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ENABLING VALUE CREATION IN SUPPLY NETWORKS WITH INFORMATION INFRASTRUCTURES

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Abstract

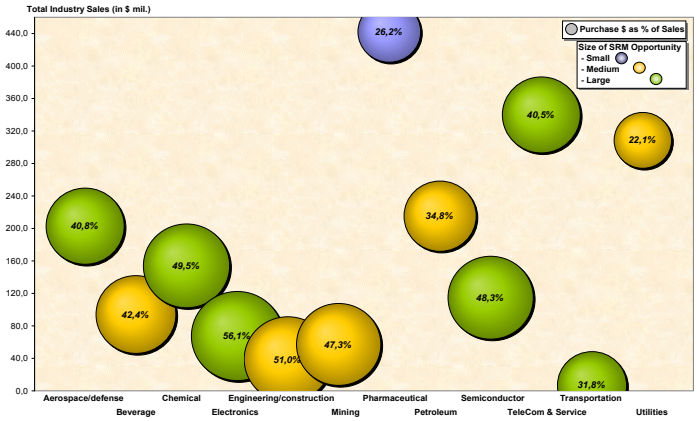
As the applications of information and communication technology (ICT) are converging and become more prevalent, intraorganizational systems like Enterprise Resource Planning (ERP) are increasingly permeating industrial networks of companies by impacting an increased number of cross-company processes. This has lead previous vertically integrated, hierarchically organized firms towards more flexible, networked forms of both organization and industrial structure, thus blurring the boundaries of firms and industries alike (Brynjolsson & Mendelson, 1993). This network effect of ICT paired with the increased demands for cost optimization and manufacturing agility encourages companies to extend their supply networks (Zheng, 1998; Harland, 1996) with collaborative, interorganizational infrastructures empowering buyer-seller relationships (Nøkkentved & Hedaa, 2000, 2001).

This large scale transformation felt by many industries is changing our perspective of ICT from deliberate technology to emergent, layered information infrastructures (Hanseth & Braa, 1998). In the purchasing-side of the firm, such information infrastructures are realized by Internet-enabled applications also called eProcurement or recently Supplier Relationship Management (Hartmann etal.,2002). The latter provides a relational enablement of the upstream activities of a firm, by encompassing all sorts of strategic and operational, planned and/or unplanned purchasing and sourcing activities.

The objective of this paper is an attempt to cross-fertilize the industrial networks approach with the latest developments in Informatics. It presents the results of a study leading to a model of socio-technical factors or SRM initiatives enabling the successful implementation interorganizational procurement & sourcing information infrastructures. This framework has been the result of a qualitative study among SRM project managers from IBM in 2001/2.

Introduction

The current global environment, marked by increased demand, decreased customer loyalty, shorter product life-cycles, and mass product customization, forces companies to optimize costs and constantly improve the quality and variety of products and services. In order to be able to meet these challenges, companies have progressed from internal to external optimization[1] by cooperating with organizations whose complementary capabilities can give the whole business network[2] a competitive edge[3]. Industrial competition is therefore advancing from being between individual companies, to being between networks or clusters[4] of partnering corporations (Christopher, 1992; Harland, 1996). As depicted, these trends are especially apparent in the upstream, supplier relationships where enterprises are acquiring increasing amounts on goods and services, with such expenditures often exceeding 45 percent of



revenue (Gadde & Håkansson, 2001). Such growth has been driven by increased focus towards "core competences" leading to the purchase of "components" rather than raw materials and the increased usage of contract manufacturing. Naturally, when these expenditures grow, suppliers' ability to directly affect corporate performance increase. To improve or sustain financial performance, many companies are currently looking at better ways to manage the supply base and optimize all transactions and total costs. In an economic environment with slow top-line growth, companies can pursue an immediate opportunity to boost profits through the cost management of supply-side expenditures. However, suppliers represent more than just a cost center. They can also be a source of expertise, capable of delivering more-innovative products, faster and cheaper (Gadde & Håkansson, 2001).

From Supply Networks to Information Infrastructures

Hence, contemporary industrial organizations are progressing from the notion of the extended supply chain into *electronically-connected supply networks*[5], which facilitate information sharing, transaction execution and collaboration among interorganizational relationships (Nøkkentved & Hedaa, 2000, 2001). This was made possible with the advent of integrated applications utilizing the Internet[6], enabling companies to develop information infrastructures to realize such supply networks[7]. In the upstream value chain, enabling information infrastructures use information and communication technologies as e-Procurement-, or more recently Supply Relationship Management (or SRM[8]). While the former focuses on enablement of indirect purchasing focused on the buying side, SRM takes on a relationship perspective and attempts to encompass all sorts of planned/structured and/or unplanned, strategic and operational purchasing and sourcing activities within the company (Corsten & Hofstetter, 2001).. As an interorganizational system (IOS), SRM information infrastructures are typically deployed to enable supplier networks involving internal functional and external supplier relationships(studied by Easton & Araujo, 2003; Müller et.al., 2003; Gadde & Håkansson, 2000, 2001), and meso-level market structures (like eMarkets delivering application, integration and content services – see Nøkkentved & Hedaa, 2001).

This paper will explore the definition and role of information infrastructures by using theories emerging from studies of large information infrastructures (Ciborra, 2001; Hanseth, 1996) and industrial networks (Ford et.al., 1997, 1998, 2002). To study the dynamics of successful enablement via information infrastructures, an exploratory study has been carried out among large procurement and sourcing implementations carried out by IBM in the last 5 years.

In order to reap the benefits of B2B, Easton and Araujo's (2003) recommend to clarify the various contextual contingencies rather than apply generic solutions. Similarly, we propose that successful enablement is conditioned by a larger number of contingencies or "performance enablers"[9] embedded in the current infrastructure. Understanding these Critical Success Factors is imperative in order to distinguish the enabling information technologies and their business prerequisites impacting on the overall infrastructure of the organization[10].

We will commence with two explanatory sections – one on information infrastructures and one in a subset encompassing supplier relationship management applications, processes and value drivers. Then we will present the objectives and methodology pursued in our research, followed by a presentation of the results. Finally we will discuss the current IMP transformation terminology with the descriptive apparatus from the Actor-Network Theory (Mattsson, 2003).

IT – from islands of automation to information infrastructures

The importance of information technology (IT) for the development of society has been rallied across the last decades as perhaps a crucial competitive factor as it simultaneously enables and amplifies the currently dominating trends for restructuring of organizations (Orlikowski 1991, Walsham, 2001). Many industries in this last decade, have experienced major transformations, enabled by more ubiquitous and integrated information systems helping companies rationalize their production and distribution infrastructures (Byrd & Turner, 2001). Recent research (Ghoshal and Gratton, 2002; Targowski, 2003), stress that old paradigms for

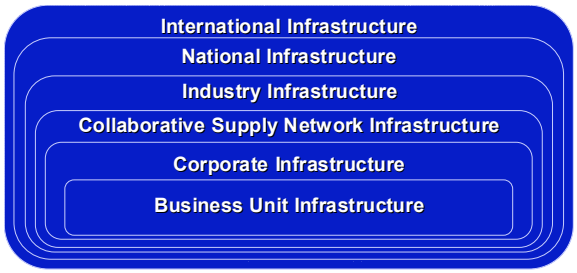
doing business will not survive in the new age of information infrastructures that extend enterprise systems and realize horizontal integration across business networks.

Defining Information Infrastructures

What we are currently witnessing is the expansion of the previously hermetic intraorganizational IT infrastructures enabled by large, multidivisional and global ERP systems, into the interorganizational domain, where companies have much less control (Johnston, 2002; De Burca & Fynes, 2001). Such interorganizational systems (IOS), have previously been undertaking data and document exchanges between companies (e.g. EDI).

Modern day IOSs (also called ERP II), are developing beyond pure integration of information into the realm of business process integration encompassing a multitude of partnering companies. These large intra- and interorganizational information systems have start displaying properties of infrastructure[11], enabling and aligning many value-adding processes in an organization (Nøkkentved & Hedaa, 2000, 2001). In essence, modern information technology challenges a company and its network by ordering resources, processes, people, and relationships, linking everyone electronically, and providing the platform for business transformation efforts – it is increasingly embedding the industrial network.

This major restructuring of the modern enterprise has often been visualized as the firm resting within a network supported like a superstructure by series of layers, each representing an infrastructural element for the conduct of business and each being supported by an industry in its own right (Renkema, 1998, Barua et.al., 2001).



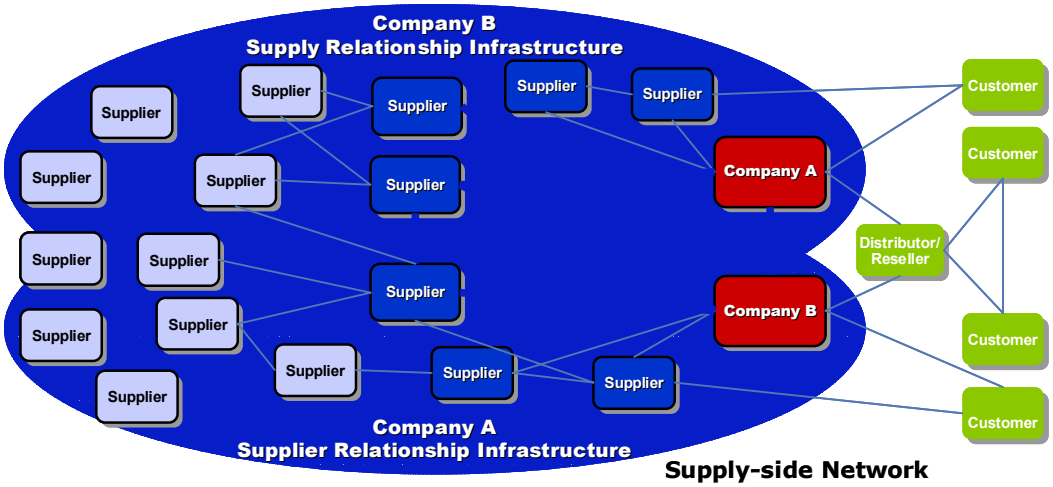
Many companies are currently attempting to manage their information infrastructures in order to deliver effective information technology (IT) enablement by such initiatives as: aligning strategy with IT architecture and key business processes (Hanseth et al, 2001; Henderson et al., 1996); universal use and access to IT resources; standardization; interoperability of systems and applications through protocols and gateways; flexibility, resilience and security (Hanseth, 1996).

The term "information infrastructure" (**II**) has been increasingly used to refer to integrated solutions based on the now ongoing fusion of information and (tele)communication technologies. An Information Infrastructure constitutes a social construction containing people, resources and procedures enabled by IT, yet extending within and beyond the boundaries of the focal firm (Ciborra, 2001; Kling & Lamb, 1999), thus enabling processes and people across a supply network (Harland, 1996; Zheng et.al, 2001). Such infrastructures encompass local industry-driven demand for variety with centralized planning and control over IT resources and business processes (Weill & Broadbent, 1998). While IIs bear connotations of the Internet-enabled information highway, companies have started using IT enabled technologies to create their own infrastructures covering often their own business network and beyond (Hanseth, 1996). Although the Internet provides one of the vehicles of communication, it doesn't contain any ability to execute processes. A corporate II utilizes information systems and communications networks to enable business activities across a supply network.

Information Infrastructures in Industrial Networks

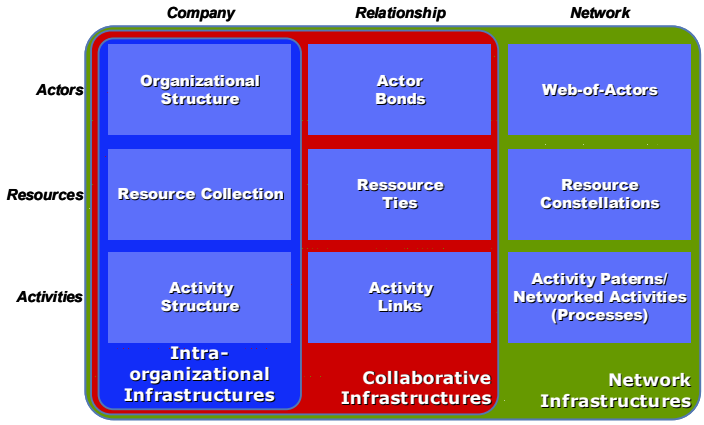
Information infrastructures of competing firms may intersect to a degree where a co-opetitive environment is established, as recently witnessed by the materialization of quasi-organizational structures like trade exchanges or eMarkets, enforcing collaboration & standards (Nøkkentved & Hedaa, 2001). Hence, information infrastructures may "embed" and drive formal and informal sections of activity structures (aka processes) within and beyond the company. They may "influence" actors behavior, roles and relationships, and enhance or constrain the relationships that companies may be able to pursue networks (Ford et.al., 2002).

With this perspective in mind, information infrastructures are present in most of the elements of the IMP Group's Interaction and Actor–Resource-Activity (ARA) constructs (Ford, et.al. 1998); they are present in the level of the firm, the relationship and the network. Beyond singular episodes, information infrastructures may transform the atmosphere of the focal firm's dyadic relationship as well as the environment permeating its business network.



Supply-side Network

Although ubiquitous, such infrastructures are not always directly aligned with the business network surrounding the focal firm – they may extend well beyond the horizon of the network.



In the writings of the IMP Group, IIs may be characterized as a *technological resource* enabling the form as a communicative unit (Gadde & Håkansson, 2002), affecting and being affected by relationships within the business network (Ford et al. 2003). However, recent evidence (Hanseth & Braa, 1996) suggests that this view of IIs as a technological component is still too unidimensional. Beyond the pure infrastructural properties attributed to such IT systems, it is becoming increasingly apparent that IIs are imposing their own logic on a company's strategy, culture and organization (Davenport, 1998). According to Hanseth (1996): "*a large information infrastructure is not just hard to change; it might also be a powerful actor influencing its own future life - its extension and size as well as its form*."

It would seem straightforward that a focal company ventures into developing such an information infrastructure aligned with its strategic demands in order to strengthen its position within its industrial network. Yet, as many studies indicated (Hanseth & Braa, 1996, 2001; De Burca & Fynes, 2001), deploying global information infrastructures leads into situations where strategic alignment does not fully explain the dynamics of implementation (Ciborra, 1997, 2001, 2002), and power struggles prevail over efficiency considerations (Hanseth et.al., 2001). Contrary to the implicit association of infrastructure as a static, solid foundation, IIs are in a constant flux of realignment, thus being *emergent* (Hanseth et al. 1996). At the limit, infrastructures seem to "drift" (Ciborra, 2001), or being created by planning as well as by "improvisation" (Orlikowski, 1996), often influenced by other larger infrastructures beyond the

control of the focal firm (like the Internet according to Barua, et.al. 2001). Hanseth lists some of the characteristics of information infrastructures (in Ciborra, 2001) as being:

- supporting or enabling[12].
- shared by a larger community (or collection of users and user groups)[13].
- open[14].
- more than "pure" technology, but rather *socio-technical networks*[15].
- connected and interrelated, constituting ecologies of networks[16].
- Layered (see also Renkema, 1998)[17].
- heterogeneous, in that the same logical function might be implemented in several different ways.
- an extension and improvement of the current “installed base”[18].

IIs are not only being the catalyst for purely inter-actor 'social' relations, instead, they enable 'socio-technical' relations, embedded in and performed by a whole range of different materials, human, technical, 'natural', textual (Latour, 1982). Introduction of IIs bring into the arena new “hidden”, yet influential actors (e.g. vendors and service providers) that may cross-fertilize best-practice processes and enabling applications, thus affecting industrial dynamics.

In summary, implementing IIs is a major transformation effort for any company, which may often be characterized as “coping” rather than “managing” or “aligning”, which mirrors what many studies in industrial networks have shown throughout the years.

Studying Infrastructures – Successful Deployment Generates Value

IIs may generate value for the focal firm and its partners when these transformation efforts lead to a successful implementation or deployment leading to measurable business benefits. Implementation success depends on a number of factors often ranging beyond the initial scope of such projects (Ciborra, 2001). During rollout, infrastructures become powerful agents of change (Johnston, 2002), forcing transformation beyond the focal company (Hanseth et.al., 2001; Hartmann et.al, 2002). Moreover, IIs are displaying a number of attributes and affect the dynamics of organizational transformation in a way that is beyond our previous perceptions or descriptions of the effects of technology in the IMP literature.

What is required to better understand the drivers of change in IIs, is a more detailed and fine-grained analysis of the mechanisms, some technical and some not, which are employed in shaping social action. We need to advance our perspective of IIs as static resources under the control of the focal firm or even the business network, towards IIs as influential “actant-networks”, mobilizing and transforming the activities, resources and actor behavior in relationships and networks, as a prerequisite of their successful deployment (see later discussion on theoretical implications). In contrast to “pure” ANT, we need to avoid anthropomorphizing technology as an actor, yet we need to consider its effects on conscious human actors interconnected within a network of relationships.

