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**Differentiation for Integration of Supply Networks**

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Abstract

The keen interest of managers and scholars in the means of supply chain integration – the technology of data interchange, the extent of information sharing, and forms of collaborative planning – has perhaps overshadowed some more significant aspects of supply networking. It is actually the differentiation of functions and reshuffling of roles of companies that drive the restructuring of processes in supply networks. In a longitudinal study we examine how operational specialization and increasing service intensity may explain many of the changes anticipated within supply chains such as customer focus, process management, outsourcing and partnerships. The results suggest that differentiation and specialization of productive and service capabilities in supply networks may indeed enforce efficient supply chain practices and use of advanced technology. Case examples of Finnish companies are used to illustrate development patterns in supply chain structures and differentiation of production capabilities, services, technology integration and organizational resources.

Key words: supply chain management, networking, specialization, industrial cases
Introduction

Already in the 1960s advances in technology were seen as forces that increase the tempo of change in complex business organizations that concurrently struggled with the requirements of regularity and standardization. In their seminal work Lawrence and Lorsch (1967) viewed that altogether the technological changes called for greater specialization, or as they call differentiation, and for tighter coordination or integration. Since the beginning of supply chain management in the 1980s (e.g. Houlihan, 1985; Stevens, 1989) companies have been increasingly concerned with the forms of integration in the supply chain context. Many consider extensive informational and organizational integration with upstream and downstream partners as a prerequisite for efficient operations and responsive supply networks (e.g. Cooper et al., 1997; Lee, 2000). While studying the obvious indicators of supply chain integration – the technology of data interchange, the extent of information sharing, and forms of collaborative planning – we, however, may be overlooking some more significant aspects of supply networking. It is actually the differentiation of functions and reallocation of activities and reassignment of roles of companies that drive the restructuring of processes in supply networks. In order to achieve competitive advantage supply chain players need to outsource some of their tasks and responsibilities and choose their own core competences. It is this type of specialization that enables integration of supply chain processes over organizational boundaries in the true spirit of networking. In order to analyze the anticipated correlation between differentiation and integration of supply networks, the objectives of this study are as follows:
1) To review how supply chain management research addresses informational and organizational integration and specialization in roles and responsibilities of supply network players.

2) To discuss models and frameworks that can explain some of the structural changes in supply chains and networks.

3) To analyze changes in roles and responsibilities as well as in the portfolios of capabilities in the selected supply chains based on the frameworks.

The structure of this paper is the following. We begin by reviewing the research about supply chain strategies, practices and integration. After the literature review we describe how empirical data was collected via a longitudinal study from 25 Finnish industrial companies. Then, we will introduce four frameworks for the analysis of structural changes within the supply chains and discuss our main empirical findings on differentiation. Finally, conclusions and suggestions for future research are given.

**Literature on supply chain strategies, practices and integration**

The origins of supply chain management (SCM) as a discipline date back to the 1980s, although over the years the meaning of the concept has evolved. SCM started as an integrative approach to the management of material flows from a source to a customer (e.g. Houlihan, 1985; Jones & Riley, 1985). In the 1990s, it was extended to cover also the management of informational and financial resource flows (e.g. La Londe & Masters, 1994; Bechtel & Jayaram, 1997). Mentzer *et al.* (2001) further expanded the scope by viewing SCM as strategic coordination of the
traditional business functions and the tactics across businesses within the supply chain for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole. Bowersox et al. (2000) as well as Anderson and Delattre (2002) expect that over the next decade companies and supply chains will further underline the importance of collaboration and value management.

