Economic Research, Vol. 24 (2012) No. 4 (1101-1112)

CURRENT ISSUES AND CHALLENGES OF SUPPLY CHAIN MANAGEMENT

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Efficient supply chain management is crucial for survival and success in a turbulent world. Current economic crisis increases its importance even further. This conceptual paper reviews latest findings in the most relevant areas of supply chain management. Six issues were identified as the most crucial for successful supply chain management.

For each of the identified current issue a thorough literature review was conducted; main findings are reviewed. The main implications of each of the issue are shown on a brief case study. Research findings and practical implications are combined in a way that enables an overview of the topics for researchers and guidelines for practitioners.

Keywords:

supply chain management,
business redesign,
information technology
risks
frameworks

JEL:
L2
L20

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I. INTRODUCTION

It has often been claimed that in the modern world the competition is no longer between single companies but between supply chains [33; 43]. Anecdotic evidence also supports this claim (e.g. the problems in automotive industry due to supplier failures or the infamous Nokia-Eriksson-Phillips example [8]). However, although supply chain management is one of the most researched topics in recent years most of the papers are focused on either mathematical methods for supply chain optimization or on specific important issue and not on an overview of business-related challenges connected to supply chains.

The challenge for firms today is namely not just to take up a supply chain management (SCM) initiative but to implement it successfully. An informatics perspective is vital since information flow is an integral part of SCM and material flow is closely dependent on information flow. But SCM initiative can be a failure unless one is aware of the issues that may arise during its planning or implementation [46].

However, SCM is, at best, still emergent in terms of both theory and practice[40], therefore both further research and classification of previous research efforts is needed. This paper mainly contributes to the second purpose; namely it presents several important issues in SCM. The paper focuses on six issues that are currently of outmost importance for researchers and practitioners in the SCM field. Firstly, it presents the main findings relating to SCM strategy, emphasizing the fact that there is no best-practice SC strategy since it is contingent on several internal and external factors. Secondly the importance of business redesign is discussed; applications of SCM namely often means not only doing things more efficiently but rather to considerably change the business processes and to restructure product/service portfolio

Even the best SC has risks. Therefore special attention is paid to the different sources of risks and uncertainty and a new approach for evaluation of these risks. After that the focus of the paper shifts to supply chain frameworks and standards; different frameworks have been developed to streamline businesses and bridge the supply chain risks. The next section on performance measurement is equally important; only a process that is monitored can be properly managed and improved. Finally, a vast majority of SC activities is supported with various information systems; thus the last section focuses on the core issues and challenging of developing IS support.

Such an approach means that the paper is not a rigorous review of all issues connected with SCM but rather an overview of selected issues and a starting point for anyone who would like to get more familiar with this exciting field. The structure of the paper follows its purpose. Each of the six selected issues is reviewed and illustrated with a short vignette (reference to full-scale rigorous case study is usually provided).

II. CURRENT ISSUES IN SCM

A. Strategic insights

In a number of organizations, cost-effective supply chain is a matter of survival as purchased goods and services account for up to 80 per cent of sales revenue while in the public sector there is an ever-increasing demand for savings in the procurement process [16].

In order to optimize the SC the following five configuration components are critical: operations strategy, outsourcing strategy, channel strategy, customer service strategy and asset network [9]. The four main approaches towards production are make to stock, make to order (see e.g. [18] for a comprehensive review of make to order SC challenges), configure to order and engineer to order – they considerably affect the correct strategy.

One of the main consequences of the lack of information exchange/coordination in the chain is the so-called bullwhip effect, which was first theoretically described in the 60s [13] and practically in the 80s with the case of Pampers diapers. The fluctuation of demand namely increases as we move up the supply chain; small fluctuations at the end of the chain can be propagated to considerably larger fluctuations for e.g. the original equipment manufacturer [7]. Although the bullwhip effect has been detected decades ago, it is still one of the most widely investigated phenomena in the modern day supply chain management research. Nepal et al. [27] and Sodhi and Tang [38] represent contemporary field research on compound causes of the bullwhip effect by considering an real life scenarios with multiple price-sensitive demand streams.