We need to move our perspective of the role of technology away from the technologically deterministic or social reductionistic (Hanseth, 1996), towards a balanced view of IIs as a necessary utility (Sawhney, 2001), providing shared, intra- and inter-organizational infrastructure for the functioning of the firm. Such a perspective needs to incorporate trends forming industrial networks of firms and the infrastructures supporting them. These are:

- *Intraorganizational optimization and homogeneity* (driven by development towards the single-instance, homogenous intraorganizational infrastructure services via ERP, while the planning & collaboration activities are handled by shared components – distributed models via component-based, need-based infrastructure)
- *Interorganizational adaptation and flexibility* (strategic issues are driving industries towards a Networked, Collaborative Business Model, while recent advances in Data Standards, Exchange and Portal Technology are enabling this shift).

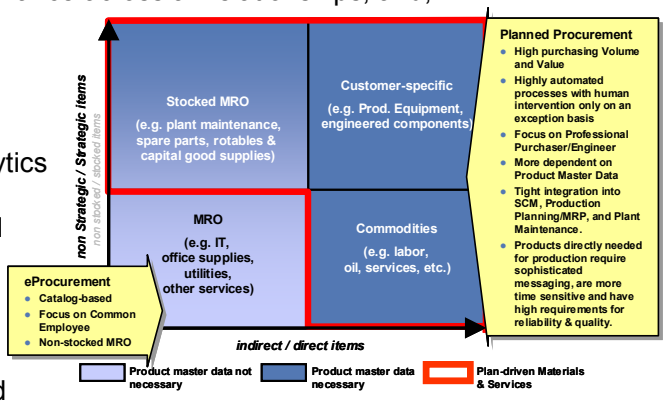
In summary, a more satisfactory account of the interwoven relationship between IIs and organizational transformations is lacking. More specifically, we need to learn more about how

this interplay works, not only that it exists. We need to understand how a focal firm's II shapes, enables and constrains organizational change. This implies that it is vital to be more concrete with respect to the specifics of the application of IIs – we can't study the whole field we should focus on an area. As mentioned this paper will focus on IIs enabling supply-side industrial networks – also labeled as supply relationship management (Roberts & Mackay, 1998).

Defining Supply Relationship Management

Supply Relationship Management (or SRM), is an umbrella term that includes a broad range of many-to-many processes that manage inbound goods and services in support of their transformation into outbound goods and services (Corsten & Hofstetter, 2001). As an emerging discipline, SRM seeks to bundle sourcing and procurement (of services and materials) with related areas as engineering, design, production, logistics, as well as the management and administration of suppliers, into a collaborative and integrated framework, enabled by technology in order to optimize enterprise profitability at acceptable risk on a sustained basis. SRM can be characterized as a broad, multidisciplined and proactive approach in managing supplier relationships and create a full life cycle view of supply decisions[19]. Its objective is to engage a larger part of the supply base, streamline the communication process leading to more informed, timely decisions and cost-effective execution. While the vision is not new (see Gadde & Håkansson, 2001), recent enablement of SRM practices with information infrastructures support companies in their efforts to:

- Effectively manage large part of their supply base;
- Extend visibility into current and potential supply base;
- Determine the right relationship strategies for each category and supplier;
- Implement processes that support the selected category and relationship strategies across the corporation;
- Enable procurement and sourcing processes and integrate interdependent processes;
- Continuously monitor & measure performance across all relationships, and,
- Empower people by transforming roles, responsibilities, skills and mindsets…

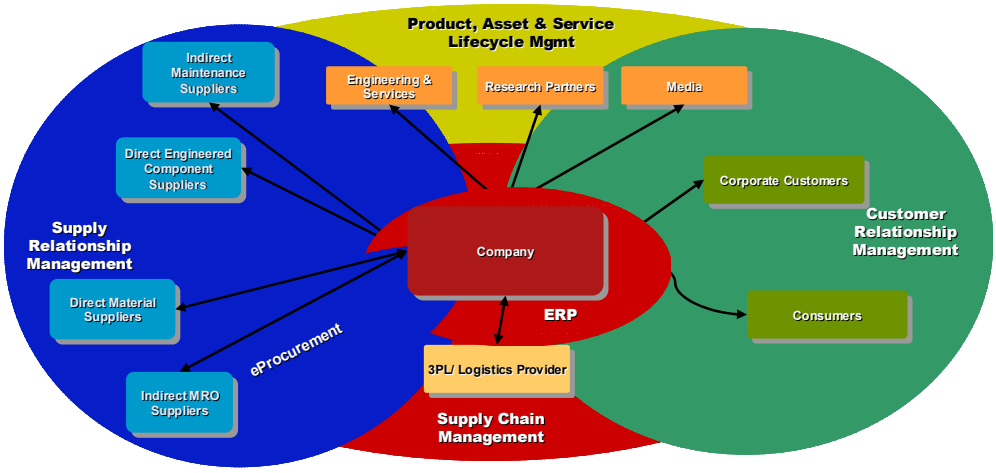


Hence, SRM extends corporate-wide procurement processes, with sourcing analytics (e.g. spend analysis) , sourcing execution, contract management, invoice payment and settlement, and - closing the feedback loop - supplier scorecarding and performance monitoring. From a procurement perspective, SRM extends the previous eProcurement practices biased toward improving purchase requisitioning, ordering, into Plan-driven (/Scheduled) procurement of stocked-products, also characterized as structured procurement (Subramaniam and Shaw, 2001). To summarize, SRM is linking traditional Supply Chain Management, Product Development and Asset Maintenance with Operational Procurement and Strategic Sourcing. It bundles all procurement and sourcing activities, establishing sourcing policies and contracts, and supporting all sorts of transactions from simple, unstructured to complex or structured (contract-/scheduling agreement-based or call-off). Hence, it enables from simple episodes, to real-time, collaborative relationships triggered by real-time exchanges between companies.

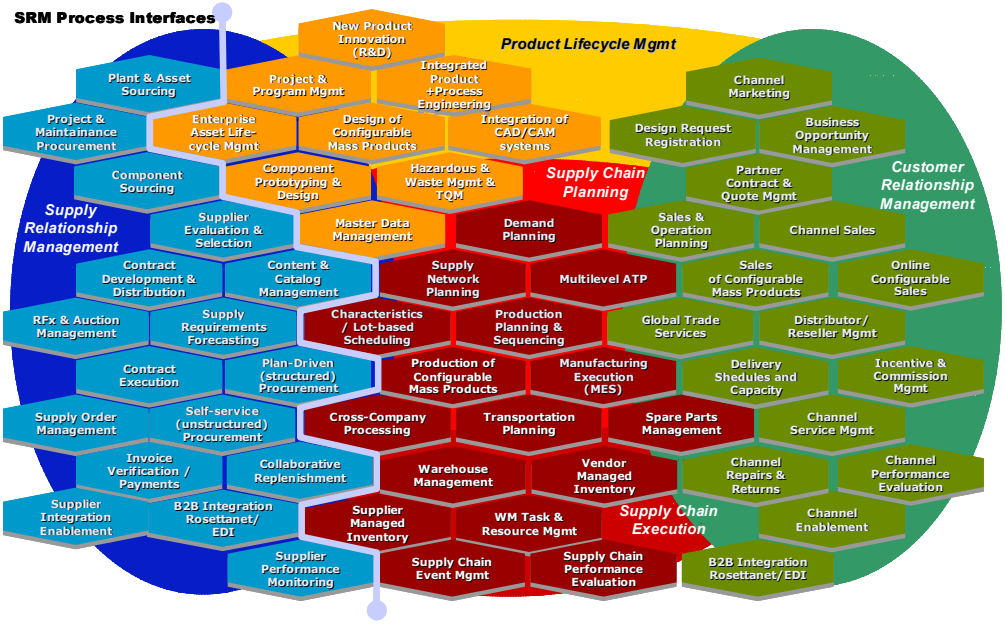
Position and Interdependencies of an SRM Information Infrastructure

The SRM domain is an extension of "traditional" supply chain management (SCM) and enriches the business practices associated with SCM. With the exception of the intraorganizational infrastructure realized via ERP (i.e. enterprise resource planning) systems, the remaining domains (like SRM), as depicted below) constitute the firm's interorganizational

information infrastructure in that it extends beyond the focal firm, incorporates its surrounding business network, and provides information sharing, transactional and collaborative process enablement (Nøkkentved, 2001).



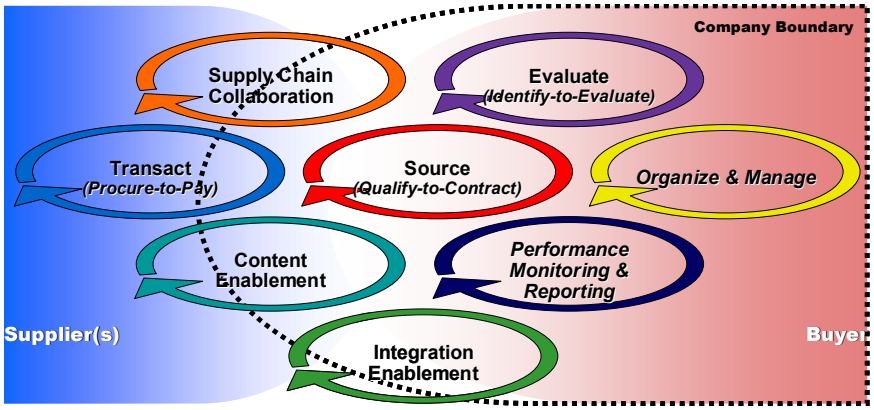
In coherence with Gadde & Snehotta's (2000) views, the idea of offering different levels of support for different supplier sizes and relationships is fundamental to the success of SRM. These infrastructures have to support all sorts of relationships, e.g. by providing a portal for simple transactions with small suppliers, or through end-to-end integration with larger, more strategic suppliers (e.g. sourcing of collaborative engineering & design).



Moreover, the domains represented above highlight another attribute of the various II domains – their close interdependency. As IIs increasingly enable and support process activities within the focal firm and across the business network, it is apparent that a multitude of activities are handed over in between the various domains. For example, SRM is supporting the area of Product Lifecycle Management (PLM) by providing sourcing and purchasing support in areas like Enterprise Asset Management, Maintenance and Project-based procurement. Similarly, the SRM process might start with the design phase in product life-cycle management (PLM) and extend to processes that typically fall under the supply chain planning (SCP) and supply chain execution (SCE) categories, such as manufacturing, fulfillment, and replenishment. In fully integrated mode, SRM would also have touch points into an organization's enterprise

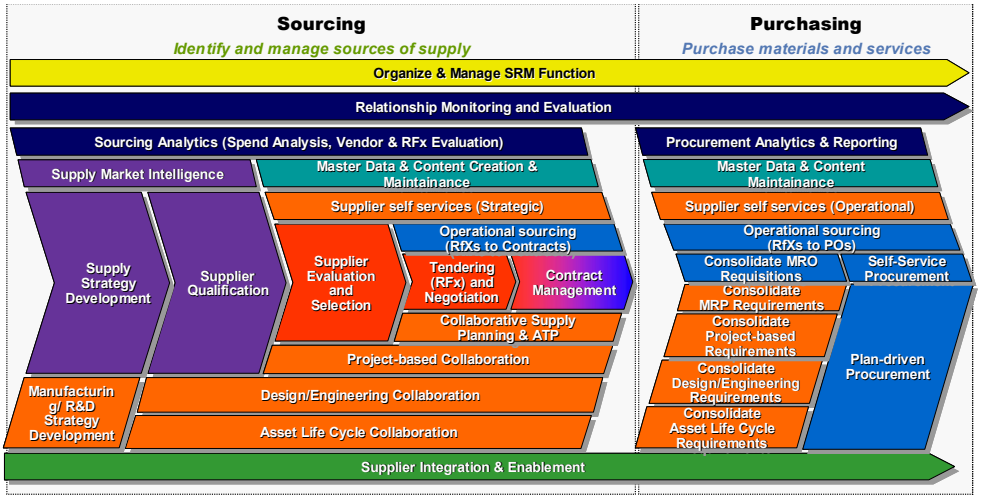
resource planning (ERP) applications, and from a demand perspective, even into customer management applications (e.g. supporting forward auctions of excess inventory, sourcing and procuring advertising and media, etc.).

To take advantage of this holistic view, all these processes must be first integrated internally and then externally. At a basic level, this is about giving suppliers a self-service view of the information they need to see - for example, order status, payment remittance information, demand forecasts, supplier scorecard information, and the like - to take costs out of managing the supply chain by speeding up processes and improving the accuracy of information. At a more sophisticated level, this is about creating real-time integration between buyers' and suppliers' processes. However, to understand how infrastructures may enable SRM processes we need to move from the meso- to the macro level.



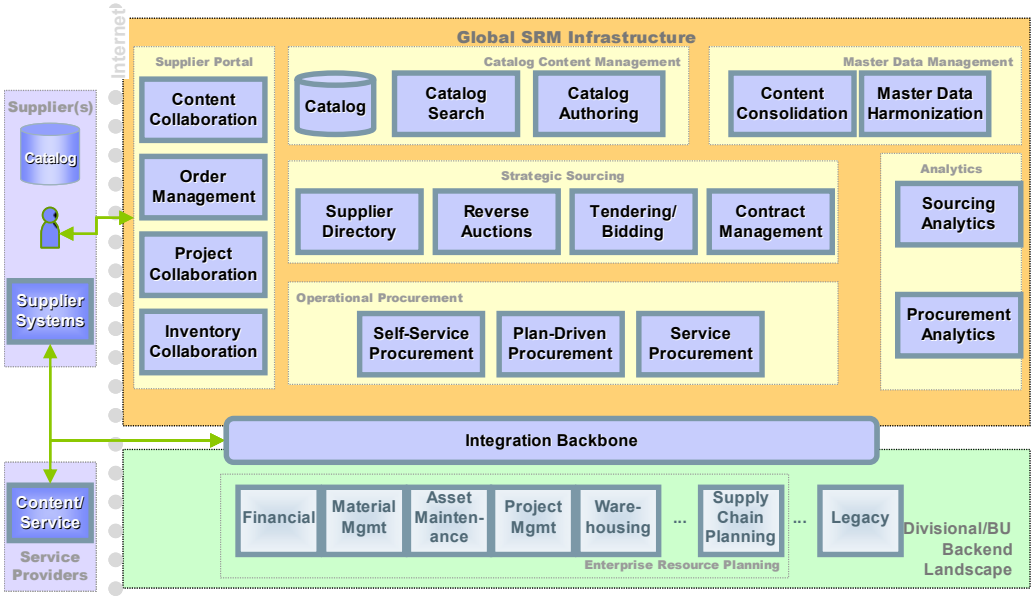
Overview of Best-Practice SRM Processes

From the vantage point of a number of studies conducted by the Center of Advanced Purchasing Studies (CAPS) and the Supply Chain Council's SCOR model (Nøkkentved, 2000) a number of best practice end-to-end SRM processes have been identified. As seen in the figure above, these interdependent process cycles are extending beyond the boundaries of the focal firm, thus in coherence with IMP's axioms, these processes are not always "controlled" or "managed", but are rather seen as "shared" and interdependent with the firm's suppliers. Thus, firms implementing infrastructures to support SRM processes need to take a more outward look and involve the key suppliers in the design and setting of such a collaborative supply network. Moving again towards the micro-level, these processes can then be disaggregated into a mosaic of potential process activities that enable transactions and relationships within and across the business network (see SRM Processes below and their definitions in Appendix 1).



Objectives of SRM Information infrastructures

Successful implementation of SRM practices will require information infrastructures that reflect buying processes and the complexion of relationships that an enterprise maintains with its trading partners (Hartmann et.al. 2002, Rosson, 2000). Building fine-grained relationship models requires moving well beyond the simple tier of suppliers as "preferred." As a result, enterprises should require that suppliers and associated agreements be accessible to multiple parties and applications within the enterprise. Moreover, complex services need to be enabled like exposure of contractual commitments, decrements against master contracts, penalties and incentives for buyer and supplier performance, multichannel interaction management, and supplier development and enablement. We have tried to depict below the types of functionality/services that current infrastructures may enable.



Although customer data models have been built and maintained for many years, the business world at large is only at the beginning in terms addressing the need to model supplier relationships (Barua et al. 2002). In summary, an SRM II need to fulfill following objectives:

- *Automation* - at a most basic level, support the automation of transactional SRM process between an organization and its supply-side trading partners. For example, purchase order routing, invoice presentment, payment, and so on.
- *Optimization* - support the optimization of processes and decision-making through enhanced dynamic, real-time analytical tools (e.g. supported via data warehouses and online analytical processing tools,
- *Visibility* - provide trading partners with visibility of information and process flows in and between organizations. It is also necessary to differentiate how suppliers may view such information; some information would be aggregated a single view for self-service users, or made available for application-to-application integration.
- *Integration* - provide a single view of the supply chain that spans multiple departments, by integrating processes, transactions and software applications for internal users and specified external trading partners.
- *Collaboration* - provide mechanisms for collaboration through the sharing of information, both internally and externally, and provide bi-directional, real-time, yet event/exception-based communication capabilities (Nøkkentved, 2000).
- *Flexibility* – provide a flexible platform thus minimizing relationship specific II adaptations and investments to be able to change suppliers with low switching costs.

