How do organizations use IT to collaborate in supply chains now, and in the foreseeable future?' More specific, the question includes:

- What new patterns of inter-firm collaboration emerge in supply chains and how is IT used and managed in the new supply chains?
- How does supply chain performance change and how does IT affect SC performance?
- How are new supply chains managed and how does IT affect SC management?

This paper describes an in depth analysis of the supply chain of the manufacturing of IT products by Unitech, a Taiwanese company, and the distribution, sales and marketing of the products to Europe. The supply chain changed considerably in 2000 when the company started a branch for service, support and sales in Europe. We regard the Unitech case as an innovative supply chain because the Unitech chain was restructured between 1995 and 2000, including the flows of information, physical goods, and cash. Also business processes were changed, investments were made in IT infrastructures, new performance indicators were selected, and the business goals and vision have changed.

We analyze the supply chain before and after the introduction of the new branch. Analysis is based on in-depth interviews, a simple open-questionnaire, and the collection of secondary data. The aim of this study is to provide insight in factors that improve the performance of a supply chain. We first review the literature on next generation supply chains and performance (section 2), present the research framework and approach (section 3), case study and analysis (sections 4 and 5), and end with conclusions.

2. Literature Review

2.1. Next Generation Supply Chains

The typical classic supply chain (SC) includes 'procurement' (acquisition of raw materials, supplies, and services for the production process), 'production' (conversion of those items into a good or service), 'materials management' (internal distribution and storage of the final good or service), and 'order fulfillment' (distribution to and ultimate consumption of the good or service by the customer)' [29].

A *narrow SC definition* focuses on the simplest network topology, namely a physical flow with each node (enterprise, company) having a single predecessor and a single successor. Information is exchanged - not only between each two successive nodes (acting as seller and buyer) - but also among *all* nodes (members of the SC). A SC may consist of either independent enterprises or individual business units of the same company [30].

In this paper we use a *wide SC definition:* 'a SC is *network* of entities that are involved - through upstream and downstream linkages - in the various processes and activities that produce value - through products or services - for all intermediate and ultimate consumers. These entities may include suppliers, carriers, manufacturing sites, distribution centers (entities), retailers, customers, and recycling entities' [14]. In the wide SC perspective two domains (worlds) are distinguished: an information world and a material or real world. Data flows between the two worlds. At least three types of infomediaries can be identified: one type between the two worlds; one in the information world, and one in the real world. Forrester [10] already suggested that the five flows of any economic activity (money, orders, materials, personnel, and equipment) are interrelated by an information network, which gives the system, what has now come to be called a SC, its own character. The emergence of intermediaries illustrates the network structure of a SC.

There are many classification models for supply chains and networks. Malone et al [23] formulated the 'move to the middle hypothesis' to explain the emergence of new organizational forms between classical hierarchies and markets. Classical hierarchies and markets are two structures to control the flow of goods and services between organizations and consumers. Classical markets are an expensive mechanism for organizations, because of the high costs for searching, executing, and evaluating market transactions. Therefore organizations tended to incorporate markets into the organizational hierarchy, leading to growth until the organization costs and agency costs exceed transaction costs [35]. According to Malone et al, ICT has an interesting dual effect on classical hierarchies and markets: ICT reduces organization costs because of automated control mechanisms, and ICT reduces markets costs because of lower searching and transaction costs. This leads to electronic business networks of smaller 'electronic hierarchies' being engaged to each other by 'electronic markets'.

An electronic business network can be regarded as a value constellation [24] grounded in the assumptions and the models of industrial economy. In this view, every company occupies a position in a value network. Upstream suppliers provide input to a company, which then adds value to these inputs, before passing them downstream to the next actor in the chain, the customer. Global competition, changing markets, and new technologies are opening qualitatively new ways of creating value. Value can still be created by individual organizations, but also opportunities emerge for value-added partnerships [19]. A value-added partnership is a set of independent companies (or business units in one organization) that work closely together to manage the flow of goods and services along the entire value chain. Usually, partnerships first develop between organizations that perform adjacent steps in the chain. From industrial marketing research [28] it is known that inter-organizational relationships contribute significantly to company performance, and that companies need to invest in network competences to gain competitive advantage.

Grandori & Soda [12] distinguish symmetric (decentralized) and asymmetric (centralized) networks. Campbell & Wilson [2] define 'value-creating networks' focusing on purposeful cooperation between firms, versus 'social networks' focusing on social capital and personal relations. Cravens et al [8] identify four network types: 'flexible', 'hollow', 'virtual', and 'value-added', according to the dimensions of volatility of environmental change and the type of inter-organizational relationship involved (collaborative or transactional).