Guidelines for supply chain strategies

Researchers have recently pursued to establish frameworks for supply chain and network strategies. For example, Harland et al. (1999) project that because of substantial changes in the nature of industries, firms, supply chains and business relationships, the competitive priorities, structure and infrastructure for supply network strategies are to be redefined. To support the selection of supply chain structure and strategy Fisher (1997) launched a taxonomy based on which a company can analyze if its product type (innovative or functional) matches with its supply chain strategy (efficient or responsive). The criteria used in the product classification include different aspects of demand such as contribution, product variety, and average stock-out rate. Li and O’Brien (2001) applied Fisher’s model when they evaluated the performance of three supply chain strategies (manufacturing to order – a market responsive process, manufacturing from stocks – a physically responsive process, manufacturing to stock – a physically efficient process). They concluded that none of the typical supply chain strategies performs best all the time. Christopher and Towill (2002) came into a similar conclusion and they stress the importance of adaptive (mixed) strategies, i.e. different strategies (e.g. agile and lean) should be designed for different operations within supply chains. They propose a three-dimensional taxonomy that bases on demand type, product type and replenishment lead time for
the determination of appropriate supply chain strategies. Also Lee (2002) complemented Fisher’s work by arguing that in addition to demand uncertainty supply uncertainty – be it stable or evolving – should be considered in the design of supply chain. Depending on the combination of demand and supply, the type of supply chain should be efficient, responsive, risk-hedging or agile. There are also studies that either compare different strategies (e.g. Closs et al. 1998) or analyze how the choice or supply chain strategy is influenced by different variables such as product life cycle and human resource management policies (e.g. Aitken et al., 2003; McAfee et al., 2002).

**Surveys of supply chain practices**

In addition to conceptual frameworks and case studies, numerous surveys have been conducted worldwide to outline the current status of SCM practices. For example, Tan (2002), McMullan (1996), Basnet et al. (2003), Sahay and Mohan (2003), Al Falah et al. (2003), Quayle (2003), Olhager and Selldin (2004), and Kemppainen and Vepsäläinen (2003) discuss the status of SCM in the U.S., Asia Pacific, New Zealand, India, Saudi, UK, Sweden, and Finland, respectively. There are also international surveys (Spekman et al., 1998; Milgate, 2001; Harrison and New, 2002) and studies that compare SCM practices used in different nations (Tan & Wisner, 2000). Only a few of the studies, however, have tried to depict the development pattern of SCM in a more profound level than just specifying the importance of different practices or estimating the severity of prospective hindrances for SCM. Thus, there is a call for more in-depth analyses of the emerging structural changes in supply chains as well as the enablers of networking.
Integration within supply chains

The importance of integration for the success of supply chains and networks has been emphasized widely (e.g. Lewis & Talalayevsky, 1997). Frohlich and Westbrook (2001) were the first ones to demonstrate based on an international survey that supply chain integration is associated with higher levels of performance. In this study about supplier and customer integration they propose measures for the direction and degree of integration activity. The level of supply chain integration is estimated also by Fawcett and Magnan (2002) who conclude based on a four-stage classification that about a half of the 52 interviewed companies had not extended beyond inter-functional integration. Over 40% of the companies are developing integration either downstream or upstream, while the remaining companies work to improve integration systematically in both interfaces. Fawcett and Magnan (2002) remind that true integration where objectives are aligned, communication is open and candid, resources are pooled, and risks and rewards are shared is not reality, at least yet.

According to Lee (2000) supply chain integration consists of information sharing, coordination and organizational relationship linkages and is an important way to create value on the markets. Smeltzer (2001) emphasizes the importance of creating connectivity among all supply chain partners and keeping in mind that the models and methods used with SMEs should be different from the ones designed for large companies. Bacghi and Skjoett-Larsen (2003) conclude that tangible benefits are the motivation for supply chain integration. Based on case studies among 14 European companies they conclude that SMEs have been in the forefront in experiencing with IT integration, while large multinationals have been slower in the adoption of IT technologies and supplier integration. The main outcome of their explorative study is the set of propositions
that emphasizes the difficulty of implementing integrated systems within supply chains and establishing true integration because integration depends largely on the power, influence, motivation and zeal of the prime mover of the supply chain. Bask and Juga (2001) as well as Baeghi and Skjoett-Larsen (2003) noted that a high degree of supply chain integration is not necessarily desirable in all situations. According to Bask and Juga (2001) strategic polarization, organization diversification and differentiated performance measurement as well as channel separation, process divergence and relationship maturation will drive companies to establish semi-integrated supply chains instead of holistic overall integration.

An analysis of structural changes in supply networks

Structural changes such as reallocation of activities and reassignment of roles within supply networks can be assessed via the development of manufacturing and service capabilities as well as transformation in the generic management profile of a company. For these analyses we have collected a longitudinal data from Finnish industrial companies.