- *Adaptability* – practices reflected in business processes, business rules which constitute the organizational routines (Nelson & Winther, 1982), are often undergoing major changes. Moreover, there is a increasing rate of technological enablement, which implies that IIs need to continuously improve or enhance their embedded processes with evolving SRM practices and technologies (e.g. mobile services),

Current trends in the IS community testifies that applications are increasingly realizing such goals via open standards (for information and process exchange), open source, and integration, in other words, the end to siloed enterprise applications, and the advent of applications that can talk to each other, ultimately in real-time. Many software vendors proclaim full support of core source-to-settle processes, yet we believe that the technology will continue to mature and add support for things that we might not have even considered.

SRM Information Infrastructures – Inhibitors

Despite the compelling nature of the benefits of B2B infrastructures (Hartmann, et.al, 2002), enterprises hoping for similar results face an uphill battle (Easton & Araujo, 2003). Because of the variety of goods and services purchased by the enterprise, the complexity of consumption, and hence complexity of cost structure, changes wrought in pursuit of business improvements will necessitate the transformation of the purchasing organization itself. Fundamentally enterprises will require different skill types to attain cost advantages through SRM. The movement to open sourcing as well as the need for more-efficient operations will necessitate re-engineering of purchasing processes. Re-engineering efforts — and ongoing purchasing operations — will require expertise beyond the purchasing department and involve other departments, business units and even trading partners. This suggests that reorganization will also be a theme of increasing recurrence. Yet, there is also a “mindset” barrier to such efforts. Most enterprises do not view suppliers as a source of competitive advantage, and enterprises are certainly not in the habit of looking to their internal procurement managers as the key to supporting internal customers through SRM. Thus, there are ingrained buying cultures and inappropriate incentive structures, that inhibit implementation of information infrastructures enabling the supply network. Some examples of inhibitors that often derail SRM efforts are often related to lack of:

- appropriate global sourcing practices - Supplier selection is still often regional and based on finding the lowest cost,
- strong, multi-criteria competitive bidding practices that take a TCO perspective.
- cooperation among business units and across functional areas.
- enterprise cross-functional cooperation during the design/engineering and sourcing cycles
- trust in or procedures to ensure suppliers’ capabilities and commitments.
- clarity on the roles of strategic sourcing and operational procurement (In some categories (e.g., capital goods, spot-buys and certain types of services) sourcing and procurement are one and the same.).
- appropriate incentive systems - managers who are compensated based on behaviors that would preclude "trusting" their suppliers to support their enterprise business goals.
- flexibility in supplier contracts and relationships that seem "cast in concrete"
- relevant information architectures that obscure visibility into enterprise spending and SRM best practices
- a set of metrics to measure non-price-related supplier qualifications[20].

In the end, the potential for value generated by such a information infrastructure is that it interconnects the symbiotic business network surrounding the firm. To summarize, such efforts are often hampered by current practices, relationships and business processes established within the firm and between its partners.

Research Objectives, Method & Study – Identifying Enablers of IIs

This paper is part of a wider research effort studying how information infrastructures enable supplier networks with constructs from the industrial network research[21] and Supply Network Strategies[22], of the Industrial Marketing and Purchasing (IMP) group (see Ford, 1997). Some of the most noteworthy constructs we use are the *interaction model*, the *ARA* (Activity links, Resource ties and Actor bonds) model[23], and the *event-based business network*[24]. From an IS/informatics perspective the current research project builds on recent research in information infrastructures (Hanseth, 1996), and theorize on the process of "dynamic transformation" of such via the Actor Network Theory (Callon 1993, Mattson, 2003). It is a preliminary effort to better understand the factors of successful transformation companies undergo in order to utilize an optimized, though adaptive information infrastructure.

The major scientific challenge of this project is centered in unearthing these factors in an exploratory and descriptive manner. Our first proposition is based on *contingency theory* (Lawrence and Lorsch 1967), in that it hypothesizes that there exist a limited number of denominators, or industry independent contingencies, that function as moderators in the process of implementing such IIs in supply networks.

While successful enablement lead to performance improvements (Subramaniam and Shaw, 2001), our focus is on the contingencies (enablers or constraints) of the successful deployment of information infrastructures supporting the SRM best practices. This effort is supplementary to the recent IMP research conducted by Hartmann et.al. (2002). Even if the company does deploy best-practice processes, it is expected that development of such infrastructures lead to major change management and transformation efforts. These as well as other factors contributing to the successful implementation like project management, technical skills and continuous application maintenance and operations skills, are assumed as given in that most organizations either develop these skill sets or insource them from external partners[25]. Hence, from a business perspective we will construct a framework that may assist companies in exposing current and lacking procurement and sourcing competencies prior to such a effort.

Methodology – Action Research and Grounded Theory

Research into highly complex socio-technical systems like (inter-)organizational networks is preferably based on an eclectic approach that tries to include many perspectives and paradigms (Brown et al. 1999). The chosen epistemological approach is based on the research traditions of interpretative research (Orlikowski 1992) and action research (Brown et al. 1999). The first perspective helps to encompass the interpretive flexibility of information systems (Orlikowski 1992) which focuses on the mutual influence of information and communication systems, organizations and human actors. By taking an action research perspective the role of the researcher is not only to observe but also to influence the system once context, problem area and status quo of current projects and solutions are sufficiently understood. Although research based upon a profound literature study has its merits, we believe that a combination of quantitative and qualitative research for this venture is most suitable as it is still in an exploratory stage. In fact, such a methodology enables the formulation of research propositions in order to trace out an appropriate questionnaire for a survey on a much larger scale and for a more in-depth analysis at a later stage.

Iterative approach – Qualitative Survey and Interviews

The research method we pursued combined findings from a*ction-research* – based on cases of pilot projects that the researcher has been involved in, with e*mpirical research.* Based on a consolidation of experiences from numerous client assignments a questionnaire was developed. Subsequently a team was assembled, which conducted a survey (assisted by the author) on CSFs of eProcurement projects conducted until end of 2002 (by IBM BCS, previously known as PwCC). A clear objective of these efforts were to enhance our understanding of value creation via the alignment of organizational (process, structure,

strategy) and technological factors. The results of this survey were published in 2002 in internal publications, which relayed current practices and potential pitfalls of procurement initiatives.

The survey consisted of over 100 questions and was administered to 50 project managers responsible for North American procurement projects selected for this survey and drawn from manufacturing and non-manufacturing industries, varying in size from the world's largest organizations to moderately sized companies. The sample concentrated on companies pursuing the creation of extensive supplier relationships enabled by information and communication technologies, especially via eProcurement, eSourcing and ERP systems. Of all the completed questionnaires, 30 were qualified as being either in the process of implementing an eProcurement solution, or were in process of extending an operational eProcurement solution for a client. In order to elaborate on the answers provided, and with the consent of the original respondents, additional questions were dispatched. After reviewing the answers, telephone interviews were conducted focusing on the issues highlighted.

While the sample was not sufficiently large to conduct statistical inferences, it did consolidate many project managers experiences not only from their current projects, but also previous ones, thus enabling us to identify issues and challenges facing such efforts.

Construct Creation via Council

Subsequently, a group of subject matter experts and project managers ("board of judges") were assembled to discuss and exploratively cluster the various contingency statements highlighted by the survey in order to define relationships between value creation factors and their underlying contingencies. The author participated as a facilitator in these discussions. For each identified value driver, 19 SRM initiatives (discussed later) were evaluated, disaggregating the issues identified by the survey into basic, distinguishable and actionable elements affecting successful enablement. These more detailed contingencies represent interdependent clusters of actions labeled as SRM initiatives, in that they did represent individual projects often initiated by companies during the course of a project. The proximities among these initiatives were evaluated leading to qualitative indications of their sequence and interdependence. Thus a structured, exploratory framework emerged which combined the following elements: Value Drivers of information infrastructures enabling SRM practices and SRM Initiatives or contingent actions companies may undertake.

This form of data source triangulation was aimed at to enhance the internal validity of our study. As can be seen, data collection and data analysis were highly iterative in nature. Theory building is the result of a spiraling process form cross-case analytic results to existing literature and back. Goedde and De Villiers (1997) refers to this methodological approach as *grounded theory*, which aim is to develop a theory from data rather than to gather data in order to test a theory or hypothesis. This means that qualitative methods are used to obtain data about a phenomenon and that a theory emerges from the data. Since this is exploratory research the research problem is not stated precisely or in terms of dependent and independent variables. We attempt to create categories (e.g. themes, concepts represented as initiatives) grounded on data and experience.

Discussion of the Survey Results

The survey of the sample of companies that had gone live with an indirect e-procurement application provided the following overall findings:

- Cost savings average 10%, but inflated expectations and poor planning have caused project cutbacks and a lack of documented Return on Investment (ROI).
- Reductions in price via demand aggregation and maverick spending deliver benefits.
- Initial projects have been successful, but future phases were uncertain.

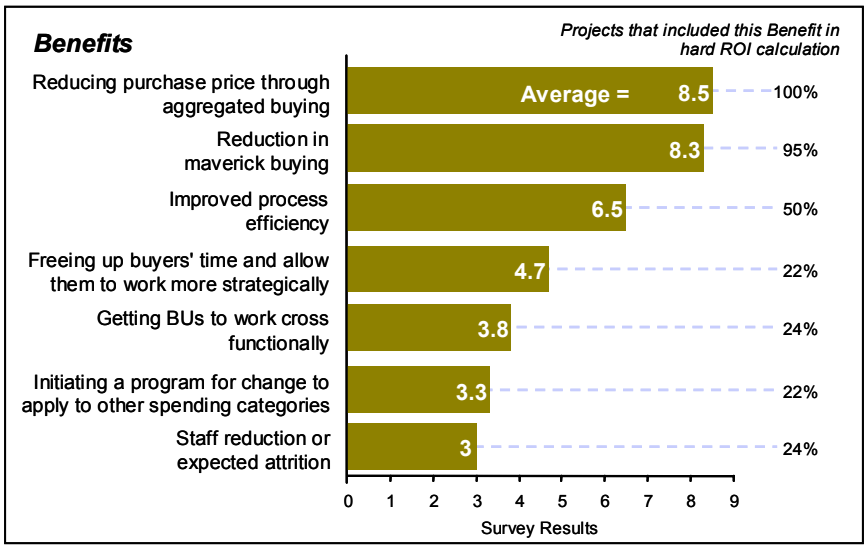
- Content management, process enforcement, and supplier enablement are the top three implementation barriers.

In the following paragraphs we will shortly elaborate on some of the major findings from the survey. With regards to the utilized functionality delivered by such systems the following table highlights what the respondents answered:

Functionality	*Answers*
Receive goods at user desktop	**70%**
Reconcile POs, receipts and invoices	**60%**
Receive goods at centralized location	**56%**
Integration to a procurement card or P-Card	**56%**
Receive purchase acknowledgements and ASNs	**50%**
International company sites	**47%**
International suppliers	**45%**
Settlement/electronic funds transfer	**18%**

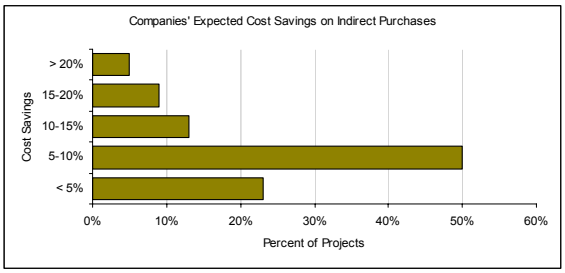
Evaluating Project success

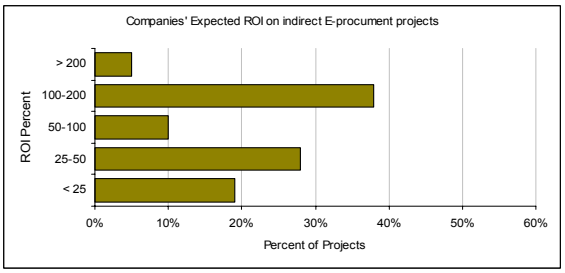
Of the buying organizations surveyed, the key drivers for their eProcurement implementations were based upon reaching project ROI based on savings and improved contract compliance. Finally some even mentioned the need to establish B2B presence. Most projects conducted ROI studies (82%), prior to an eProcurement Implementation. The median payback period was greater than 18 months.



Efforts to improve compliance to supplier agreements were measured by companies via reduction in maverick buying (where with a technology solution, maverick buying was expected to decrease), enforced purchasing restrictions to catalogued items, and optimized and enabled approval rules and processes (improved process efficiency). Moreover most companies highlighted that spend aggregation across multiple Business Units, and increased compliance and greater volume of spend per contract, led to increased buyer leverage for price reduction and/or volume discounts.

In the two graphs below the averages expected cost savings and the expected ROI of the e-procurement project are shown. The median range for the expected ROI was 25%-50%, with a low of less than 25% and a high greater or equal to 200%, while the median expected cost savings were less than 10%.





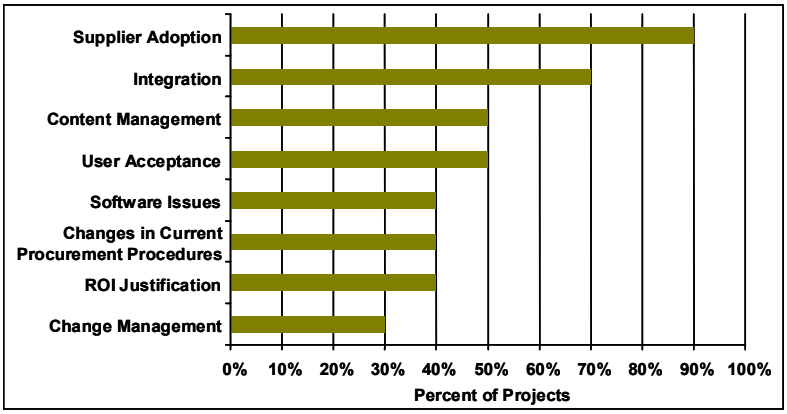
Obstacles in eProcurement Implementations

The majority of respondents (78%) claimed that they were on track to achieve their ROI, while those not on track cited Catalog Management, Supplier Adoption, Organizational Problems (lack of management support, employee commitment to change, lack of allocated resources) and Business Process issues (User Adoption and Change management) as the main reasons.

Issues	*Rating(Avg)*
Content / Catalog Management (includes the creation, distribution, presentation, syndication, and management of content and electronic catalog	**6.5**
Getting chosen suppliers enabled	**5.6**
Changing/enforcing internal business processes	**5.5**
Obtaining accurate baseline spending data	**5.3**
Backoffice integration	**5.2**
Getting resources from Business Units	**5.2**
Building internal consensus around project scope	**4.7**
Building internal consensus around which suppliers to select	**4.2**
Building internal consensus around spending categories to target	**3.8**
Lack of good international suppliers	**3.7**
Finding qualified domestic suppliers	**3.2**

Scale: 1 = Not at all problematic, 10 = Extremely problematic

These reasons were consistent with how projects typically scaled back from their original scope. These results were controlled by asking what were the main obstacles in implementing more advanced commodities (e.g. direct materials, stocked-MRO, etc.).

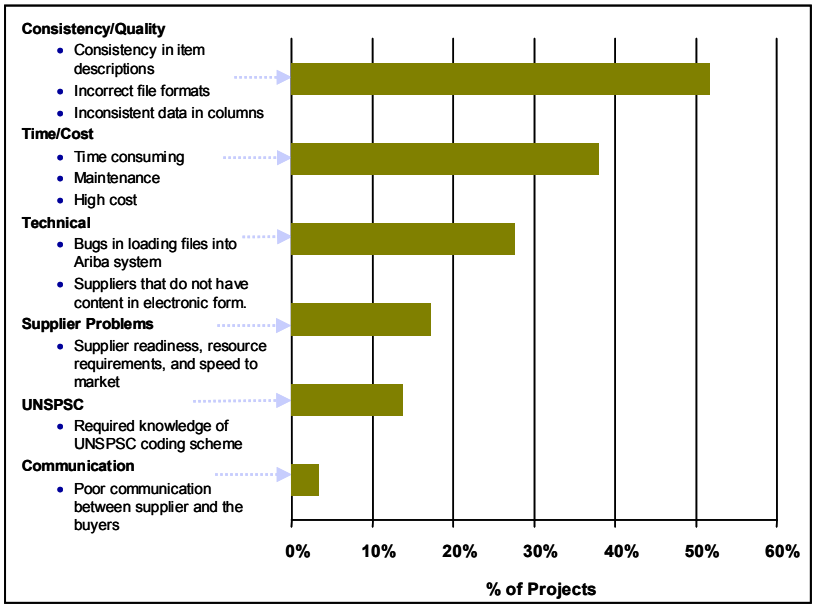


Elaboration on the Main Problems of Implementation

As mentioned, we did conduct subsequent interviews with the various project managers in order to elaborate the survey findings and provide a richer picture of the trends identified. The interviews focused on the four major areas of supplier adoption, content management, and change management. Most of the major statements from the interviews were sampled and

consolidated into the table of Appendix 2. In the following we will shortly sketch the findings of these interviews.