These classifications of supply networks offer limited operational assistance for individual companies trying to manage their networks (supply chains) effectively. Therefore Harland et al [14] proposed a classification based on two dimensions: (1) the degree of network dynamics (high – low), and (2) the degree of firm influence (high – low power) in the network. As a result, supply networks can be classified into four types (from high/ high to low/low). The model includes nine types of networking activities that an organization can perform to coordinate and manage supply networks: partner selection, resource integration, information processing, knowledge capturing, social coordination, risk and benefit sharing, decision-making, conflict resolution, and motivation.

2.2. Supply Chain Management

Ganeshan et al [11] reviewed the literature on Supply Chain Management (SCM) since 1950 and identified developments on three management levels, operational, tactical, and strategic decision-making. In the last two decades SCM has evolved from (operational) logistics into decision making on products, markets, value, and business networks. Trying to assess the actual scope of SCM is much more difficult than simply defining a supply chain. The business spectrum ranges from international supply chains down to a number of related sequential activities undertaken under one roof, but in independent cost centers. Ganeshan [11] adds that a SC is managed either as a single entity through a dominant member or through a system of partnerships requiring well developed cooperation and coordination.

Campbell and Wilson [2] found that in many networks and SCs described by academics, the network members themselves do not recognize or identify their network position. Managers reported to have no sense of being part of a larger entity, but to have a focus of dyadic or at the most triadic relationships.

A business network is defined as a set of two or more connected business relationships in which exchange in one relationship is contingent on (non-) exchange in another [2]. Stevens [31] defines SCM as ‘a series of interconnected activities which are concerned with planning, coordinating and controlling materials, parts, and finished goods from supplier to customer.

Integrated supply chain management (ISCM) or lean thinking of supply was labeled as the best practice in the field of supply chain management in the 1990s [14, 17, 18, 36]. Unfortunately, while this may be a theoretically interesting and even desirable proposition, practically it may be an impossible goal for many buyers. For example, recently, researchers recognize that the ISCM approach fails to take account of the many circumstances when the buyer is not in the position to create extended supply chain relationships to eradicate waste and inefficiency [6,7].

As a result, Cox [6,7] proposed the power perspective in dealing with these challenges, and distinguished between “attributes of buyer power relative to supplier” and “attributes of supplier power relative to buyer”. Cox proposed a power relations matrix with four cells: buyer dominance, inter-dependence, in-dependence, and supplier dominance. Typically, when putting these relations into a supply chain, there are at least two ideal SC types. Figure 1 shows one ‘ideal type’: buyer dominance in a SC. This occurs if a buyer has dominance (>) or inter-dependence (=) over the suppliers in all tiers up to the raw material suppliers. In this way power regimes in industries can be mapped. Cox reports that buyer dominance is often found in food retail, aerospace, automotive, IT hardware, process construction projects, chemical processing, and contract manufacturing. On the other hand, supply chains favoring buyer-supplier independence or supplier dominance include: IT systems integration, strategic consulting services, retail banking services, sugar processing, Internet routers, markets for most branded products and services, and ad-hoc construction projects [Cox, 2000a,b].

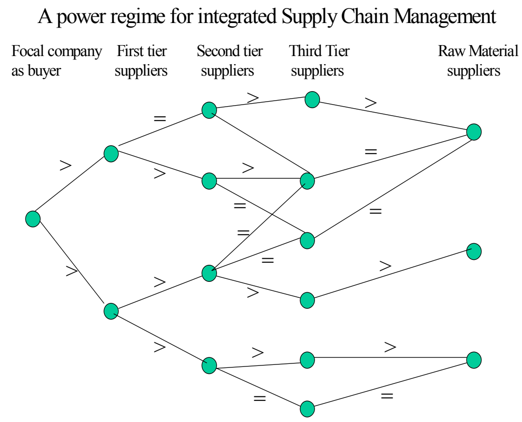

Figure 1. Power relations in a Supply Chain (Cox, 2001)

2.3. Performance of integrated supply chains

Hausman [15] states that SC performance refers to meeting the end customer requirements, including product availability, on-time delivery, and all the necessary inventory and capacity in the SC to deliver that performance in a responsive matter.

The performance of a supply chain can be evaluated in many ways, e.g., higher flexibility, customer orientation, customization, flexibility and better cost-effectiveness. Kleijnen et al [21] investigated performance metrics used by organizations to evaluate business performance in a supply chain. Organizations now often use multiple metrics (balanced scorecard) and various scorecards are used across a supply chain. Various authors stress the importance of multiple metrics and the difficulties (sub optimization etc) that emerge when multiple actors use different metrics.