Data collection

The study reported here was carried out via management interviews. In total 25 executives from six supply chains – here called the elevator, paper machine, power plant, measurement instrument, mobile phone and paper product supply chains – were interviewed based on a structured 6-page questionnaire. Depending on the type of the chain, two to six companies were included per each supply chain. The executives we interviewed had in average over ten years experience within the company, and they were typically responsible for the logistics functions, supply chain management or the entire company.
In addition to the supply chain and industry-based categorizations, the studied companies are classified into three role-dependent groups that are focal companies, large channel partners and small channel partners for the analysis of structural changes. The focal companies, six in total, are typical brand owners in global markets, and they are among the leaders based either on market share or leadership in product innovation. The multi-national companies of those have sales over one billion euros, and the business units we interviewed have sales of at least 200 million euros. The suppliers, customers, and channel partners of the focal companies form the two other groups – large and small channel partners – based on sales volume and the scope of operations. Nine large channel partners operate in multiple locations, typically globally, and their sales exceed 200 million euros. Ten small channel partners are local and sales figures are less than 100 million euros.

The personal interviews that took from 1.5 to 5 hours per company to complete included several types of questions. Characteristics of strategy, organization, supply chain structure and practices within the supply chains were specified in classification questions (7-point scale) and in percentage-scale questions (0-100 per cent scale). For the classification questions, the managers defined the position of their company in the early 1990s and today, and based on current strategic views they also anticipated the position of their company at the beginning of the 2010s. Complementary information was collected via some open-ended questions. All in all, the collected empirical data enables rather detailed and comprehensive analyses. For example, structural changes that we illustrate based on the normative frameworks can be assessed and elaborated based on the classification questions.
Differentiation of manufacturing capabilities

Structural changes in manufacturing capabilities are analyzed based on the product-process matrix introduced by Hayes and Wheelwright (1979). First, we introduce the framework and illustrate hypotheses of general development patterns in differentiation and networking. Second, an overall analysis of the individual cases studied is summarized. Third, role- and chain-specific analyses potentially revealing more detailed information about the transformation of manufacturing capabilities are discussed.

The need to compare and evaluate production capabilities arises from the proliferating opportunities to allocate a desired product mix into different facilities and locations worldwide. A practical way to visualize the pursuit of economies of scale and scope of a company or a plant in manufacturing is the product-process matrix (Figure 1). According to the framework production facilities can be characterized by the pattern of material flow, layout of machine centers and worker assignments, as well as the degree of automation and methods of production planning and scheduling. The classification of process structure ranges from a flexible job shop to a disconnected batch line and a worker- or machine-paced connected line and further to a continuous automated flow. The mix of products and components ranges from one-of-a kind, customized products to low volumes of many differentiated products, then to high volumes of few standardized products and all the way to commodity products with high production volumes. When positioned into the product-process matrix, any efficient facility should be located close to the diagonal. Under the main diagonal there are out-of-pocket costs caused by capital intensive, automated machines and product changeovers, whereas above the diagonal opportunity costs incur because of prohibitively high variable costs and lost sales opportunities.
Figure 1  Manufacturing capabilities transform typically from a product factory system with general suppliers to sourcing from large-scale component suppliers (1) and to focusing on on-site installation and service (2) as illustrated in the product-process matrix. Emerging contract manufacturers typically act as coordinators of the portfolio of manufacturing capabilities (3).

Based on the empirical data, the changes in the capabilities of manufacturing units have been quite negligible over the last decade. In volatile business environment, the companies seem to reach more robustly towards the so-called economies of integration, where varied volumes of products are produced with automated production lines (e.g. FMS). In more stable businesses companies aim to standardize products and further automate production processes, i.e. move to the lower right corner of the framework. One of the generic development patterns of integrated product factories that have been using general suppliers is two-way divergence (Figure 1). Plants and operations change both towards more automated lines and sourcing of standard components from high-volume manufacturers and to increasing use of flexible installation and service often provided by smaller firms. It is the general suppliers that in search of economies of scale may start module-based production and overtake assembly operations linked to installation.
As an outcome, product factories can become hollow in terms of manufacturing operations due to the divestment of production and assembly resources and service offerings of contract manufacturers.