Why is Catalog & Content Management (CCM) Important?



Almost half of all projects surveyed scaled back suppliers, users, and categories from the original design because of issues with receiving and creating content from suppliers. CCM was listed as a major barrier to supplier adoption citing cost, value, communication, and technical issues. On the other hand, active users will only embrace an eProcurement system if relevant and frequently updated content is present. As projects progress from simple to strategic product & service categories, CCM becomes even more important as it requires duplicate master data within the firm's transactional systems (i.e. ERP). Catalog & Content Management was identified by project managers as one of the most problematic of all eProcurement issues. The issues highlighted by the answers were:

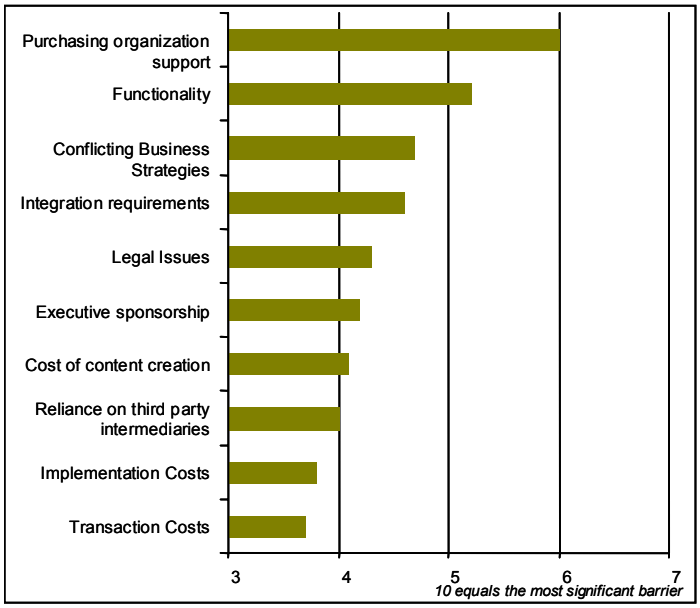
- Consistency / Quality of content (50% respondents) - 70% of projects do not use a content service provider (CSP) citing high costs and eProcurement vendor content, however, good content and searches are mandatory for user adoption and ROI realization.
  Time / Cost (35% respondents) - content costs $3-$4 per SKU for creation and $1-$2 for maintenance by 3rd party vendors; buyers need to have dedicated team for CCM; maintenance frequency also affects cost in that over half of suppliers update content less than six times a year.
- Technical (25% respondents) – most eProcurement software vendors were not providing adequate CCM services.
  Non-Catalog purchases - 25% of eProcurement purchases are non-catalog, 18% (14%) of suppliers are roundtrip / punch-out enabled (have buyers using roundtrip / punch-out)
- Supplier Problems (20% respondents) - almost half of suppliers did not have eCatalogs in place at the project start date, while few suppliers support on-line inventory and configurable products on their web sites. This leads to buyer-centric content strategies.

Issues with Supplier Adoption

Supplier Adoption was identified as a reason for stalling project progress in six of the 15 stall responses. The successful projects seemed to have a phased approach to implementation and a manageable scope. The most frequent Supplier Adoption problems cited were:

- Change Management – denoting that strategies/expectations are inconsistent between supplier and buyer, leading to low commitment by supplier and buyer, and limited resources being allocated for the tasks. All this leads to increased reliance on 3rd party providers to create, maintain, and house content which is costly.
- Integration & Technical – lack of technical resources with adequate skills; lacking supplier enablement in terms of content and transactions.

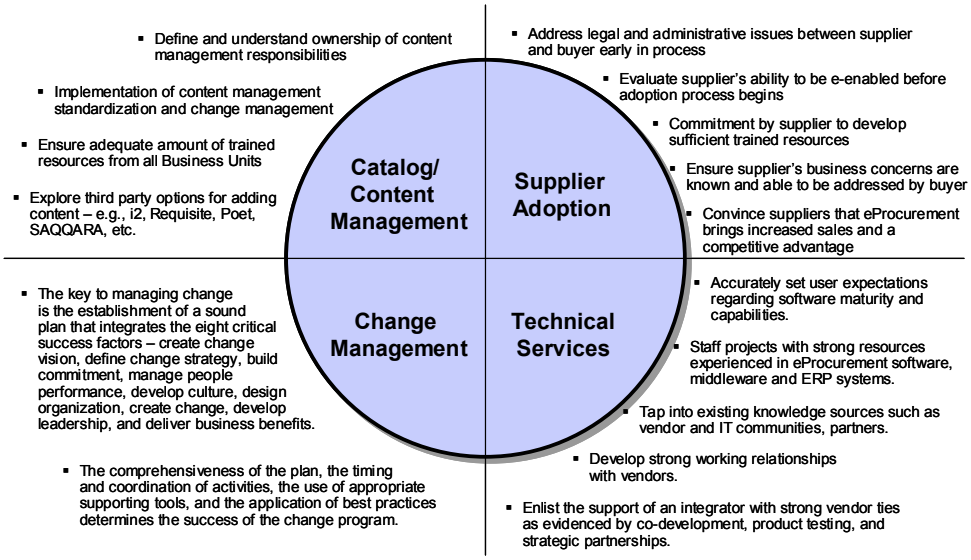
- Legal & Security – Supplier concerns about security of data available to suppliers and marketplaces.
- Cost & Benefit – Suppliers do not see the value of making the changes necessary to conduct business with buyers and marketplaces.
- High transaction costs – although the most common PO format for buyers is XML, buyers used the more expensive EDI format with 28% of suppliers. Suppliers still prefer email and fax more often than any other PO format.



Issues with organizational inertia – the need for change management

Organizational and process issues were identified by 80% of respondents as another significant challenge they faced. The barriers to change that managers face in procurement projects include:

- Organizational Scope – 44 %of projects state that change management was the reason for the failure of organizational adoption of new business processes (meaning getting users to standardize around common processes, and change their modus operandi), which leads to Political resistance – 44% of projects state change management failed in gaining management support and sponsorship
- Change Complexity – eProcurement implementations were viewed as extraordinarily complex because the changes occur between several organizations as well as within organizations; 60% of projects cite change management as the reason for failure to move into complex commodities.
- Lack of Skills – Existing buyer skill set falls short of those needed by a strategic sourcing analyst.



After describing the various obstacles and inhibitors of such implementations, most of the given recommendations or critical success factors were summarized and clustered under the four areas identified as key challenges –see figure below. They were subsequently used as an input to the next phase of the investigation which looked at the initiatives necessary to prepare an organization for such projects and enable value creation.

Value of SRM Information infrastructures

Finally, one of the areas we received input from the participants were the KPIs and value of the value of SRM adoption, which is justified only when the perceived benefit is large enough to cover the costs. Benefits of using SRM IIs include enhancing effectiveness and improving efficiency when costs comprises of initial investment and on-going expenses of implementing them. SRM supports companies to reduce the time, effort and costs of buyer company associated with requesting, sourcing, negotiating and, ultimately, purchasing from suppliers. It further enables purchasing staff to extend the speed, quantity, and quality of information processing that has more long-term effects (i.e. on revenue). It is found that the higher the value they perceive from e-procurement adoption, the higher level of e-procurement utilization sophistication (REF). The participants were ask to provide examples of the KPIs used by the companies to calculate the ROI of adoption (see previous section. Below we provide an overview of the factors linked to value creation.

Impact	*Enabler*	*Value creation*
		DECREASE COSTS
Reduce Material Costs	Demand aggregation	Volume Discount
	Better external and internal information tools	Better and flawless line of arguments during negotiations
	Enhance supplier engineering collaboration	Reduce unit price of new parts
	Parts content integrator	Reduction of parts base maintainance
Lower process costs	Compress sourcing cycle time	Inventory level
	Simplified processes	Execution costs
	Automation	Purchasing administrative costs
	Supplier rationalization	Supplier management (less suppliers)
	Ensure global compliance	Less Maverick buying
	Supplier self-service	Part of relationship costs externalized
	Reduce risk of quality reduction and price increase	Supplier performance monitoring
		INCREASE REVENUES
Increased revenues	Better cost price	Better FP price position
	Better market share	Better finished product margin
	Collaboration & Compress sourcing cycle time	Accelerated Time to Market
		INTANGIBLE BENEFITS
Intangibles - Brand Image	Better brand image for corporation	Easier market penetration - less sales effort
		Better company gross margin
Intangibles - Allocations	Demand allocation	Quality improvement
		Product innovation
Intangibles -Risk Reduction	Ensure global compliance	Corporate guided contract's conditions

Discussion and Results of the Council Meeting

The council meetings had the objective of defining the objectives and enablers of such information infrastructures supporting SRM practices in organizations. The aforementioned survey results were used as input and the participants ranked the various statements into enablers or SRM initiatives that companies have to pursue. Based on existing literature and practice, 6 value clusters were identified encompassing 19 business initiatives.

SRM Information Infrastructures – Value Clusters

As mentioned, the value proposition of SRM extends previous eProcurement solutions by enabling strategic sourcing, and integrating the supply chain and product life-cycle functions of a business. Moving beyond the simplistic eProcurement focus on minimization of transaction costs and cost savings(Gadde & Håkansson, 2001), and utilizing the aforementioned objectives of an II, we identified 6 interdependent value clusters for the business (see table).

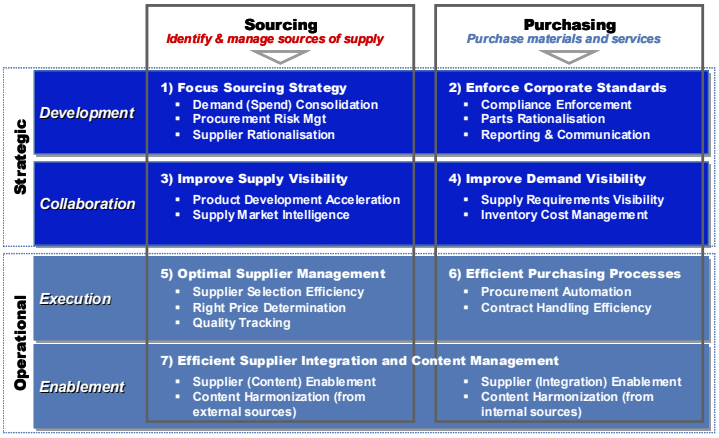
Value Clusters	Description	Process Domains	Affected KPIs
Value Optimization	Getting the optimal total cost of purchased materials and services by consolidating demand, getting the right price and enforcing appropriate purchasing behaviors	Source & Monitor	Spend within (out) contract per commodity Price variance per commodity Average order quantity per supplier per year Average number of parts per category
Sourcing Optimization	Ensuring security of supply through intelligent sourcing, robust procedures and flexible purchasing	Evaluate	Average spend volume per supplier ABC distribution of purchasing spend by supplier Process cost (number of suppliers, number of RFPs / RFQs, number of contracts negotiated, cycle time
Process Efficiency	Reduce transaction and operational costs by automating and enforcing selection and procurement processes	Transact + Enable	Number of errors per purchase order Contract compliance Contract handling cost Cost per transaction for "procurement to delivery" cycle time
Complexity Reduction	Reducing types of demand, rationalize procurement requirements and harmonizing master data to support procurement activity	Monitor + Collaborate	Average cost of content preparation & maintenance Number of PO refusals due to incorrect data Number of wrong shipments Number of parts per product per material group
Supplier Collaboration	Working with suppliers on joint process improvement and capability development	Collaborate	Product development process costs Warehousing cost and Inventory levels Number of reportable production and assembly problems for typical product
Organizational Empowerment	Defining the organizational structure and processes for optimized purchasing and supplier management	Organize	Turnover Percentage of purchasing staff with job roles linked to purchasing strategy Annual performance against job goals

The above categorizations helped the team identify what companies need to do to implement an SRM II. These interdependent SRM initiatives represent concrete actions that companies can pursue in their attempts to reach a number of objectives.

1. Value Optimisation	*2. Sourcing Optimization*	*3. Process efficiency*	*4. Complexity reduction*	*5. Supplier collaboration*	*6. Organizational Empowerment*
1.1 Compliance Enforcement	2.1 Supplier Rationalization & Qualification	3.1 Procurement Automation	4.1 Content Harmonization	5.1 Product Development Acceleration	6.1 Manage & Evaluate Purchasing Staff
1.2 Demand Consolidation	2.2 Procurement Risk Management	3.2 Contract Handling Efficiency	4.2 Parts Rationalization	5.2 Inventory Cost Management	6.2 Reporting & Communication
1.3 Right Price Determination	2.3 Supply Market Intelligence	3.3 Supplier Selection Efficiency	4.3 Capital Investment & Tracking	5.3 Supply Requirements Visibility	
		3.4 Supplier Enablement		5.4 Quality Tracking	

These are the meso-level SRM infrastructure enablers representing both actions that need to made at the network, relationship and company level, incorporating both actor deployments, resource investments and activity transformations. Appendix 3 summarizes their objectives and typical actions taken by companies to realize them, while Appendix 4 presents the typical impacts they have and how they can be measured. For example, *demand consolidation* attempts to reduce costs by consolidating the demand from multiple units within a corporation to enable aggregated contracts with fewer suppliers; such consolidation often leads into bigger spend volumes/contract and earning higher discounts from the suppliers. This initiative was hence classified under the "Value Optimization" value cluster. For each of these initiatives a detailed template has been created that incorporates, business context, objectives, business levers, KPIs, measures/metrics, and related SRM processes. Another perspective explored was the relationship between various SRM initiatives or enablers and their relative alignment within the overall Supply Network Strategy of a firm. The team placed the various initiatives under the various SRM objectives and then categorized them as shown in the matrix above.

Classification of the SRM Initiatives into II Enablers



In order to understand the role of infrastructure in value generation, the respondents were asked to grade the fulfillment of each of the major value creation KPIs identified in the previous phase vis-à-vis the identified, descriptive SRM initiatives on a 0-5 Likert scale (from 0: "no influence" to 5: "high influence". Employing a confirmatory factor analysis using a non-parametric (Kendal-T) correlation matrix (in that there were less than 20 ranking responses), seven factors (with eigenvalues>1) explained 81,66% of the variance in the ratings (α>.7). Based on this analysis a number of SRM information infrastructure enablers were identified.

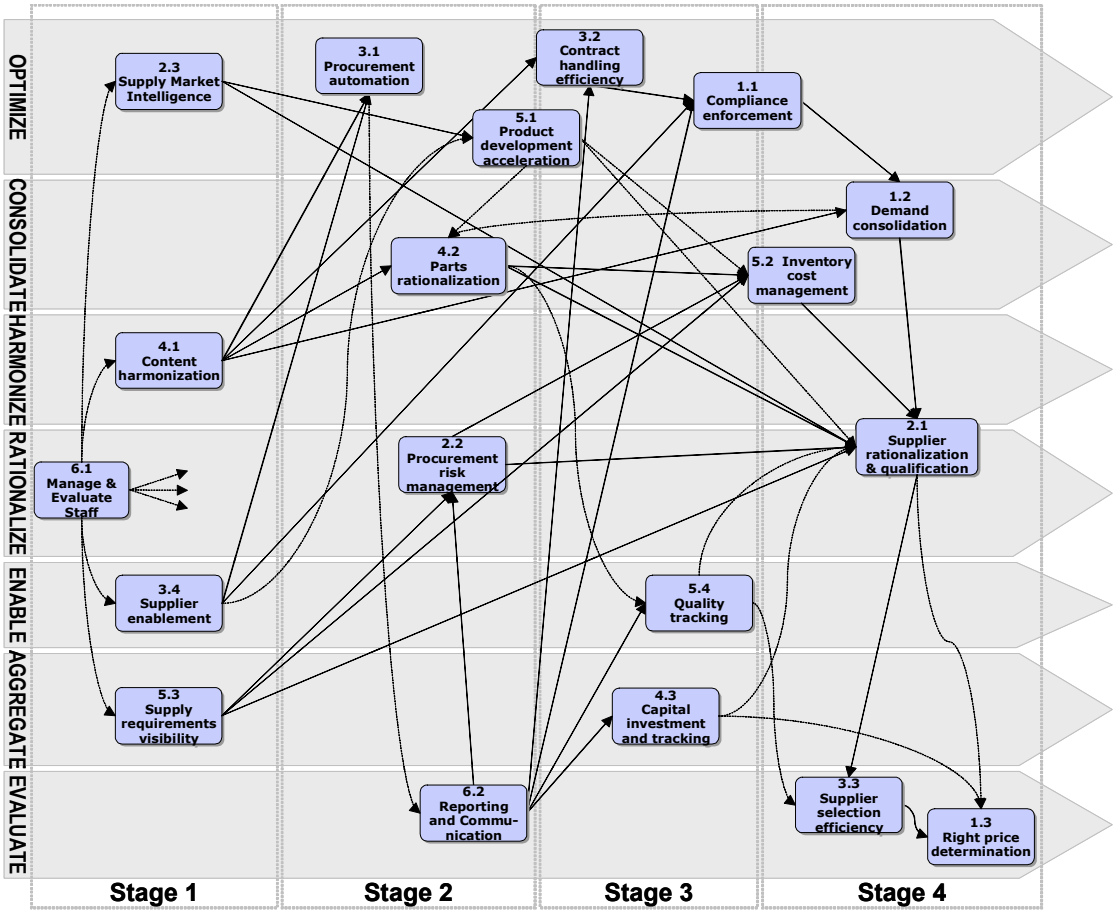
SRM Initiative	Optimize	Consolidate	Enable	Rationalize	Evaluate	Aggregate	Harmonize
Expl. Variance %	21,65	36,90	49,41	59,11	67,92	75,66	81,66
Product_development_acceleration	-0,85						
Supply_market_intelligence	-0,84						
Procurement_automation	0,80						
Contract_handling_efficiency	0,80						
Compliance_enforcement	0,50						
Demand_consolidation		-0,88					
Parts_rationalization		-0,73					
Inventory_cost_management		-0,78					
Supplier_enablement_			-0,92				
Quality_tracking			0,63				
Manage_Purchasing_staff				-0,85			
Procurement_risk_management				-0,68			
Supplier_rationalization_&_preq				-0,56			-0,55
Supplier_selection_efficiency_					0,85		
Right_Price_determination					0,77		
Reporting_and_communication					0,71		
Capital_investment_tracking						0,88	
Supply_requirements_visibility						-0,70	
Content_harmonisation							-0,78

Based on the varimax-rotated factor pattern we assume the first dimension describes *Optimization* efforts that an II can support (primarily process automation & reengineering). The second dimension supports the *Consolidation* efforts. The third dimension consists of indicators for *Enablement*, where the fourth dimension, *Rationalization* supports efforts to improve management of staff and risk. The fifth dimension supports *Evaluation* activities, the sixth *Aggregates* internal demand based on ongoing product sales and asset maintenance, while the final dimension helps companies *Harmonize* their internal content. This exploratory construct seems coherent with the objectives we outlined (see page 9), yet it naturally deviates from the conceptual business value clusters originally identified.