Lambert and Pohlen [22] present a framework for SC metrics in which Customer Relationship Management (CRM) and Supplier Relationship Management (SRM) are the two processes that capture the overall performance of a SC, by analyzing every supplier-customer link in the SC. Every supplier-customer link in a multi-tiered network can be classified as ‘managed’, ‘monitored’, non-managed’, or ‘non-member’, where ‘managed’ and ‘monitored’ tiers provide SC metrics.

Kleijnen et al [21] and Kaufman et al [20] propose the analysis of cases in a supply chain to identify performance indicators. Kleijnen et al suggest investigating performance measures in different sections of a supply chain: upstream, midstream, and downstream.

2.4. IT, SCM, and SC performance.

A well-known framework for analysis of the impact of IT on organizations and business networks is the model by

Venkatraman [33]. In this model five levels of IT-induced business transformation are distinguished. The first two levels have an intra-organizational focus, localized use of IT, and evolutionary business changes. The upper three levels require inter-organizational IT standards and use, radical changes in inter-organizational business practices, requiring fundamental knowledge of the entire business network. Clark & Stoddard [5] support the claim of Venkatraman that benefits will increase when IT is integrated with business processes. They propose a frame-work that focuses on the '...merging of technological and process innovations in order to achieve the potential to transform both organizations and inter-organizational processes and relationships'. Stoddard and Jarvenpaa [32] identified the need to assess risks and costs in deciding to either follow an evolutionary or revolutionary approach, as well as to review the possibilities embedded in the capabil-ities of the people in the organizations that are being confronted with these changes. Benjamin & Wigand [1] addressed the developments in value chain linkages based on IT and identified the bilateral links between buyers and suppliers by using EDI techniques. These database links and sharing databases between firms are described as electronic supply chain integration. This does not necessarily involve redesign of business processes.

Clark and Lee [4] investigated the effects of IT innovations on SC interdependence, coordination and performance. They looked into 'Continuous Replenishment Process (versus the traditional order process)' and 'value pricing or Every Day Low Cost'. The findings indicate that innovation of the inter-organizational IT infrastructure enables 'policy and process redesign', 'increased interdependency between firms', and 'expanded coordination', leading to improved 'channel performance'.

Of particular importance is the linkage between business and IT within an organization. Henderson and Venkatraman [16] distinguish in their Strategic Alignment Model between the business domain (business strategy and business architecture) and the technology domain (information strategy and IT architecture) in an organization. The two domains can influence each other in two ways. They distinguish two main perspectives on how the alignment between the domains can take place. In the first perspective (alignment) the business strategy is the driving force for business architecture or information strategy, ultimately affecting the IT architecture. In the second perspective (impact) the IT strategy is the driving force for IT architecture or business strategy, ultimately affecting business architecture.

Oesterle et al [26] focus on the IT architecture across organizations in a supply chain. They found two business factors (availability of intermediaries and availability of electronic services) and two technology factors (the presence of a 'business bus', and the use of ERP systems) that determine the growth of a business network. They define the business bus as an infrastructure in a group of organizations (or even an industry) consisting of a communication network, communication standards and services, application services and intermediaries, ideally in the form of a standardized socket and a plug to go with it for organizations to do business.

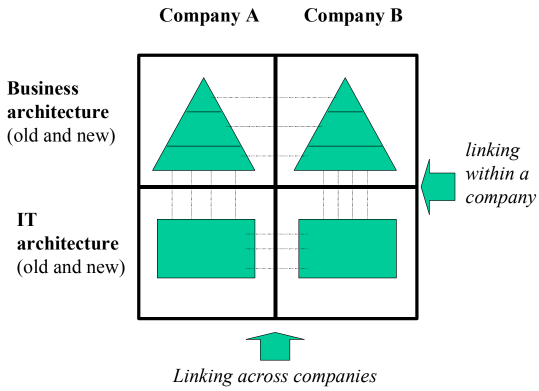

Figure 2. Extended Strategic Alignment Model.

3. Research approach

Figure 2 shows our research model to support the analysis of SC performance and the role of IT, based on the literature on SC, SCM (including power relations), and SC performance. The rationale of the approach is that within an organization (say Company A), the IT architecture and the business architecture influence each other vice versa (Henderson and Venkatraman, see section 2.4). Also, across organizations in a SC (say between companies A and B (and more)), business architectures influence each other vice versa (section 2.1, 2.2), and IT architectures influence each other vice versa (section 2.4, e.g. the business bus), depending on the bargaining power positions of the companies in the SC and on the strategic alignment in the organizations involved in the SC. Additionally, organizations in a SC can choose performance metrics to evaluate SC performance and to support managerial decision making in and across companies (section 2.3).