Major trends among the companies studied are illustrated in Figure 2. The companies that operate in power and machinery industries perceive economies of scale important, and thus they try to change both production facilities and product mix so that they could move from discrete manufacturing towards bulk producers. This is driven not only by the intensifying cost competition but also by the standardization of product designs, for example in engines. In equipment and electronics industries the companies look for economies of integration, while process industry players maintain their positions.

Figure 2   Changes in manufacturing capabilities within Equipment & Electronics, Power & Machinery and Process industries. The arrows indicate the direction of the development over time (early 1990s – 2002 – early 2010s).
The portfolios of manufacturing capabilities as well as the changes taken place over time are
different among the supply chains studied. The supply chains of paper products, paper machines
and measurement instruments have had and expect to have rather stable positions in the product-
process matrix. Significant switching of roles has taken place and is expected to continue in the
chains that produce and delivery power plants, elevators and mobile phones. For example, in the
case of power plants, the brands owners responsible for the assembly of engines and plants make
investments in order to move their operations toward lower right corner on the diagonal, i.e.
transform design and construction capabilities to mass manufacturing capabilities. This
development pattern is, in fact, in line with the expected evolution of facilities and product mixes
over the life cycle of products and production technologies described by Hayes and Wheelwright

The profiles of the three supply chain roles (focal companies, large channel partners and small
channel partners) that we identified are somewhat heterogeneous. The focal companies appear to
have different profiles as a result of different industries and markets as well as the extent of
outsourcing. The large channel partners can be identified either as installation and service
companies or as component suppliers, while the small channel partners locate mainly close to the
upper left corner of design and discrete manufacturing capabilities.

**Differentiation of service capabilities**

The development of cooperation and organizational relationships – the actual forms of
networking – can be analyzed in the model of service channels (Apte & Vepsäläinen, 1993;
Tinnilä & Vepsäläinen, 1995), which is a normative framework for identifying efficient service
strategies (Figure 3). Observed changes are discussed in the same order as in the case of production capabilities: the description of the framework, hypotheses on the changes, illustrative examples of development patterns, and finally chain- and role-specific profiles.

When analyzing a particular service process, we distinguish the delivery channel of that service consisting of organizations and systems. Four types of channel organizations are: principal or customer or owner (the service is procured within the organization, or "hierarchy" that needs it); agent or alliance, including experts, consultants, and representatives as parties cooperating in providing the service; service personnel such as sales office or manufacturer's service organization; and market network, or "market" with customers relying on self-service. The type of customer need to be satisfied by the services can be described in terms of frequency and timeliness of transactions, uncertainty and information complexity involved, and types of resources used. On the scale from complex to simple there are contingent relationships, which involve discretion over several options, at the complex end. At the other end, there are standardized mass transactions defined with absolute clauses on actions. Customized delivery and standard contracts with less flexibility and uncertainty are positioned in between. In this framework, efficiency refers to the ability to deliver the desired service at the lowest total cost including both production and transaction costs of service provider and customer. Similarly to the product-process matrix, services should be located close to the main diagonal because of the cost trade-off.

Since the early 1990s the generic strategy of the companies has shifted from the strong production focus to the recognition of marketing, which is mixed with the increasing customer
service aspect. In ten years many of the companies expect to apply clearly more customer-focused strategies. Generally there are two main trends in service capabilities as shown in Figure 3. Manufacturing industries appear to follow information-intensive services such as banking and insurance by transforming generic customer services into self services typically offered via the internet and into advisory services using partnerships with own professionals and outside experts. The trend towards partnerships is stronger but the call for scale economies to accommodate the growth in global markets is expected to force the participation in more powerful transactional services such as order service, e-commerce and exchanges.

Figure 3 Services change typically from internal administrative and production routines first into large scope general services (1) as illustrated in the service-channel matrix. The next stage is the divergence of services as indicated by emerging expert services (2) and self services (3).