Staging Realization – Relationships between the SRM Initiatives

It was also evident that most of the initiatives could not be implemented at once. Each one, e.g. content harmonization may represent a significant project, which needs to commence before we can start rationalizing parts or automating processes. As, content, change management and integration were found in our survey to be instrumental to the success of II deployment, we need to address them early on, followed by a progression into other initiatives. While most companies would like to commence with rationalizing their supplier

base, after discussions in the group we found that it was rather the effect than the cause. Hence, we run an exercise with the team where we had to assign arcs (meaning probabilities) depicting an initiative's interdependencies. The scores and arcs consistency were verified with MSBNx (a Toolkit for Modeling and Inference with Bayesian Networks). We drew the given consensus relationships between the various initiatives (as a graph), used success as the hypothesis node, and run a number of inferences calculating posterior probabilities and likekelihood scores for structures. The analysis is reported in Nøkkentved (2003), while below we have provided as an explanatory graph containing the initiatives, the enablers and the most probable stages that a realistic deployment will pursue. Remark that there might be multiple paths of implementation.



It is evident that a lot of preparation needs to take place before we even start "automating procurement processes"; companies need to have:

1. defined clear roles, responsibilities and procedures for managing and developing staff,
2. clear procedures for scanning the market for new or additional suppliers (defined evaluation criteria, RFI procedures, etc.)
3. defined clear and standardized content in the form of product classifications (e.g. UNSPSC), and supplier records (e.g. DUNS),
4. clear procedures and roles in relation to supplier adoption – exchange data standards (XML/EDI) for transactional and content information,
5. clear overview of the internal requirements for goods & services based on customer demand (i.e. the ability to create demand, maintenance and MRO forecasts).

It's all about the way we use current and new technologies to improve relationships with suppliers to drive business value for both parties to create long-term, sustainable

relationships. Although technology is the enabler, SRM initiatives encapsulate a different way of thinking about how companies should deploy technology to work with suppliers. Making these improvements may require some radical thinking about the way that companies can work together to create that win-win scenario.

Limitations and Future efforts

There are many limitations to the chosen methodology. For example, a one-year study does not provide a detailed historic perspective of the projects studied. We attempted to ameliorate this by asking interviewees their perceptions and experiences stretching beyond these projects. It must also be noted that the survey was not designed to demonstrate the existence of all suggested obstacles and CSFs, but rather to explore the replicability of "common" factors leading to success or failure. Obviously this research has concentrated on a small number of factors. The role of information infrastructures in the other relationships that surround the firm also needs investigating, as do the typology of tentative initiatives and value drivers described above. Additionally, it must be recognized that this is only an exploratory study and it is difficult to generalize the findings from such a small sample. Future studies can be designed to test some of these findings directly with companies from a longitudinal perspective in order to cross-fertilize findings between the theoretical disciplines of information infrastructures and industrial networks.

Clearly, there is much scope for further development of the theory in this area and further empirical testing is needed in order to confirm the general applicability of the framework presented. The SRM Initiative framework is still under development. We are currently investigating total potential savings and improvement possibilities produced by each business initiative by utilizing benchmarks on sourcing categories, processes and KPIs. Some of these benefits are moderated by the industry and current purchasing practices. Quantification of these SRM benefits may lead into a clear view of potential benefits by implementing such practices. These investigations are currently made on various client assignments.

Theoretical Implications – IMP, ANT and II Transformation

Beyond these significant limitations, our study has exposed the need for a more expansive methodology (Walsham, 1997) for inquiring into the real-world processes by which associations of humans and non-humans (information infrastructures) coalesce into persistent industrial networks or fail to do so (Sidorova & Sarker, 2000; Wagner & Scott, 2001). What became clear during the investigation was the distinction between the business-level objectives of such initiatives (as shown in our value clusters), and then the infrastructure-level enablers. There seems to be a significant different view depending on what perspective we choose to pursue, yet both levels are becoming increasingly inter-reliant as II enable an increasing number of formal and non-formal business processes (i.e. activities), and enrich job roles based on predefined / ad-hoc workflows hence changing inter-actor interaction patterns. Many transactions are subsequently executed between non-human actors, where their mirrored human counterparts are only involved in formalized activities in cases of exceptions.

Even as the IMP Group is vocal about the need to consider both social and technical interdependencies, especially in relation to technological innovation (Ford et al. 2002), it is not at all as explicit how human and non-human actors are methodologically related and not clear about their performative aspects. Mattsson (2003) believes there is some untapped potential for Actor-Network Theory[26] (or ANT) in the IMP-related interaction and network studies, in that ANT provides a richer or more "precise" methodology for studying dynamics of involvement of technical as well as social/organizational dimensions in boundary setting and also the involvement of actors in the network processes. Adopting an ANT perspective can help highlight transformations involved in forming, transforming and maintaining heterogeneous network (Law, 1999), before these activities become black-boxed – formalized and hidden

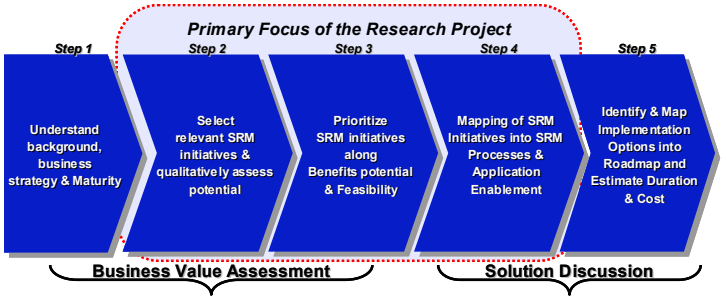
from observation. Focusing on these processes foregrounds the emergent and progressive manner in which IIs enable or constraint business relationships (Monteiro, 2000).

Actors in a particular topology influence each other through their links (or interactions according to the IMP Group). ANT suggests that a process of *translation* takes place, a process that explains how and why some actors take the attributes and properties of the actors they are connected too (Callon, 1991, Law, 1999). This translation process enables an actor/entity (simple or complex) to inscribe its properties and attributes onto other actors in the pertinent topologies. Certainly, in any given topology not all actors are able to inscribe their properties and attributes equality into other actors (also described as actants - Walsham, 1997, Law & Hazard, 1999). An actant is an independent entity with the potential to become an actor in a given topology or in multiple topologies simultaneously, perhaps performing and behaving differently in various topologies depending on its relative position in the respective network. While the actant does not directly affect changes in actor-network, s/he/it may have to be considered in the translations (to perform and/or be performed) depending on its position in the relevant topology.

Information Infrastructures as actant-networks

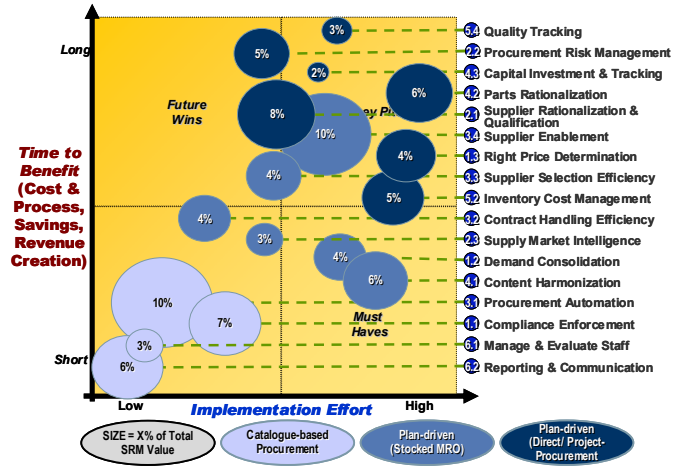
Like any actor, IIs lead human actors or coalitions to build ever-shifting alliances with others. They might be used by top management, playing the role as a powerful change agent, while later lower levels of the organization might use the dissipating IT infrastructure to help them bring the change process under their influence and into speed they preferred. Finally, large, global IT infrastructures epitomized by ERP systems may after their painful integration into the corporate infrastructure, may turn out to be a constraining actor resisting all organizational change (Hanseth, 1996). Consequently, IIs may be viewed as *actant networks* in that they contain modularized, interconnected best practice business processes, skills and business rules of diverse areas, all translated into software. Upon introduction in the corporation, IIs mobilize a large network of internal and external actors plus other actants (i.e. software vendors, hardware vendors and service providers delivering a constant stream of renewed knowledge. All these participants are indirectly (and some directly) involved in a company's transformation efforts without being the direct decision-makers or instantiators of change.

Managerial Implications



An important question in the mind of many managers and practitioners in the SRM domain relates to the "right approach" to implement such initiatives in organizations. Knowing how they may enable or constrain value and what factors affect this value is important to answering this question. Our research attempts to construct such a valuation framework to identify the organizational initiatives and performance measures that are impacted by such applications, and how the process, organization, and "extended enterprise" process-level characteristics determine the level of the value (Subramaniam and Shaw, 2001). Our research has identified a number of *value drivers* operationalized via SRM enablers and initiatives (representing actual CSFs, that may help the prioritization process of such efforts).

Given the complexity of implementing these kind of information infrastructures, it seems viable that the identified SRM Initiatives may by used during the beginning of such a project to investigate the status and maturity of the organization to embark upon such a project.



Another perspective is related to the sequence that these initiatives are supposed to be implemented. Very few companies have the ability to embark on a monolithic transformation effort (Davenport, 1998), thus it is imperative for such infrastructure projects to link strategic necessity, with current needs, capabilities, potential for value creation and ease of implementation. Managers can use the SRM initiatives framework and the highlighted KPIs (in Appendix 4), to calculate their value potential. Based on their organization's maturity with regard to the SRM processes, they will be then able to identify which initiatives and subsequent application features they would pursue.

Concluding remarks

Enablement of complex, collaborative supply networks with information infrastructures may lead to a highly-probable, though slow, Lamarckian evolutionary process, rather than a revolutionary inflexion point of current business practices in Procurement and Sourcing among Industrial Organizations. Notwithstanding, the value of using the Internet-based IT - or any supply chain/relationship management tool - may not significantly improve until the company re-invents itself to embrace internal and external transformation – not an easy undertaking.

In the course of this paper we have investigated the issues faced by companies during their deployment of IT-based information infrastructures supporting upstream procurement and sourcing activities. We identified a number of business-level SRM initiatives that affect both actors, activities and resource adaptations in companies, yet are necessary to enable an organization with these technologies. These were then clustered into information infrastructure enablers and a conceptual construct was presented defining their interdependencies. Based on the results of our investigation and the conceptual analysis, theoretical and practical implications were drawn. While the latter was self-explanatory based on the need of companies to structure their B2B efforts in a time & efficient manner, our recommendations regarding the former has wider repercussions for studying the role of technology within the setting of industrial networks. Information Technology enables infrastructures that resemble the business networks they are supposed to enable, thus taking on a lot of the ARA attributes. Hence, we propose that transformation in industrial networks need to consider IIs as powerful actors, affecting activity structures and resource constellations in industrial networks.

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APPENDIX 1: SRM PROCESSES

The table below further details the various SRM process domains and activities.

	SRM Process	Description
Plan & Evaluate	**Supply Market Intelligence**	A supply strategy needs to be defined in order to set clear targets for procurement departments. Market information, technology and industry trends are collected along with information about the supply base. This process should facilitate search of alternative suppliers via internal and external sources (e.g. Dun & Bradstreet, Marketplaces).
	Supply Strategy Development	Supply Strategy Development is initiated by assessing the organization's supply needs. Products and/or product groups are combined into sourcing categories. Based on required relationship density and other analysis, a supply strategy is derived for each of the sourcing categories. The process often incorporates following activities: Demand aggregation & planning, portfolio analysis, purchasing strategy planning, category management and purchasing controlling
	Supplier Qualification	The process of pre-qualifying potential suppliers into vendor list(s). This includes the definition of the qualification criteria, discovery and identification of potential suppliers to be qualified, the process of collecting information about suppliers (e.g. via a self assessment) and the analysis of this information. This process reduces risk of supply and shrink buffer inventory with reliable and expedited processes for supplier discovery and qualification
Source	**Supplier Evaluation & Selection**	Process of pre-qualifying potential suppliers by analyzing past procurement patterns/volumes and mapping these to future spending, taking into account technology and industry trends. Strategic Sourcing is the process of sourcing a strategic contract for a material group. A request for proposal or information is submitted to pre-qualified suppliers and responses are evaluated.
	Contract Development	The process of searching for existing and creating new draft contracts, by sending RFIs to selected suppliers, selecting relevant bids, and managing a negotiation phase with the suppliers that leads to negotiated contracts. Negotiations lead to a signed contract, which can be utilized by different business units to execute purchase orders or call-offs.
	Contract Distribution & Execution	Contracts may be distributed to all business units. Subsequently all purchasing transactions will be checked and matched to current local or global contracts. All transactions are constantly monitored for contract compliance by controlling the source of supply in given purchase orders.
Collaborate	**Design & Engineering Collaboration**	Design collaboration is a Strategic Sourcing process of jointly developing a product design or engineering specification (often with an external design or engineering/ construction partner involved. It is an iterative process where several versions of the design are reviewed and discussed using for example, CAD redlining tools. In the end a final design is approved. This process is typically used while sourcing non-standard, to-be engineered items.
	Life Cycle Collaboration	This process is centered around the Management/ Maintenance of assets (i.e. buildings & equipment), and collaborative Project Management via the utilization of shared document management facilities.
	Collaborative Supply Planning	Collaborative Supply Planning is focusing on the exchange of forecasts on expected demand for particular components towards suppliers. It is an iterative process which also encompasses continuous maintenance and planning of services. Moreover, it supports collaborative exchange of replenishment information and inventory visibility. Information is exchanged and verified with suppliers, whom also would provide available-to-promise information during procurement execution.
	Supplier Services	Supplier Services are providing access for suppliers to conduct a range of processes from registration, bid response and order management (PO Notifications, GRs, ASNs, Invoices, etc). The process allows buyers to benefit from procurement automation by enabling smaller and non-integrated suppliers to take part in the buy-sell-process. The process starts with creating catalogue content and includes the processing of orders by the supplier as well as invoices and the data collection about performed services.
Transact	**Self-service procurement**	Self Service Procurement is the process of purchasing non-strategic or indirect goods. Demand is primarily generated on an ad hoc basis, and users are all employees in an enterprise, not just professional buyers. Example commodities are office material, work, clothes, IT equipment. The process supports adaptive requisitioning (i.e. split or grouping of requisitions), order processes, confirmations and good receipts.
	Plan-driven procurement	Plan Driven procurement (linked to ERP MRP, Material Mgmt, Project and Plant Maintenance Systems) is the process of procuring material or services that are planned, as opposed to unplanned. In terms of technology, demand for direct material is usually planned by MRP or APS systems, and transferred to an e-procurement application in the form of a requisition (e.g. a manufacturing company with many disparate planning systems consolidates procurement in one e-procurement hub, or a company centralizes procurement activities for planned and unplanned maintenance requirements).
	Service Procurement	Asset-focused service procurement provides support to employees ordering: a) simple services (e.g. using electronic catalogs), b) order time-based planned or unplanned services (e.g. facility services like temp labor), c) maintenance services, d) complex services job (e.g. engineering services or complex facility services), and e) outsourced and contracted services (e.g. asset security services) After-Sales services focus on a) handling customer service requirements (services and service parts) created by service orders or service contracts, yet executed by a 3rd party, and b) fulfilling service parts requirements automatically created by service parts planning and inventory management.
	Operational sourcing	Operational Sourcing is the process of sourcing unassigned demand on a case by case basis. This process is primarily used for items that are not purchased on a regular basis and where no catalogue exists. Unassigned demand will be collected and a professional purchaser decides how to find a supplier for the required item. Example commodities: consulting services; new training services; a large technology installation.
	Invoice Verification & Payment	This process concludes the procurement transaction by receive and review supplier's invoice for correctness. Invoice may be blocked for payment if the tolerances defined by the company have been exceeded, and initiate a dispute process. After verification, the necessary postings are triggered in accounting, Invoices can be electronically received to shorten the order-to-payment process and to reduce transaction costs. An approval process is available for invoice review. Evaluated Receipt Settlement may accelerate the verification process Invoices are the basis for the payment.
Monitor	**Relationship Monitoring and Evaluation**	Relationship Monitoring is the process of analyzing and monitoring existing supplier relationships. Supplier performance and supplier compliance to contract conditions is analyzed on a ongoing basis, as well as suppliers' financial stability and product quality. Relationship Monitoring functions as an early warning system and indicates supplier improvement opportunities.
	Sourcing and Procurement Analysis	Analytics offer ample analysis functionality to support the operational and strategic e-procurement process by providing predefined reporting (e.g. on Vendor, supplier, bid and contract evaluation, order tracking, delivery analysis, payment card and invoice analysis). Most typically companies conduct Global Spend Analysis, which identifies corporate spend on an enterprise-wide level in order to gain a clear and an accurate view of the corporate spend across multiple systems. It helps to discover sourcing opportunities with substantial savings potential for individual products and categories
Enable	**Content Enablement**	Content Management is the process of managing the flow of content that support procurement activities. Most usually, content revolves around suppliers and product data (often in the form of a searchable catalogue). Depending on the sophistication of the procurement processes, synchronization of back-end, onramp and exchange content is required Content refining the structure and processes necessary to successfully create, manage, and maintain a unified catalogue to support the non-stocked products scenario. This process can be partly outsourced to suppliers or insourced in the case that suppliers do not provide structured content.
	Integration Enablement	B2B integration requires an exchange infrastructure or middleware that provides an open environment for message-based open integration. It should provide common business process semantics to ease integration of external and internal components, and should drive the actual execution of processes by handling the messaging among applications (like ERP) and between companies. Moreover, integration enablement may connect a firm into external catalogues and services from private and public marketplaces.