We did in depth analysis of one SC case. The use of a single case study as a basis for drawing inferences about a particular area of study is related to an interpretive epistemological stance [34]. From this perspective the validity of an extrapolation from one or more individual cases depends not on the representativeness of such cases in a statistical sense, but on the plausibility and contingency of the logical reasoning used in describing results from the case, and in drawing inferences and conclusions from those results [9, 25, 34].

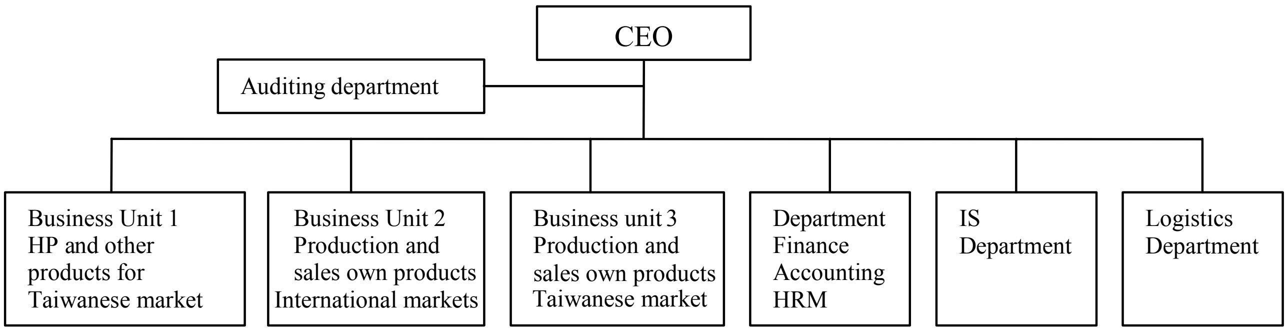

Figure 3. Organizational structure of Unitech Taiwan

We selected a 4-tier supply chain (i.e., including up-stream, mid-stream, and down-stream relationships), with a focal company of medium size and global reach. The principle methods of data collection are in-depth interviews with the managers of the focal company and its downstream UE. Also, a questionnaire with simple open questions was answered by the CEO and CIO in Taiwan (the focal company). Other sources of data included personal communications with IS staff, and internal documents. Secondary data sources include a Taiwanese master thesis, website data of the focal company, UE and their retailers, Internet based reports, and a public financial report of the focal company.

All interviews were based on open questions, the answers summarized and transcribed. Interviews are tailored to each person and focus on their SC perceptions. Formal interviews were taken by visiting the senior managers in the companies in Taiwan and in the Netherlands with managers in different positions in the supply chain to further understand the process from different perspectives (triangulation). Each interview took about 90 minutes and e-mails were used after interviews to fill in the blanks. The following open-ended questions were used as the basis for interviews with managers:

- What new business processes are emerging in the SC?
- How are business process interdependencies changing in and between organizations in the SC?
- What IS/ IT architectures are emerging in the SC?
- What problems exist in the fit between business architectures and IS architectures?
- How is the performance of the supply chain monitored and controlled? Which metrics are used? By whom?

4. Case Description

4.1. Unitech Taiwan (the focal company)

Unitech Taiwan was established in 1979 and has grown to a company of 360 employees and US$ 170 million turnover in 2000. It started in 1979 with the design and manufacturing of state of the art IT products. The product lines of the company varied over time, following the demands for IT products. Recently the company established better partnerships with its local material suppliers, and implemented a new geographic and product oriented organization structure (3 business units and 3 departments, figure 3).

Business unit one (BU1) focuses on importing Hewlett-Packard, Apple, and Fuji products, for sales, distribution and services on the Taiwanese market. BU2 focuses on R&D, procurement, manufacturing and marketing of own products for *Automatic Data Capturing* (ADC) for the international markets cooperating with international sales offices in USA (since 1987), China (1998), Europe (1999), and Japan (2001). BU3 is responsible for R&D, procurement, manufacturing and marketing of ADC products for the Taiwanese market, using 5 local branch offices. Business units two and three cooperate with third parties in Taiwan to provide total solutions of ADC products for specific industries. The three departments are responsible for (i) logistics, (ii) IS for Unitech worldwide, and (iii) finance, accounting and HRM.