Figure 4 illustrates the changes in service strategies among the companies according to a somewhat different grouping than with productive capabilities. The machinery industry that has traditionally offered so called general services understand now that to survive in global
competition some of their business must become standard and transaction-based, while some of the customers may be worth of customized services. The companies in equipment and process industries have not changed their strategies significantly, while the suppliers and contract manufacturers clearly reach towards customized services in the hope of closer partners.

Figure 4  Changes in service capabilities in the equipment & process industries, machinery industry as well as among the suppliers & contract manufacturers (CM) over time (early 1990s – 2002 – early 2010s).

Re-profiling of service strategies has taken place in the supply chains of elevators and mobile phones, while the profiles of paper product and paper machine chains are rather unchanged. Minor adjustments can be observed in the cases of power plants and measurement instruments. For example, all players of the measurement instrument chain – contract manufacturers, brand owner and system integrator – aim to move from routine and normal towards customized services and partnership relations. The three supply chain roles do not explain the positions of the companies in the service-channel matrix. However, especially the channel partners –
regardless of the company size – seek to establish closer relationships and even partnerships with their customers.

**Differentiation of technology integration**

A major concern in supply networks, especially for component and system suppliers, is the integration of new inventions into products and finding the right target market for the products. We apply the technology-market portfolio (Jahnikainen and Vepsäläinen, 1992; Mäkelin and Vepsäläinen, 1995; Jahnikainen and Vepsäläinen, 1998) to describe the life cycles of product technologies (Figure 5). The dimensions of the framework are technology integration that describes how innovations are combined into the product offerings (component, module, system) and type of target market (customers, segments, global markets) that indicates the expected market potential. Usually a product line relying on proprietary technology starts the life cycle from the lower left-hand corner, i.e. integrates new technology in a component into a customer-specific application. Later modular designs are motivated by increasing demand, and some successful products reach global markets. Three generic strategies over the life cycle can be specified in the portfolio as special application, customized/flexible product and standard system.

When looking at the cases of the supply chains, the core products have started as special applications for rather specific customers. Most of the companies see their role increasingly as integrators, often even before they have reached stable modular product design. The segmentation of the market is well underway, and more comprehensive and integrated product lines and modules are needed. This also means that the originally small national markets have expanded to attract the interest of larger companies in related global industries. The emphasis in
the evolving markets is shifting away from the role of innovator to the positioning as module supplier, component manufacturer or market specialist. There are very different development patterns indicating that the roles and responsibilities of the companies are differentiating through specialization.

Figure 5 The evolution of supply chains positioned in the market-technology portfolio. Starting with special applications, larger segments are expected to be reached by modular designs (1), and larger systems are offered on the basis of proprietary technology (2). The use of component suppliers for parts delivery becomes viable with standardized designs (3). The expected stage after standard components and customized products is standard systems.

Generally, industrial roles of the companies have shifted from narrow and specialized towards broader participation. In the early 2010s, many of the interviewees expect to have a more integrative role in the supply chain, especially in electronics and machinery industries as well as in contract manufacturing (Figure 6). While in electronics and contract manufacturing the objective is more customer-specific systems, typical suppliers and players of the machinery industry expect to see more market-based segmentation.
The life cycles of new technologies and product lines offered to different customer segments offer some interesting insights. Our analysis based on the technology-market portfolio indicates more obvious differences among the chains than in the production and service capability analyses. The supply chains of power plant and paper machine have similar profiles: most of the contract manufacturers view themselves as special application providers that may offer modules in the future, the brand owners offer either flexible/customized products or integrated systems, and global component suppliers aim to provide standard systems instead of only parts. The operations of paper and mobile phone supply chains are quite different from the machinery industry: the profiles are closer to customized product and component supplies. The players of the elevator supply chain locate further up in between system integrators and standard system suppliers. The supply chain role, or perhaps company size, influences the integration of
technology. The focal companies and large channel partners make investments in order to provide integrated or standard systems. Most of the small channel partners settle with their established roles, while some see themselves transforming from component suppliers to system integrators.