APPENDIX 2: SRM SURVEY QUALITATIVE OUTCOMES

During the subsequent interview with the project managers participating in the survey a number of statements were registered and clustered under 4 major CSFs for realizing the benefits of eProcurement projects.

Areas	Project Outcomes	Organizational Challenges	Technology Challenges	Key Learnings
Business Process / Change Mgmt	▪ Level of payback possible with aggressive sourcing ▪ Surprising price reductions from some suppliers ▪ Analysis of Office Depot supplies indicated they were buying – absolute discretion – insight to inappropriate spend ▪ Benefits from self service auctions ▪ Being positioned as a leading edge organization and achieving significant savings ▪ Cross business unit collaboration ▪ High user acceptance of creating PO's in a system for the first time ▪ More user friendly than expected – user acceptance once it was in use ▪ Good level of support within company ▪ Executive level support positive and ongoing ▪ Company is seeing this as a long term investment in changing the way they do business and committing resources to ensure ongoing success with specific responsibility to grow the system. ▪ Many resources to gather an understanding to fully support the system. ▪ Use of Travel & Expense reporting module drove user satisfaction and user adoption	▪ Getting users to standardize around common process ▪ Gaining agreement on the best level of process control ▪ Cultural differences that dictated different business processes ▪ People to change the way they did business ▪ Moving to a self service model ▪ Accept less than what their current system did ▪ Break in processes ▪ Including all user requests ▪ Lack of internal skill-sets for this type of engagement and the startup curve ▪ Training ▪ Change Management ▪ Changing the organization ▪ Getting consistent data on PO, receipt and invoice for a smooth 3 way match	▪ Being an early adaptor of a new technology (software not very robust) ▪ Rate of product growth and development ▪ Clear and accurate road map ▪ Helping the software company identify and fix all of the bugs in their very new product ▪ How to organize receiving	▪ Get strategic sourcing group involved earlier ▪ Push for more and better sourcing prior to going into full implementation so that supply base is smaller and more adaptable ▪ Understanding of expected business process ▪ Better business structure sooner ▪ Complete approval workflow in eProcurement application rather than ERP
Supplier / Catalog Adoption	▪ Gaining understanding of supplier adoption ▪ Allowing for the company to take ownership of the supplier adoption process ▪ Active users continue to use system if content is present	▪ Getting content loaded and suppliers on board with content that is meaningful to users in geographically dispersed areas ▪ Supplier Adoption	▪	▪ Focus on supplier adoption – you need a lot of suppliers to transact with if the project is to be successful. ▪ Allow much more time for supplier adoption ▪ More aggressive on content and business plan ▪ Better content strategy ▪ Analyze each commodity stream to understand if it is really a candidate for eProcurement as some processes and commodities do not lend themselves to this technology ▪ Not underestimate the time and resource requirements to perform content management ▪ More work with corporate purchasing on catalog development process ▪ Would not prepare supplier catalogs ▪ Better target user base, content and suppliers.
Program Mgmt	▪ Amount of low dollar/high cost transactions able to be processed without human interaction and the realization of the system's impact at achieving this. Over 60% of the orders are in this category, yet they make up only 10% of the spend. This is a great savings having low cost processing for these orders. ▪ Ability of PwC team to implement a new technology to over 2000 users across 30 operating companies in 9 states ▪ Speed of the first rollout and	▪ Executive sponsorship and managing scope ▪ Client commitment ▪ Lack of consistent commitment from purchasing and IT ▪ Merger – working with resources that weren't committed ▪ Dealing with a large merger that was occurring ▪ Make Business Process decisions and changes ▪ Deployment -who will be	▪ Functionality issues and limitations ▪ Didn't work as advertised ▪ Bugs in the upgrade version ▪ Unstable first release of new version ▪ Lack of robust integration to ERP ▪ Product knowledge (integration software knowledge)	▪ Sponsors identified and in place ▪ More management of sponsorship up-front ▪ Get more robust support and buy in from executives at outlying business units. ▪ Assign more resources ▪ Get better client resources ▪ Insist on dedicated resources ▪ Make sure decisions are made early ▪ Reset expectations, strive for

Areas	Project Outcomes	Organizational Challenges	Technology Challenges	Key Learnings
	number of users ▪ Ahead of peers ▪ The move to consolidated billing and the removal of current process of approving every individual office supply invoice. This client was not focused at all on Business Process improvements and so it was a positive surprise that they were willing to include this BP improvement	next ▪ Process standardization and change management ▪ Building new business entity to support the initiatives and develop offerings to support broader client base ▪ Managing number of applications		quicker deployment ▪ Develop a complete eStrategy, including eProcurement, supplier adoption, market place ▪ Being a member of our marketsite was our primary driver ▪ Rethink timing of benefits of project
Integration / Technical	▪ Integration to ERP system ▪ Relatively simple software installation ▪ Tech knowledge transfer from consultants ▪ Lack of major production outages	▪	▪ Complexity of integration, workflow ▪ WMS integration ▪ User data load ▪ Java applet downloads ▪ Integration to multiple backend systems ▪ Middleware connection to procurement system ▪ Integration to ERP systems ▪ Platforms in different countries with different operating software ▪ Split server architecture	▪ Wait for a newer software version ▪ Make fewer modifications to the software to ease ability to upgrade to newer version ▪ Software selection earlier in the process ▪ We made several project decisions that were dependent upon a third party that did not produce results ▪ Define a new integration model with the ERP; to consider the user requirements instead of show case

APPENDIX 3: SRM INITIATIVES – OBJECTIVES & ACTIONS

Cluster	Business Initiatives	Initiative Objective	Typical Actions
Value Optimization	**Compliance enforcement**	Reduction in total cost of purchase by ensuring the compliance of disparate business units in handling and adhering to centralized approvals / contracts and the control of company-wide procurement processes.	Higher predictability and higher committed volume decreases supplier's costs (e.g. safety stock, stock outs). ▪ Implement Spend Reporting to make Spend transparent (per Supplier, per Commodity, per Contract). ▪ Implement central groups per commodity group responsible for compliance. ▪ Define company-wide interaction processes with central compliance groups. ▪ Define company-wide approval rules (take geographical situation into account) change management and training ▪ Implement transportation cost reporting ▪ Set up procurement services via intranet and do not allow other procurement channels
	Demand consolidation	Improved contracted item prices by consolidating demand from multiple BUs within a company, also leading to reduced procurement process costs. Demand aggregation increases purchase volume with the selected vendors.	As a Buyer, leverage higher purchasing power and get higher price discounts ▪ Suppliers can decrease costs with higher committed volume from the buyer ▪ Refine material and vendor master coding. ▪ Make purchasing behavior transparent (Spend (contracted, not contracted), Supplier, Commodity, PO). ▪ Define cooperation guidelines for different facilities to consolidate demand. ▪ Align processes to aggregate orders and route them consolidated to the supplier.
	Right price determination	Achieve higher cost transparency & price determination by involving qualified vendors in best price evaluation (bids & reverse auctions), which further clarify the suppliers' price structure & contingencies.	Use of supplier portfolio and coordinated qualification and selection of suppliers across business units (process definition, selection criterias) ▪ Use efficient, electronic access and visibility to supplier performance, to evaluate significantly more responses to RFQs and identify best prices based on multiple criteria (quality, etc.) ▪ Leveraging technology (i.e., auctions, support for RFx development and evaluation) extends traditional sourcing capabilities and results in compressing the sourcing process timeline. ▪ Make visible historical data of negotiations for several years (Supplier history) and conduct price arbitrage across divisions)
Sourcing Optimization	**Supplier rationalization & qualification**	Rationalize or deproliferate Supplier-base to determine how many and which suppliers to maintain for a given commodity or specific part commodities, and manage associated risks.	As each Supplier has specific value added, the buying organization needs to pre qualify a portfolio of suppliers and understand their interdependencies. ▪ Make spend transparent (Supplier, Commodity). ▪ Define Supply Strategy per commodity group. ▪ Align processes for implementation of Supply-base strategy. ▪ Select value adding suppliers. ▪ Align/Concentrate spend per supplier group (strategic, non-strategic) per commodity group.
	Procurement risk management	Manage trade-off between procurement cost (unit price, process cost) and procurement risk (e. g. Lead Time, Quality, Delivery Reliability) by enabling the buyer to determine tactically the optimal order quantities to be allocated to suppliers.	Notion of risk management is linked with supplier follow up, either logistic agility, potential capacity, financial health, or potential ability to change. ▪ Identify and prioritize the risk factors per commodity group ▪ Make the single supplier relationship transparent towards the risk factors (as-is) ▪ Group the suppliers by the risk factors ▪ Define per relationship and per risk factors the to-be status and the required measure to achieve the status
	Supply Market Intelligence	Understand the upstream market, and know what kind of changes have to be done in the near future. Match product enhancements to new suppliers. Prepare for strategic sourcing and negotiations - Search for potential sourcing risks for strategic suppliers (bankruptcy, excessive demand, etc)	Supply market intelligence enables purchasers to effectively analyze upstream markets to improve sourcing decisions. ▪ Classify supplier relationship types. ▪ Determine performance monitoring strategy for given relationship densities. ▪ Identify the supplier performance measures. ▪ Create a supplier scorecard ▪ Purchasing info base construction ▪ Purchasing reports and surveys ▪ Proposition of new components, technology and alternatives to design office and engineering
Process Efficiency	**Procurement automation**	Reduce cost and increase speed of procurement processes by automation and elimination of unnecessary steps. Reduce rework (e. g. due to incomplete orders by improving data quality).	Procurement automation provides purchasers with effective tools to reduce time spent in the purchasing process ▪ Make number of POs transparent (Supplier, Commodity, departments). ▪ Redesign and automate process for procurement and supplier interaction. ▪ Adapt supplier selection criteria or e-enable suppliers. ▪ Reorganize work of purchasing department (Staff redeployment into more value adding areas).
	Contract handling efficiency	Cost efficient management and re-negotiation of existing contracts in handling of suppliers, contracts, and purchase information on a consolidated basis.	Global visibility of contracts and ability of reusing contracts improves contract handling process costs. ▪ Define contract handling standards per commodity group. ▪ Implement cross-unit coordination processes. ▪ Implement central contract management and monitoring.
	Supplier selection efficiency	Accelerate the selection process of pre-qualified suppliers through Rfx automation, supplier self-entry, weighted criteria evaluation and collaboration on the content of the RFx proposal.	Better information, a defined supply strategy per commodity group and insight into the evaluation criteria lead accelerates selection of suppliers across business units ▪ Make spend transparent (per supplier, per commodity, per contract) ▪ Align processes for implementation of supply base strategy ▪ Select value adding suppliers ▪ Align/ concentrate spend per supplier group
	Supplier enablement	Reduce supplier adoption and content mgt process costs by integrating suppliers into procurement processes and content management processes. Provide web-access to non-enabled suppliers to reach efficiency in more supplier relationships.	Evaluate supplier's ability to be e-enabled before adoption process begins ▪ Make the cycle times (PO approval and supplier confirmation) transparent ▪ Address legal and administrative issues between supplier and buyer early in process ▪ Ensure supplier's business concerns are known and able to be addressed by buyer ▪ Implement supplier adoption (communication, incentives, training, ramp up) ▪ Define strategy to IT enable more suppliers along the procurement process ▪ Define and understand ownership of content management responsibilities
Complexity Reduction	**Content harmonization**	Synchronize and harmonize supplier product content, supplier info, and internal master data to ensure the quality and efficiency of the enterprise-wide procurement activities by reducing additional effort in catalogue maintenance and increasing	Investigate capabilities of suppliers to support a harmonized content supply chain ▪ Investigate industry standards (UNSPSC) ▪ Implementation of content management standardization and change management ▪ Explore 3rd-party content providers ▪ Define global content strategy to target the individual needs of the business units and the capabilities / possibilities of the suppliers ▪ Select and/or enable suppliers to participate in the defined content creation and maintenance processes

Cluster	Business Initiatives	Initiative Objective	Typical Actions
		visibility of group-wide activities per supplier.	
	Parts rationalization	Reduce the number of different materials and consolidate # of parts purchased for similar uses to streamline material handling for production, inventory management and supplier selection.	The same part/ item with multiple codes throughout information systems may be rationalized to reduce duplication, excess inventory, evidence of unnecessary parts complexity in the product portfolio ▪ Create parts database and define parts groups in the Procurement department responsible for limiting complexity ▪ Identify duplicates in the parts database ▪ Define and implement parts rationalization strategy
	Capital investment & tracking	Follow up of investment and tools made for and kept by the suppliers is one main driver for negotiation. The quality is almost always dependant on the degree of investment made in this field.	Better return on investment may be achieved by recognizing what is available and plans put in place to leverage assets e.g. reduction of software licenses which can be shown to be non performing, reduction of communication devices which are hired and not used ▪ Code assets as part of delegation of workflow approvals ▪ Track assets using fields
Supplier Collaboration	**Product development acceleration**	Streamlining Product Development Process from a cost and time perspective by reducing the iteration steps in sourcing a product design or engineering specification with an external design or engineering partner.	An accelerated product development process increases revenue through shortened time to market, and reduced costs through reduced process time ▪ Make number of products developed, supplier involved and documents revised transparent by enabling a collaborative design & development process ▪ Define strategy on partner enablement and involvement in the development cycles(technical needs, document handling) ▪ Implement / align processes along strategy – work on project base (document standards, handling rules, document indexing, retrieval)
	Inventory cost management	Reducing inventory levels through shorter supplier lead times, reduce inventory holding costs via cycle time reduction, and streamline inventory mgmt to handle demand fluctuation across several facilities.	Inventory levels are highly dependent on cycle/lead times – reducing cycle/lead times lowers inventory requirements and holding costs ▪ Make stock level and costs per commodity transparent ▪ Evaluate per commodity group the company wide required stock levels and demand ▪ Centralize the planning of demand and the monitoring of inventory levels across several facilities
	Quality tracking	Improve quality of inbound deliveries, in order to take appropriate measures without delay. Use quality information in supplier evaluation and further contract negotiations	Improved quality tracking will enhance the purchasing organization's ability to follow up supplier performance and thereby increase adherence to quality demands ▪ Classify supplier relationship types and identify quality standards/commodity ▪ Determine performance monitoring strategy for given relationship densities ▪ Identify the supplier performance measures ▪ Create a supplier scorecard
	Demand / Supply Requirements visibility	Improve supplier collaboration, improve the supplier's inventory turns & costs, by providing more accurate production plans and visibility into future end-product customer demand.	Improved collaboration across the production process provides suppliers with increased visibility into raw material inventories and future demand, which allows them to better plan and adjust their own inventories and manufacturing requirements ▪ Make number of products under contract transparent ▪ Install ongoing forecasting capabilities of customer demand and establish close linkage to commodity purchasing ▪ Establish cross functional team on demand management process and validation
Organizational Empowerment	**Reporting & Communication**	Bring transparency to purchasing activities by defining appropriate KPIs and reporting formats, and making them available in a real-time (web-) reporting environment..	Having effective reporting and communication in place is mainly a pre-requisite for other business initiatives to reach their full potential. Diffusion of information on processes, contracts, selections, suppliers, price deviations, enables internal & external communication and ensures support of top management to supply activities. ▪ Identify reporting capability required and incorporate into reporting set ▪ Establish a communication part on the supplier portal ▪ Create change management information internal bound and external bound on the extranet ▪ Collaborate with top management to get efficient reporting
	Manage purchasing staff	Report and communicate purchasing activity to senior management and other departments. Continuously empower and evaluate the purchasing & sourcing staff.	Translate company strategy in the evaluation indicators for purchasing staff , balance workload, keep people trained on the right areas ▪ Define the Purchasing and Sourcing organization ▪ Identify and improve roles and responsibilities. ▪ Use procurement process analytics to identify opportunities for improvements ▪ Constantly report information relevant to purchasing actions or problem