The ADC market has many specific features. First, the whole market is relative small, which makes well-known large scale manufacturers less interested in entering this market. Second, due to the trend towards open architectures (rather than dedicated architecture), it has become much easier to provide total solutions for specific application domains. This contributes to considerably higher profit margins than when selling only standardized hardware. Third, entry barriers are quite high because of the IT skills required to be an ADC manufacturer. Fourth, since the standards and the requirement vary from region to region, it requires domain knowledge and cooperation with local companies to enter local markets over the world. Finally, due to the feature of short product life cycle, distributors, systems integrators and retailers in Europe will prefer manufacturing partners with trustable services and good reputations.

Before 1998, the niche markets of Unitech were mainly in Taiwan because of limited capital and human resources.

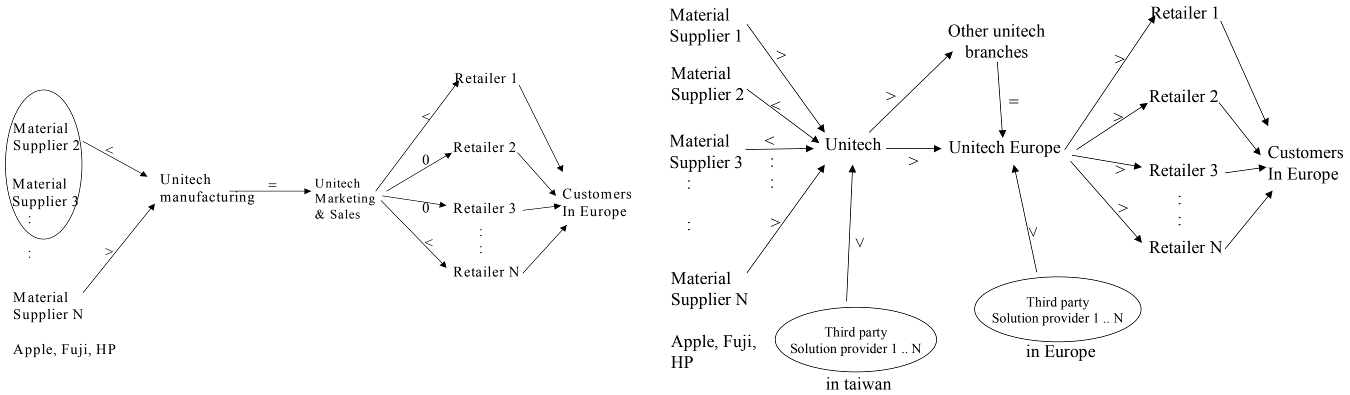

Figure 4. Power relations in the Unitech Supply Chain in 1997 (LEFT) and 2001 (RIGHT)

In Europe Unitech sold via its distributors and retailers only highly standardized ADC hardware with limited profit. The total supply chain for ADC products was mainly located in Taiwan, except for some materials that were obtained from foreign large enterprises. Most suppliers were located in Taiwan, having long term and good partnerships with the company. The over 40 suppliers of ADC parts provide IC circuits, electronics, PC boards, plastic models, and so on.

In 1998 Unitech was allowed to sell its own stocks over the counter in Taiwan, and got more funding from the capital market. Unitech top management repositioned and redefined the business goals and strategy for the ADC products from local market focus into global wide reach. Unitech faced two primary challenges when going global. First, it had to improve its reputation; second it had to create a quick response to the demand side and service requirements on the global markets. To do this, Unitech started to restructure its business and organization infrastructure, and started branches outside Taiwan, one in 1999 in the Netherlands (UE) to address requirements in Europe.

4.2. Unitech Europe

The mission of Unitech Europe (UE) is to "provide the highest customer satisfaction with information, products, and services." UE has only around 15 staff, and none-core business activities, such as logistics, accounting, and web page maintenance, were outsourced. UE staff 'has multi-language communication skills, and aims for in-depth understanding of the real customer needs and urgent requirements'. This is seen as the driver for the great growth rate of UE in the last three years.

The ADC products in Europe are sold in several industries and include applications for inventory control, shipping and route accounting, warehousing, item tracking, asset management, and healthcare. Actually, Unitech Europe created opportunities to compete with worldwide large enterprises such as Symbol, Intermec, HHP, and Casio.

Strategic benefits of UE for the focal company can be observed. In the first place, while being member of the Auto Identification Manufacturers Association in Europe and USA, the focal company became one of the world market players for ADC. As a result, the focal company was noticed by large enterprises, and was included in their global supply chains as a manufacturer of low priced ADC. The focal company nohw became the primary supplier in the ADC market in Asia, which helped to further improve reputation. Unitech had acquired knowledge about the worldwide ADC needs, and had learned how to collaborate in design, manufacturing, and distribution in several sites.