**Differentiation of resource base and organization principles**

Rapid international expansion coupled with the life cycle of organizations from the pioneering leadership to an increasingly complex structure of distributed units and functions also leads to different network-type structures. This adaptation is illustrated with the organization-resource portfolio (Jahnukainen and Vepsäläinen, 1992; Mäkelin and Vepsäläinen, 1995; Jahnukainen and Vepsäläinen, 1998), which has two dimensions: the resource base and the organizing principle of the company (Figure 7). The resource base considers the increasing geographical scope of sourcing, production and marketing activities from local to multinational to global, while the other dimension indicates the organizing principles starting with functional hierarchy and developing via multidivisional and matrix forms to fully process-based structures.

Typically fast international growth moves the organization from simple functional hierarchy, to product or customer divisions, and sometimes all the way to a global network organization. The case companies indicated a strong move from the simple hierarchy structures based on product and market divisions towards network organizations. Furthermore, it is anticipated that within the next decade many companies will become a part of process-oriented supply chains, and generally the expected changes are at least as significant as the realized ones, if not even larger.
Even the small companies that offer local installation and customer services may belong to a global network of companies and operate according to process management principles.

Figure 7   An illustration of the typical changes of organizational structures along with geographical expansion based on the organization-resource portfolio. It is hypnotized that after the initial growth and adoption of a divisional structure, the differences among functions will dominate the decisions that concern centralization and outsourcing.

The companies operating in the machinery industry emphasize the change from being locally responsive to balancing of multi-national operations that has happened over the last ten years. Further attempts are directed towards the global coordination of companies and supply chains alike within the companies that already now have globally recognized brands. Also the suppliers expect to build process-based organizations but with local resource base.
Figure 8  Main changes in organizational resources in the machinery industry as well as among the suppliers and the companies that have global brands (time periods indicated are the early 1990s, 2002 and the early 2010s).

Similar to the technology-market portfolio, the organization-resource portfolio reveals high expectations especially in the supply chains of measurement instruments and power plants, where all players from brand owners to small contract manufacturers anticipate the shift from local to multidivisional organization continue towards network organizations. The manufacturing organizations of the paper supply chain are still rather local, although both its supplier and customer base are more and more global and networked. The focal companies are most advanced in terms of organizational resources, even though some of the large channel partners claim to have global process-based organizations as well. The small channel partners anticipate restructuring within their organizations but not in the resource base, and instead of specialization they look forward to reaching the growth stage.
Conclusions

In this paper we have characterized supply chain evolution on the basis of changing roles and responsibilities of the companies because specialization and differentiation in terms of outsourcing of production, logistics, product development and other core functions impacts the operational logic of companies. For example, some of the product companies have outsourced production and R&D and now focus on the management of customer relations and coordination of the supply-demand network. Thus, besides improved IT and the extended scope of material management, differentiation of functions and reallocation of activities are essential for integration of supply chains and networking.

In future successful supply networks have to rely on widely different and diverged capabilities. In production, typical product factories are being replaced with high-volume component suppliers and flexible assembly and installation operations. The service relationships are being polarized into expert services and internet-based self services, complementing the previous general services. In addition, firms need to choose their strategic positioning in terms of technology and markets and either serve as integrators or focus on developing standard components. Differentiation can be done also in organizational resources that can be either global or local. When activities are reallocated within supply chains, integration with suppliers and customers can follow the advices presented in literature.
Future research

In future studies, quantitative information concerning the operations and structures of supply chains should be collected in addition to the type of data collected here via management interviews. Larger surveys could provide statistical evidence for the phenomena under study if more detailed hypotheses are formulated on the basis of the networking ideas introduced here. For instance, it would be worthwhile to analyze the recognized patterns in structural changes in more detail, and perhaps find out recurring cycles instead of linear changes. More extensive data would also extent the types of research problems. For example, the need for coordination within supply chains and networks could be further explored by analyzing the types of coordination mechanisms such as routines, data sharing, and incentives in use.

Based on the collected empirical data it would be interesting to analyze the correlation between the use of integrative methods and structural changes in supply chains and networks. That type of analysis would indicate what forms of integration and what types of information systems different types of companies should implement. Another topic of further analysis is the correlation between the changes that are visualized in the product-process matrix and the service-channel matrix. For example, does the transformation of manufacturing capabilities translate into some specific changes in the portfolio of services?
References