APPENDIX 4: SRM INITIATIVES – IMPACT AND KPIS

Cluster	Business Initiatives	Business Impacts	KPIs
Value Optimization	**Compliance enforcement**	▪ Automating checks of existing contracts during approval processes, ▪ Decentralization of approval across different business units ▪ More consolidation of volume per contract ▪ More effective supplier contract management due to better reporting ▪ Reporting on contract compliance and actions that can follow .	▪ Spend per commodity under contract (Contract compliance) ▪ Ratio of spend per supplier under contract and not under contract of the same commodity ▪ Price variance per commodity ▪ Number of contracts / commodity ▪ Delta prices
	Demand consolidation	▪ Visibility of expenditure per supplier at group level will improve application of rebates, volume consolidation, inventory management and central reconciliation/ visibility of contracts under negotiation ▪ Supplier rationalization will be possible through greater awareness of supplier competencies ▪ Demand aggregation ▪ Enhanced supplier relationships	▪ Ratio of number of products produced and number of products ordered by customer ▪ Inventory level of finished (or ready to sell) goods ▪ Inventory turn level for materials ▪ Obsolete inventory on total inventory ▪ Number of supplier per commodity
	Right price determination	▪ Manual qualification and selection process will be improved through automation ▪ Reduction in qualification process through the reduction of the same supplier being qualified numerous times across business units ▪ Supplier selection process costs ▪ Price discount % eAuction over traditional auction ▪ Price discount moving non- compliant spend to eAuction	▪ Ratio on number of actual delivering Suppliers per set of commodity ▪ Number of involvements of individual suppliers in quotation process per set of commodity ▪ Sourcing cycle time ▪ Process Cost (# of suppliers, # of RFP/RFQ, # of contracts negotiated, throughput time) ▪ Price Variance / commodity
Sourcing Optimization	**Supplier rationalization & qualification**	▪ Visibility of total expenditure per supplier per commodity will enable better deals to be structured and ongoing performance monitored through greater focus ▪ Less effort will be required to brief suppliers on how to deal with the organization ▪ Lower Supplier selection & maintenance costs	▪ Average spend Volume per Supplier ▪ ABC distribution of purchasing spend over supplier-base ▪ Average supplier selection & maintaining costs ▪ Price per unit / commodity
	Procurement risk management	▪ A clear strategy can be developed for key and fall back suppliers ▪ Monitoring of supplier performance will lead to greater risk mitigation evidence and associated strategies ▪ Less reliance may evolve through dependence on bottleneck suppliers ▪ Average Spend Distribution per Supplier Group (strategic, non-strategic) per commodity group ▪ Reduced risk – increased supply stability; increased availability to promise ▪ Lower Unit Prices and improved Quality of material & services ▪ Inventory stock outs (pos. effect)	▪ Spend per supplier per commodity group ▪ Supplier rating Score Card Elements (Quality, Lead Time, Financials Key Figures, etc.) ▪ Number of unplanned stock-outs ▪ Max price differences between suppliers for same commodities
	Supply Market Intelligence	▪ Improved procedures for registration and acquisition of alternative suppliers ▪ Databases can be created on information on key suppliers for future improvement initiatives ▪ Harmonization of supplier records vis-à-vis external supplier bases (e.g. Dun&Bradstreet's DUNS classification) ▪ Lower Information search, qualification & risk mgmt cost	▪ Supplier life-span per commodity ▪ Number of design changes originated in the purchasing department ▪ Number of supplier files complete with external information
Process Efficiency	**Procurement automation**	▪ Some inefficient manually operated procurement processes with suppliers and within the company may be removed through workflow approvals and risk mitigation strategies ▪ Inconsistent procurement processes may be removed through control, standardization and then automation ▪ Lower Procurement Process Cost and Error rates ▪ Less Maverick buying – more consolidation and reduction of spend	▪ Procurement cost per PO ▪ Procurement throughput Time ▪ Number of Errors/ per PO ▪ Number of contracts/ BU, scheduling lines/BU ▪ Number of incomplete or false purchase order
	Contract handling efficiency	▪ Through greater awareness of contracts under management and recording, application of standard leading practices may be improved ▪ Contract Handling Process Cost ▪ Supplier Selection Process Cost ▪ Perform outsourced sourcing service for other business units / organizations	▪ Spend per commodity under contract ▪ Spend per commodity not under contract ▪ Number of Suppliers per commodity under contract ▪ Contract Handling Cost
	Supplier selection efficiency	▪ Industry metrics may be applied to lead to better contract formation and allocation of expenditure ▪ Greater focus may be applied with key suppliers through considering total expenditure and development of suppliers leveraging their talents for core competency development ▪ Lower Supplier Selection Process Cost ▪ Perform outsourced sourcing service for other BUs/ organizations ▪ Lower Selection Process Cost (# of suppliers, # of RFP/RFQ, # of contracts negotiated, throughput time)	▪ Average spend Volume per Supplier ▪ ABC distribution of purchasing spend over supplier-base ▪ Average supplier maintaining costs ▪ Average supplier selection cost ▪ ABC distribution of supplier disputes & suits and ABC distribution of quality
	Supplier enablement	▪ As many suppliers have limited IT capability to operate the sales order process electronically, opportunities will be able to be created by scaling processes to supplier types using past experience ▪ Increase supplier adoption rate, Increase of e-business exchanges ▪ Lower Procurement Process Cost – catalogue update cost ▪ Real time information, Reduction of data entering costs and mistakes, Reduction of interfaces maintaining costs ▪ Increase of visibility across Supply chain	▪ Cost per transaction for procurement-to-delivery cycle ▪ Share of suppliers interacting electronically ▪ Time passed between final PO approval and supplier confirmation ▪ PO through-put time/cycle time ▪ Number of planning changes & delays
Complexity Reduction	**Content harmonization**	▪ Lower Material Handling Costs ▪ Reduction of error rate (due to manual entries and lack of cost information) ▪ Lower Supplier Selection Process Cost (improved Selection Efficiency) ▪ Increase of catalogue and contract driven procurement (decrease of spend and administrative costs) ▪ Reduction of Maverick buying and quality of the information for the end user ▪ Content Preparation/Maintaining Cost	▪ Average content preparation/maintenance cost per supplier and commodity groups ▪ Number of PO refusals due to in correct data ▪ Number of wrong shipment
	Parts rationalization	▪ Material Handling Process Costs ▪ Inventory Carrying Cost ▪ Inventory Capital Cost ▪ Joint product design ▪ # of parts	▪ Number of parts per product per material group ▪ Number of new parts per commodity group/ per time unit (to be judged against the breadth of the product line) ▪ Inventory Level per commodity group ▪ Material Handling Process Costs
	Capital investment & tracking	▪ Unit cost ▪ Level of investment in cost structure ▪ Impact of depreciation on ROI and stock exchange share value	▪ Ratio of investment in cost structure ▪ Follow up of quantities made by a given tool

Cluster	Business Initiatives	Business Impacts	KPIs
Supplier Collaboration	**Product development acceleration**	▪ Collaboration with suppliers will be able to be improved through transfer of documents electronically thereby reducing errors ensuring version control and discussions conducted in real time by looking at editable documents ▪ Product cost follow up during development phase ▪ Time to market /Throughput-time ▪ Product Development Process Cost ▪ Pricing /configuration	▪ Number of iterations and number of days for typical design change or release ▪ Number of reportable production and assembly problems for typical product ▪ Fit of manufactured product to original specification ▪ Number of purchasing problems during production
	Inventory cost management	▪ Safety stock of inventory will be able to be reduced through enterprise wide awareness of availability ▪ Large hidden inventories will be exposed and expenditure budgets cut to reflect real need rather than perceived need ▪ Inventory Carrying cost ▪ Inventory Capital Cost ▪ Inventory Management Process Cost ▪ Improved supply chain performance	▪ Average Stock Level per commodity group ▪ Warehousing cost per average value of stock ▪ Number of people in inventory mgmt per average value of stock ▪ Inventory Mgmt Process Cost
	Quality tracking	▪ Supplier performance can be improved by targeting areas of weakness highlighted through record capture and monitoring for trends ▪ Information may be manipulated to produce trends and report by exception ▪ Improved Customer Service Levels	▪ Customer satisfaction index ▪ Ratio of Defects versus Received (return index)
	Demand / Supply Requirements visibility	▪ Customer demand may be met through better demand communication ▪ Document management, certificates and audit needs may be improved ▪ Improved Forecast Accuracy leads to lower Unit Price and Increased Inventory Turns, plus improved Throughput Time	▪ Ratio of number of products produced and number of products ordered by customer ▪ Inventory level per product ▪ Inventory turn level for materials
Organizational Empowerment	**Reporting & Communication**	▪ Improved performance visibility and monitoring ▪ Better reporting information throughout the corporation ▪ More efficient communication (lower process costs) ▪ Faster response due to better information-/ event-flow.	▪ Brand image of corporation ▪ Number of world class suppliers proactive to sell ▪ Satisfaction index of other departments
	Manage purchasing staff	▪ Efficiency of Purchasing budgets ▪ Better Role allocation ▪ Improved employee satisfaction ▪ Efficiency of purchasing staff	▪ Allocation of purchasing staff to purchasing actions ▪ Price deviation per product category, per design project, ▪ Ratio of purchasing cost per sales unit