5. Case Analysis

Case analysis is done in four steps. In section 5.1 we analyze the SC from single company perspectives, i.e. applying the left part of the extended strategic alignment model (figure 2) to individual companies in the SC. In section 5.2 we analyze the SC from a multiple company perspective, creating the integrated SC perspective, using figure 2. We conclude the analysis with the SC performance (5.3) and the role of the IT architecture (5.4).

5.1. Analysis from Single Company Perspective

Because the Unitech Taiwan (the focal company**)** changed the business scope and size since 1990, the old IT infrastructure did not meet the performance required, thus creating a misfit between business and IT. The first changes aimed to achieve a better internal fit. Afterwards in the second stage, the growing importance of external linkages (global support, collaborative working, information sharing) resulted in further changes in the organization and operation of IT and a new IT strategy. From a strategic alignment perspective, the first stage is of a "*strategic* *execution*" type: the changes started with the business strategy, then affected the organizational structure, and finally impacted the IT infrastructure. At that moment the company tried to expand the market and to deal efficiently with the systems in place. This fits a change strategy with a finance-oriented focus. In the interviews the management of the focal company acknowledged indeed that they appreciated the actions being taken at that moment. The second stage (and the forthcoming changes) can be identified as of the "*service level*" type: changes in IT strategy affect the IT infrastructure, which influences the organizational structure. This is consistent with the new company objectives aiming to streamline the inter-organizational and intra-organizational processes. Management believes that the new IT strategy will be realized by implementing a new IT infrastructure.

We now focus on UE. When starting business in Europe, cooperation and ordering between Unitech and UE initially took place via traditional ways (phone, fax). When UE started operations from a physical location in the Netherlands in 1998, this resulted in changes at the business operation level and the IT architecture. In 2001, after the initial experiences with business and information requirements, UE decided to further develop its own IT architecture for satisfying other requirements. For UE the first stage of changes could be classified as "*strategic execution*": in order to achieve the new business strategy, UE had to re-build the company structure and acquire a proper (but simple) IT infrastructure. This started with a new business strategy, then a new business architecture and IT architecture. The next stage of changes can be categorized as "*service level*", because UE tries to make better use of the IT architecture and better link the business architecture and IT architecture via a well-planned IT strategy.

Finally, the material suppliers and the partners in Europe did not report any significant changes in their IT architectures since 1997, even though there were significant changes in business strategy and structure. However, it is expected that suppliers and retailers will try to adopt a new IT architecture and infrastructure to establish better connections with the new IT architectures of the focal company and UE, in order to benefit more and share more. Thus business objectives affect the IT strategies.

To summarize, from the single company perspective, business strategies appear to be the main driver of the SC changes, while IT appears an enabling role to achieve fit in the SC.

5.2. Analysis from an integrated SC perspective

The structure of the supply chain in 1997 and 2001 is given in figure 4. Unitech Taiwan designs and manufactures ADC products and acquires materials from up to 40, most local, suppliers. To make customized products and create value-added, local third party solution providers are invited to participate in the supply chain. When the original products are shipped to UE, third parties (such as system integrators and value-added providers) in Europe are actively or passively participating to provide total solutions for various application domains. Additionally, software upgrading or maintenance can be done or supported by other third parties. To achieve special requirements, local customization can be accomplished even with the help from FC or local partners in Taiwan.

UE has to manage its own inventory levels, using its own ordering policies. If Unitech Taiwan has problems to deliver extra orders to UE on time, then UE can ask other Unitech branches, thus making these also players in the EU supply chain. In the future, retailers and distributors around Europe will order and receive products from UE to sell these to their customers in various sectors. UE offers demonstrations, on-line training, in housing training, and after-sale maintenance.

We now analyze the supply chain link by link, and compare up-stream, mid-stream and down-stream. Upstream, between material suppliers and Unitech Taiwan (UT), UT changed its business strategy, but there was almost no change in the linkages between the business architectures. UT also changed its IT structure, ('strategic execution') providing a new interface to link with its suppliers. However, suppliers did almost not change IT architectures, so there was no real improvement in the fit between these two parts.

Midstream, both UT and Unitech Europe (UE) have good internal fit between business and IT ('strategic execution'), and there is a good inter-organizational fit between the two companies, especially for the business level. The inter-organizational linkage at the IT architecture level is still of a loose type. Further analysis of the midstream section of the SC shows improving business performance after a few years, due to a better fit in IT architecture ('service level'). From a SC perspective, UT and UE had IT-enabled synchronized operations.

Downstream, UE and European retailers showed good fit in business strategy and architectures, probably due to the movement of physical location by UE, and, for the IT part, due to the use of new IT architecture as a partnership control mechanism. The IT linkage was improved and showed better fit, even though UE has no bargaining power forcing its partners to upgrade their existing old IT architectures.

Figure 4 shows the power structure before and after the physical location movement of Unitech to Europe. The power structure of the Unitech SC appears to be more complex in the situation before moving. After moving to Europe, Unitech partners had a low or relative inter-dependence power position. This makes it much easier for the focal company to affect or promote certain activities in the whole chain. In other words, after the physical location movement, despite that there are more parties involved in the SC, surprisingly the whole structure reflects better status, providing a better platform to improve or synchronize the actions of all chain members. On the other hand, in the old SC the focal company and the retailers in Europe had either low power or independent relations, and it was really difficult for the focal company to improve the whole SC efficiency and total performance.

With respect to the bargaining power of suppliers the Unitech ADC product strategy of "few quantities but various types" has interesting consequences. The strategy implies that Unitech requires relatively low quantities of specific materials. As a result Unitech has low bargaining power over the primary suppliers.

5.3. Measuring SC performance

From a business perspective, there were at least two significant benefits of splitting UE from the focal company. The first benefit was that UE got closer with the local distributors and retailers. This has resulted in rapid responses and more services, e.g., demonstrations of up-to-date total solutions, rapid repairs and upgrading, in-house and online training, better after-sales maintenance. It also resulted in better prices and financial payment policies, stronger relationships between UE and its partners and potential partners (or customers). The second benefit were the new ways of (local) cooperation, such as third party system integrators, distributors, and solution providers. As a result, the new linkages in the supply chain created not only more value-added activities for the whole chain (e.g., maintenance, being total solution providers, upgrading the products, customization of products, and various types of services), but also helped in creating more business on specific domain applications. The performance of the supply chain improved within a couple of years, measured as improved customer satisfaction, annual sales, and profit margins.

Performance measures used in the Unitech SC are listed in table 1. For the supplier part the measures used by UE include the order fulfill rate and inventory turnover. Unitech Taiwan, Unitech Europe, and the other downstream partners use the criteria annual sales, customer satisfaction, profit margin, and inventory level. The basis for benchmarking was primarily the comparison with the performance of previous periods and the actual performance of competitors. Managers in Unitech Taiwan and UE report to have no clear view on better ways to evaluate the SC. Balanced score cards (BSC) are not used in the Unitech supply chain.

5.4. The IT Architecture

Before 1997, the IT architecture of Unitech Taiwan (UT) consisted of separate systems for the various business functions. In 1997 the company started an in house project to integrate the isolated information systems. The new systems worked more efficient and better than the old ones, but had a limited business scope and were mainly designed for the use by staff in Taiwan.

Also in 1997, UT established web sites to face the challenges of electronic commerce and to satisfy the requirements of suppliers with a relatively large bargaining power (such as information sharing, online ordering, enquiring inventory status). UT management didn't aggressively try to create strong linkages with the systems of suppliers. One reason was the relatively small order quantity and small variation in product requirements. Hence, except for EDI, there was almost no advanced inter-organizational linking of information systems. In the near future UT management expects that a new enterprise resource planning (ERP) system and related systems will be implemented, due to intra-organizational forces (need for more internal integration) and inter-organizational requirements (need for more streamlining of coordination, especially in the foreign branches). Indeed, in April 2002, UT started a contract with Oracle, Anderson Consulting, and a Taiwanese systems integrator to implement Oracle ERP, CRM, and Business Integration to further improve overall e-operations in UT worldwide and to enhance competitive power, operational efficiency, and to speed up systems on-line.

The development of the IT architecture of UE differs from that of the UT, due to its own characteristics and requirements. UE purchased a standard software package

Table 1. Performance measures used in the Unitech Supply chain.