APPENDIX 5: SRM INITIATIVES – NONPARAM.CORRELATIONS

Variable	by Variable	Kendall Tau b	Prob>|Tau b|
Demand_consolidation	Compliance_enforcement	0,0330	0,4527
Right_Price_determination	Compliance_enforcement	0,0874	0,0533
Right_Price_determination	Demand_consolidation	0,2560	<,0001
Supplier_rationalization_&_preq	Compliance_enforcement	0,2661	<,0001
Supplier_rationalization_&_preq	Demand_consolidation	0,2005	<,0001
Supplier_rationalization_&_preq	Right_Price_determination	-0,0579	0,2078
Procurement_risk_management	Compliance_enforcement	0,1276	0,0040
Procurement_risk_management	Demand_consolidation	-0,1040	0,0189
Procurement_risk_management	Right_Price_determination	-0,1497	0,0010
Procurement_risk_management	Supplier_rationalization_&_preq	0,3402	<,0001
Supply_market_intelligence	Compliance_enforcement	-0,3515	<,0001
Supply_market_intelligence	Demand_consolidation	-0,0073	0,8700
Supply_market_intelligence	Right_Price_determination	0,1974	<,0001
Supply_market_intelligence	Supplier_rationalization_&_preq	-0,3184	<,0001
Supply_market_intelligence	Procurement_risk_management	-0,0457	0,3087
Procurement_automation	Compliance_enforcement	0,1921	<,0001
Procurement_automation	Demand_consolidation	-0,1014	0,0221
Procurement_automation	Right_Price_determination	-0,2895	<,0001
Procurement_automation	Supplier_rationalization_&_preq	0,3998	0,0000
Procurement_automation	Procurement_risk_management	0,3129	<,0001
Procurement_automation	Supply_market_intelligence	-0,5139	0,0000
Contract_handling_efficiency	Compliance_enforcement	0,4239	0,0000
Contract_handling_efficiency	Demand_consolidation	0,0730	0,0993
Contract_handling_efficiency	Right_Price_determination	-0,1048	0,0216
Contract_handling_efficiency	Supplier_rationalization_&_preq	0,4182	0,0000
Contract_handling_efficiency	Procurement_risk_management	0,3827	0,0000
Contract_handling_efficiency	Supply_market_intelligence	-0,4340	0,0000
Contract_handling_efficiency	Procurement_automation	0,5604	0,0000
Supplier_selection_efficiency_	Compliance_enforcement	0,1987	<,0001
Supplier_selection_efficiency_	Demand_consolidation	0,2806	<,0001
Supplier_selection_efficiency_	Right_Price_determination	0,5439	0,0000
Supplier_selection_efficiency_	Supplier_rationalization_&_preq	0,2054	<,0001
Supplier_selection_efficiency_	Procurement_risk_management	0,1740	0,0001
Supplier_selection_efficiency_	Supply_market_intelligence	0,1297	0,0046
Supplier_selection_efficiency_	Procurement_automation	0,1186	0,0094
Supplier_selection_efficiency_	Contract_handling_efficiency	0,1907	<,0001
Supplier_enablement_	Compliance_enforcement	-0,2536	<,0001
Supplier_enablement_	Demand_consolidation	-0,0131	0,7673
Supplier_enablement_	Right_Price_determination	0,0292	0,5234
Supplier_enablement_	Supplier_rationalization_&_preq	-0,1721	0,0001
Supplier_enablement_	Procurement_risk_management	-0,2223	<,0001
Supplier_enablement_	Supply_market_intelligence	0,1397	0,0019
Supplier_enablement_	Procurement_automation	0,1351	0,0026
Supplier_enablement_	Contract_handling_efficiency	-0,1677	0,0002
Supplier_enablement_	Supplier_selection_efficiency_	0,0705	0,1232
Content_harmonisation	Compliance_enforcement	0,2675	<,0001
Content_harmonisation	Demand_consolidation	0,0969	0,0298
Content_harmonisation	Right_Price_determination	-0,1493	0,0012
Content_harmonisation	Supplier_rationalization_&_preq	0,3604	<,0001
Content_harmonisation	Procurement_risk_management	-0,0296	0,5114
Content_harmonisation	Supply_market_intelligence	-0,2310	<,0001
Content_harmonisation	Procurement_automation	0,2115	<,0001
Content_harmonisation	Contract_handling_efficiency	0,2926	<,0001
Content_harmonisation	Supplier_selection_efficiency_	0,0683	0,1372
Content_harmonisation	Supplier_enablement_	-0,0800	0,0766
Parts_rationalization	Compliance_enforcement	-0,0481	0,2727
Parts_rationalization	Demand_consolidation	0,4796	0,0000
Parts_rationalization	Right_Price_determination	0,2469	<,0001
Parts_rationalization	Supplier_rationalization_&_preq	0,2459	<,0001
Parts_rationalization	Procurement_risk_management	-0,2546	<,0001
Parts_rationalization	Supply_market_intelligence	0,1030	0,0204
Parts_rationalization	Procurement_automation	-0,0686	0,1214
Parts_rationalization	Contract_handling_efficiency	-0,2400	<,0001
Parts_rationalization	Supplier_selection_efficiency_	0,2102	<,0001
Parts_rationalization	Supplier_enablement_	0,1389	0,0018
Parts_rationalization	Content_harmonisation	0,2361	<,0001
Capital_investment_and_tracking	Compliance_enforcement	-0,2719	<,0001
Capital_investment_and_tracking	Demand_consolidation	0,1183	0,0075
Capital_investment_and_tracking	Right_Price_determination	0,0108	0,8123
Capital_investment_and_tracking	Supplier_rationalization_&_preq	0,0308	0,4927
Capital_investment_and_tracking	Procurement_risk_management	0,0023	0,9593
Capital_investment_and_tracking	Supply_market_intelligence	0,1165	0,0093
Capital_investment_and_tracking	Procurement_automation	0,0352	0,4315
Capital_investment_and_tracking	Contract_handling_efficiency	0,0676	0,1298
Capital_investment_and_tracking	Supplier_selection_efficiency_	0,0672	0,1404
Capital_investment_and_tracking	Supplier_enablement_	0,1381	0,0020
Capital_investment_and_tracking	Content_harmonisation	0,1679	0,0002
Capital_investment_and_tracking	Parts_rationalization	0,1736	<,0001
Product_development_acceleratio	Compliance_enforcement	-0,3632	<,0001
Product_development_acceleratio	Demand_consolidation	-0,3632	<,0001
Product_development_acceleratio	Right_Price_determination	-0,0011	0,9809
Product_development_acceleratio	Supplier_rationalization_&_preq	-0,2204	<,0001
Product_development_acceleratio	Procurement_risk_management	-0,0634	0,1715
Product_development_acceleratio	Supply_market_intelligence	0,5873	0,0000
Product_development_acceleratio	Procurement_automation	-0,2999	<,0001
Product_development_acceleratio	Contract_handling_efficiency	-0,4517	0,0000
Product_development_acceleratio	Supplier_selection_efficiency_	0,0562	0,2346
Product_development_acceleratio	Supplier_enablement_	0,1552	0,0008
Product_development_acceleratio	Content_harmonisation	-0,2218	<,0001
Product_development_acceleratio	Parts_rationalization	-0,0219	0,6335
Product_development_acceleratio	Capital_investment_and_tracking	0,0112	0,8087
Inventory_cost_management	Compliance_enforcement	-0,1111	0,0151
Inventory_cost_management	Demand_consolidation	0,5120	0,0000
Inventory_cost_management	Right_Price_determination	0,1963	<,0001
Inventory_cost_management	Supplier_rationalization_&_preq	-0,0756	0,1034
Inventory_cost_management	Procurement_risk_management	-0,0075	0,8703
Inventory_cost_management	Supply_market_intelligence	0,0697	0,1318
Inventory_cost_management	Procurement_automation	-0,1287	0,0053
Inventory_cost_management	Contract_handling_efficiency	-0,0835	0,0703
Inventory_cost_management	Supplier_selection_efficiency_	0,2033	<,0001
Inventory_cost_management	Supplier_enablement_	0,0565	0,2217
Inventory_cost_management	Content_harmonisation	0,1147	0,0136
Inventory_cost_management	Parts_rationalization	0,2953	<,0001
Inventory_cost_management	Capital_investment_and_tracking	0,2293	<,0001
Inventory_cost_management	Product_development_acceleratio	-0,2955	<,0001
Quality_tracking	Compliance_enforcement	0,0633	0,1649
Quality_tracking	Demand_consolidation	-0,0229	0,6160
Quality_tracking	Right_Price_determination	0,1461	0,0019
Quality_tracking	Supplier_rationalization_&_preq	0,0079	0,8652
Quality_tracking	Procurement_risk_management	0,3416	<,0001
Quality_tracking	Supply_market_intelligence	-0,0999	0,0305
Quality_tracking	Procurement_automation	0,0021	0,9641
Quality_tracking	Contract_handling_efficiency	0,2961	<,0001
Quality_tracking	Supplier_selection_efficiency_	0,0171	0,7157
Quality_tracking	Supplier_enablement_	-0,3366	<,0001
Quality_tracking	Content_harmonisation	-0,0683	0,1408
Quality_tracking	Parts_rationalization	-0,4124	0,0000
Quality_tracking	Capital_investment_and_tracking	0,1818	<,0001
Quality_tracking	Product_development_acceleratio	-0,2645	<,0001
Quality_tracking	Inventory_cost_management	0,2143	<,0001
Supply_requirements_visibility	Compliance_enforcement	0,1466	0,0009
Supply_requirements_visibility	Demand_consolidation	0,2534	<,0001
Supply_requirements_visibility	Right_Price_determination	-0,0500	0,2697
Supply_requirements_visibility	Supplier_rationalization_&_preq	0,1605	0,0003
Supply_requirements_visibility	Procurement_risk_management	0,0046	0,9182
Supply_requirements_visibility	Supply_market_intelligence	-0,1547	0,0005
Supply_requirements_visibility	Procurement_automation	0,0448	0,3130
Supply_requirements_visibility	Contract_handling_efficiency	0,1486	0,0008
Supply_requirements_visibility	Supplier_selection_efficiency_	-0,1212	0,0075
Supply_requirements_visibility	Supplier_enablement_	0,1204	0,0069
Supply_requirements_visibility	Content_harmonisation	0,0495	0,2683
Supply_requirements_visibility	Parts_rationalization	0,0043	0,9227
Supply_requirements_visibility	Capital_investment_and_tracking	-0,4106	0,0000
Supply_requirements_visibility	Product_development_acceleratio	-0,1819	<,0001
Supply_requirements_visibility	Inventory_cost_management	0,0657	0,1515
Supply_requirements_visibility	Quality_tracking	-0,0958	0,0361
Reporting_and_communication	Compliance_enforcement	0,1873	<,0001
Reporting_and_communication	Demand_consolidation	0,0288	0,5231
Reporting_and_communication	Right_Price_determination	0,2534	<,0001
Reporting_and_communication	Supplier_rationalization_&_preq	0,0912	0,0465
Reporting_and_communication	Procurement_risk_management	0,2894	<,0001
Reporting_and_communication	Supply_market_intelligence	-0,0190	0,6779
Reporting_and_communication	Procurement_automation	0,1512	0,0009
Reporting_and_communication	Contract_handling_efficiency	0,3368	<,0001
Reporting_and_communication	Supplier_selection_efficiency_	0,3805	<,0001
Reporting_and_communication	Supplier_enablement_	0,0204	0,6543
Reporting_and_communication	Content_harmonisation	0,2600	<,0001
Reporting_and_communication	Parts_rationalization	-0,1935	<,0001
Reporting_and_communication	Capital_investment_and_tracking	0,0727	0,1096
Reporting_and_communication	Product_development_acceleratio	-0,3012	<,0001
Reporting_and_communication	Inventory_cost_management	0,2154	<,0001
Reporting_and_communication	Quality_tracking	0,4409	0,0000
Reporting_and_communication	Supply_requirements_visibility	-0,0877	0,0524
Manage_Purchasing_staff	Compliance_enforcement	-0,1500	0,0010
Manage_Purchasing_staff	Demand_consolidation	-0,0502	0,2695
Manage_Purchasing_staff	Right_Price_determination	-0,1999	<,0001
Manage_Purchasing_staff	Supplier_rationalization_&_preq	0,2525	<,0001
Manage_Purchasing_staff	Procurement_risk_management	0,2034	<,0001
Manage_Purchasing_staff	Supply_market_intelligence	0,0484	0,2934
Manage_Purchasing_staff	Procurement_automation	0,0158	0,7300
Manage_Purchasing_staff	Contract_handling_efficiency	-0,0630	0,1699
Manage_Purchasing_staff	Supplier_selection_efficiency_	-0,0208	0,6566
Manage_Purchasing_staff	Supplier_enablement_	0,0470	0,3069
Manage_Purchasing_staff	Content_harmonisation	-0,1131	0,0145
Manage_Purchasing_staff	Parts_rationalization	-0,0483	0,2874
Manage_Purchasing_staff	Capital_investment_and_tracking	0,0167	0,7164
Manage_Purchasing_staff	Product_development_acceleratio	0,2794	<,0001
Manage_Purchasing_staff	Inventory_cost_management	0,1197	0,0115
Manage_Purchasing_staff	Quality_tracking	0,0900	0,0566
Manage_Purchasing_staff	Supply_requirements_visibility	0,1948	<,0001
Manage_Purchasing_staff	Reporting_and_communication	-0,1698	0,0003

[1] In the last decade a rising number of companies have been working with improvement, integration and automation of their intraorganizational processes realized via enterprise resource planning (ERP) systems. The wider deployment of ERP systems and innovations in messaging and tracking technologies that allow real-time management of supply chain activities, has resulted in more compatible process and information Furthermore, the Internet has emerged as an ubiquitous communication platform on which companies can collaborate with their partners, reduce cycle times and enforce data and security protocols.

[2] According to Johnsen et al. (2000), two distinct streams of research have influenced the recent creation of the concept of Business networks: (1) the research on industrial networks conducted by the Industrial Marketing and Purchasing (IMP) group and (2) the operations- and logistics-based research on supply chain management. Members of the IMP group have developed models to provide a better understanding of business markets in terms of the nature of buyer–supplier relationships and the embeddedness of these in 'industrial networks', modeled as interconnected actors, activities, and resources (Håkansson and Snehota, 1995). Much of the same language is used to describe the building blocks and nature of supply networks (Harland, 1996).

[3] According to *Coordination Theory*, managing is a highly information-intensive activity and applying information technology (IT) to this area has a profound impact (Malone and Crowston 1994). According to Malone (1997), the dominant logic of the future might be the idea of connected decentralization enabled through a higher information technology intensity. Benjamin and Wigand (1996) have elaborated on the effects of IT and the potentials for reducing transaction and coordination costs when organizational units cooperate. This direct interrelation of IT performance and coordination costs compensates for the additional coordination requirements within networked environments. Therefore, IT enables extended networking among business units, a phenomenon called 'Electronic Strategic Networking Effect'.

[4] Clusters within networks are mentioned by Håkansson and Snehota, 1995.

[5] Supply networks as a development from linear, supply chains were presented by Harland, (1996). One way of distinguishing between supply chains and supply networks is to analyze the types of interdependencies that exist. Supply chains may be defined by the long-linked technology that is employed by firms acting in what Porter (1985) has described as value systems, i.e. a set of connected value chains. Whereas value creation in supply chains equals a value chain logic, the same analogy cannot be made for supply networks. In other words, value networking firms relying on a mediating technology is not the only viable model in supply networks. Interdependencies in supply networks are not given, and supply networks are not captured by Porter's (1985) value system. The analysis of value creation in supply networks must take account of type of activities that various actors' rely upon.

[6] Porter acknowledges the impact of the Internet on the supply chain (Porter, 2001) and asserts that the Internet is the most powerful tool available today for enhancing operational effectiveness as it allows the exchange of real time information thereby creating improvements throughout the value chain. But he cautions that the advent of internet technologies alone will not help firms achieve competitive advantage as traditional sources such as scale, human resources and investments in physical assets continue to play prominent roles. Indeed, the open nature of Internet technologies makes if easier for companies to use them. This minimizes the opportunity for them to deliver competitive advantage.

[7] Recent literature (e.g. Lamming et al, 2000; Gadde & Håkansson, 2001; Dubois, Hulthen & Pedersen, 2003), proposes that supply networks may be seen as an extension of supply chains, seeking to explain the commercial complexity associated with the creation and delivery of gods and services from the source of raw materials to their destination in end-customer markets. They also suggest that the supply network concept is more strategically relevant since it ties together the resource potential of the network in an effective manner. According to the industrial network model, business relationships, including supply chain relations, are outcomes of interaction processes where different actors try to influence one another. Any relationship consists of a combination of activity links, resource ties and actor bonds (the so called A-R-A model, see note 13 taken from Håkansson & Snehota, 1995) that together with other relationships form network structures. From an industrial network approach the supply chain perspective contributes substantially to our understanding of efficient flows of materials, but it fails to consider that relationships are not independent, but embedded (Gadde et al, 2002).

[8] Supply Relationship Management (SRM) seek to unite engineering, design, sourcing, specification of services and the physical logistics, as well as the management and administration of suppliers needed to optimize enterprise profitability. SRM practices attempt to drive maximum value from the entire supply base at acceptable risk on a sustained basis.

[9] The decade-long controversy on the value of information technology (IT) investments (and their effect on productivity improvements) have recently been conciliated by the work of the MIT economist Eric Brynjolfsson (1993), who has questioned and subsequently provided empirical explanations of the time-lack of IT investments and productivity effects. His research highlighted that IT contributes to productivity and profit gains only when combined with large investments in process redesign, attention to human resources (i.e. change management) and a willingness to innovate around IT in a inimitable way thus creating lasting competitive advantage (Orlikowski, 1992, 1996). Thus, Barua, et.al. (1995) suggest a multi-stage, process oriented study to measure the first-order and higher-order impact of IT.

[10] See in an exposition of IT infrastructures in Hanseth's (1996) dissertation.

[11] In Webster's dictionary infrastructure is defined as: "a substructure or underlying foundation; esp., the basic installations and facilities on which the continuance and growth of a community, state, etc. depends as roads, schools, power plants, transportation and communication systems, etc."

[12] This means that an infrastructure is design to support a wide range of activities, not especially tailored to one. It is enabling in the sense that it is a technology intended to open up a field of new activities, not just improving or automating something existing. This is opposed to being especially design to support one way of working within a specific application field. This enabling feature of infrastructures plays important roles in policy documents like those mentioned above.

[13] An infrastructure is shared by the members of a community in the sense that it is the one and the same single object used by all of them (although it may appear differently). In this way infrastructures should be seen as irreducible, they cannot be split into separate parts being used by different groups independently. An e-mail infrastructure is one such shared irreducible unit, while various installation of a word processor may be used completely independently of each other. However, an infrastructure may of course be decomposed into separate units for analytical or design purposes.

[14] They are open in the sense that there is no limits for number of user, stakeholders, vendors involved, nodes in the network and other technological components, application areas or network operators. This defining characteristic does not necessarily imply the extreme position that absolutely everything is included in every II. However, it does imply that one cannot draw a strict border saying that there is one infrastructure for what is on one side of the border and others for the other side and that these infrastructures have no important or relevant connections.

[15] Infrastructures are heterogeneous concerning the qualities of their constituencies. They encompass technological components, humans, organizations, and institutions. This fact is most clearly expressed in the last bullet paragraph above. This is true for information technologies in general, as they will not work without support people. An information system does not work either if not the users are using it properly. For instance, flight booking systems do not work unless all booked seats are registered in the systems.

[16] Different networks -- some compatible and closely aligned, others incompatible and poorly aligned -- are superimposed, one on top of the other, to produce an ecology of networks. Thus, infrastructures are connected into ecologies of infrastructures and in that respect they are layered - linking logical related networks - and integrating independent components, making them interdependent.

[17] Infrastructures are layered upon each other just as software components are layered upon each other in all kinds of information systems. This is an important aspect of infrastructures, but one that is easily grasped as it is so well known.

[18] Building large infrastructures takes time. All elements are connected. As time passes, new requirements appear which the infrastructure has to adapt to. The whole infrastructure cannot be change instantly - the new has to be connected to the old. The new version must be designed in a way making the old and the new linked together and "interoperable" in one way or another. In this way the old - the installed base - heavily influence how the new can be designed.

[19] “SRM is the proactive management of a company's entire relationships with suppliers across all business areas with the goal to deliver, procure... SRM differs from e-procurement because it does not only look at the operative business processes but also supports such strategic sourcing tasks as strategy development, outsourcing decisions, integration of suppliers, and materials group management.” (Dr. Daniel Corsten, Joerg Hofstetter, University St. Gallen)

[20] Such metrics might be: on-time delivery; quality of product; quality of service; category coverage; production lead times; bar coding, electronic data exchange (EDI), Web or XML; updated manufacturing technologies and R&D commitments; fulfillment costs; payment terms and electronic funds transfer (EFT) capabilities; the cost and business value (e.g., marketability of new features) vs. the cost efficiency of standardization

[21] *Networks* are organizational structures in between markets and hierarchies (Hedaa, 1997; Ford et al., 1998). The network theories aim to render organizational issues in inter-organizational networks, and focus on strategic positioning or power configurations. Networks typically exist in heterogeneous business-to-business markets, because e.g. trust here is beneficial to all members as it allows the network to define its context and thus its immediate environment (Håkansson and Snehota, 1994 in Ford ed., 1997). Network-theory emphasizes the importance of two basic questions: (a) Who does what?, and (b) How are their activities connected? Furthermore, it highlights that companies in general should only perform those activities in which they may perform better than average compared to major competitors in the long run, i.e. focusing upon core competencies. Where industrial marketing is very much a matter of establishment and development of customer relationships, the network paradigm adds at least three important factors: (1) power, (2) influence and (3) trust.

[22] See in Gadde and Håkansson (2001).

[23] In general, *actors, activities* and *resources* go into the description of external networks as independent factors (Håkansson and Snehota, 1995): a) *Actors* are characterized by their performing of activities and controlling of resources. Actors in an industrial network may be perceived broadly as individual persons, groups in organizational, or organizations. Which actor is going to be at the focus will depend upon the actual context. b) *Activities* are performed by actors when using and transforming resources and considered to be links in longer chains of activities. One such example is the chain of value added in the transformation of raw materials and other inputs into complex products and services. c) *Resources* are controlled by actors and the value of resources is determined by the activities in which they are to be used Examples of resources are technology, finance, capital and personnel (Ford, 1997).

[24] See Hedaa and Törnroos for a detailed description, 1997. Event-handling is a relevant view of the performance of such infrastructures.

[25] Other systems development practices which contribute to project success are effective project planning, effective change control, business justification, compatibility of skills with the skill set needed for project requirements, and leadership by a “champion” who markets the project internally

[26] The last two decades have seen the emergence of what has come to be referred to as 'actor-network theory' (ANT) though its progenitors Latour (1996) and Callon (1997, 1991) disown this 'naming'. The most pertinent aspects of ANT as a theory is its attempt to describe the interplay between various elements (or actors) in networks where human and non-human elements (or nodes, or actors) are present.