	Self-evaluation	Evaluated by Unitech
Suppliers	Quality level, cost (but a big gap between expectation and real situation)	Pre- and Post- selecting, filtering, testing and tracing (periodically)
Unitech (focal company)	Quality, delivery date, and cost	------
Unitech Europe (UE)	Quality, delivery date, and cost	Annual goals of business revenues, expenses, net income, accounts receivable, inventory turnover, customer satisfaction.
Retailers	unknown	Business revenue, and collection of accounts
Overall supply chain	------	BSC is not found

with some customization to meet the basic requirements of internal control (accounting, finance, inventory management, sales) and to be on-line fast. For the external coordination part, since IT was not regarded as a core activity, UE used an outsourcing strategy to quickly build a web site. In addition to the basic operational functions (such as providing basic company information, product information, and partner information), the web site also provided functions to enhance relationships with partners and potential partners. For example, UE evaluates the relationships with its partners by checking regularly if a partner keeps using the product catalog of UE on its web site. The strategy could be viewed as a passive way in verifying the loyalty of partners. With these functions (as well as the e-mail system), UE operates without problems on a basic level of information sharing with partners. As a result, the linkage of the IT structures among partners is loosely coupled.

Both internal systems and web systems are only first versions and the management of UE is planning growth of the architecture and functionality. Since there is no direct system link with the focal company in Taiwan, the problem of systems isolation needs to be solved. For example, inventory control and customized demand of UE cannot be linked automatically to the focal company, thus causing inefficiency and a negative effect on overall performance.

6. Conclusions

The aim of this study was to provide insight in factors that improve the performance of a supply chain. We developed the 'extended strategic alignment model' (figure 2) based on the literature on next generation supply chains, supply chain management, and the role of IT and business architectures. The model and related questionnaire were used to perform in depth analysis of the Unitech supply chain, and to answer the three research questions raised in the introduction.

Question one, '*What new patterns of inter-firm collaboration emerge in supply chains and how is IT used and managed in the new supply chains?*' During the period 1995-2002, UT developed into UT plus UE plus local European companies plus, in Taiwan Oracle, Anderson Consulting, and others. From isolated applications in UT and UE (in 1996) Unitech developed towards integrated systems and websites (in 2000). First this was done by implementing standardized office software and local websites, then by intensifying partner relationships (EDI) in the SC, and finally by ERP package implementation (2002). There is no SC wide planning of IT infrastructure, and no IT driven strategy to improve SC performance. It was found in the ADC Unitech supply chain that the local IT architecture and systems support the business and affect inter-organizational IT only on a one to one basis.

Question two, '*How does supply chain performance change and how does IT affect SC performance?*' Overall performance of the UT SC increased considerably in the period investigated, measured as rapid responses, more customer services, more customized products, rapid repairs and upgrading, better prices, stronger SC relationships. SC performance is measured in many ways by organizations in a SC. There is no common performance measure, nor a shared balanced scorecard. Companies tend to measure supply chain performance from a perspective limited to one or a few tiers in the chain.

Basically, there are two philosophies for improving SC performance: process improvement (with efficiency and synchronization over the chain), and product improvement (value-added and customized). From the case study and the literature review, most companies and supply chains emphasize the first strategy, and use process benchmarks. Typical examples are order fulfill rate and inventory turnover rate. This strategy highly depends on the fit between business architecture and IT architecture, either within or between organizations. As a result, in the end the overhead costs and inefficiency will be eliminated.

Hence, if a supply chain competes in a competitive environment, the strategic alignment between IT and business among upstream and downstream partners will be the key factor for success. On the other hand, if the second strategy were adopted, re-positioning the values of the products and calling for the assistance from more value-added providers, would be a better way in obtaining financial gains for the whole supply chain members. The power structure will strongly affect the possibilities for this strategy, since it requires more complicated relationships for the whole supply chain.

Questions three, *'How are new supply chains managed and how does IT affect SC management?'* From the case analysis, it appears that for a small to medium sized worldwide player in manufacturing, the best way to establish a global supply chain is to be not fully dependant on the use of IT. Instead, a proper physical move (i.e., location move) with the selection of a proper niche market would be the first step to be done, because under the IT product market, due to the high risk of product, IT itself does little help in establishing the trust. In other words, we conclude that IT should be regarded as a facilitator to deal with a business problem, rather than a solution for the problem. UT first moved to Europe, then the local companies were attracted into better and tighter relations.

An interesting observation can be made with respect to power distribution in the supply chain. The case study shows that originally Unitech Taiwan had a dominant position in the SC. Over the years UE and downstream companies increased their power position, without any of the companies (including UT) having clear control systems for the integrated SC. This suggests that to achieve improved SC performance it can be effective that the powerful player in the chain (UT) transfers control (power) to an organization in another position (upstream/ downstream). This is in line with the findings of Chandra (2001) that a powerful company can decide more easily on control, but not on structure and optimization of a SC.

Following this case in the coming years, adding more supplier and customer perspectives, and adding comparisons with other cases and industries can find more answers on the questions raised.

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