Another important decision is whether push or pull system should be used. The push system schedules the jobs in advance for a series of work centres, and each work centre pushes its completed jobs to the succeeding work centres. In a pull system uses a 'pull' approach, where a work centre finishes its operations and then requests the next job from the preceding work centre[29].

I. CASE STUDY: STRATEGIC ISSUES IN UTILITY SECTOR

In the past, utility companies were organized as a traditional downstream SC, generating, distributing and supplying a commodity (i.e. electricity, water). In the last decade utility sector has undergone major changes in terms of liberalisation, increased competition, efforts in improving energy efficiency, and in new technological solution such as smart meter and grid operations. Effectively, traditional utility supply chains are under pressure to change tackling several strategic issues:

1. multi-commodities, delivering several products or services to the customer,
2. multi-jurisdictions, meaning SC will be spreading across different states/countries regardless of the geographical borders,
3. multi-tariffs, as a result of dynamic pricing and multi-commodities.

The enablers of change in utility companies are IT and IS support. IT and IS support forms an infrastructure that enables customer relationship management and information sharing. Both are vital for effective utility SC management since final consumption affects whole SC and energy has limited or no option of stocking. From energy sector SC management point of view, final consumption is core since it directly affects upstream SC – generation and distribution. In order to have lean utility SC, consumption data have to be shared upstream.

Information processing and sharing also affects SC reward system and pricing policy. Past SC reward systems have been focusing on a company or even department (i.e. purchasing). Future SC reward schemes could take into account integral SC measures that will enable deep insight into the roles of each organization in the SC.

B. Business redesign in SCM

After successful strategy formulation, companies have to identify areas of possible improvement in quality of product or service, lead times or operational costs [31]. This step takes an integral view of all organisations involved into the supply chain in order to renovate their operations towards supply chain excellence. Business Redesign (BR) or business process redesign and informatisation efforts integrate the radically strategic method of Business Process Re-engineering (BPR) and more progressive methods of Continuous Process Improvement (CPI) with appropriate IT infrastructure strategies. BPR is a thorough re-engineering strategy that critically examines current business policies, practices and procedures, rethinks them and then redesigns the mission-critical products, processes and services [32]. BPR seeks improvements by

elevating efficiency and effectiveness of the business process that exist within and across organizations. On the opposite, CPI refers to minor and specific changes that one makes in an existing business process [20]. CPI relies on building a fundamental understanding of customers' requirements, process capability, and the root cause of any gaps between them by developing culture of continuous improvement in the areas of reliability, process cycle times, costs in terms of less total resource consumption, quality, and productivity. Six Sigma and Total Quality Management (TQM) are examples of approaches to CPI.

Since direct changes can have a detrimental result, companies develop business process models. A business process model is an abstraction of a business that shows how business components are related to each other and how they operate [42].

The main purpose of developing and analysing business process models is to find revenue and value generators inside a reversible value chain or a business model's value network. The reason for modelling is that supply chain is a complex production system consisting of a network of manufacturers and service suppliers related to logistics systems that provide transportation and storage. The use of modelling allows companies to create a compact representation of states, actions and events of the modelled system [24].Such a modelling approach should combine high-level models for supply chain design with detailed models for engineering the accompanying information systems and enable rapid instantiation of specific supply chain configurations from a repository of standard building blocks [47]. SCOR helps in this quest as it provides a basic process modelling tool, an extensive benchmark database, and guidelines on how to measure the supply chain operations.

II. CASE STUDY: BUSINESS PROCESS REDESIGN IN AN OIL INDUSTRY

The case study deals with the fulfilment/procurement process in an SC that contains a petrol company (with multiple petrol stations at different locations) and a supplier which transports the petrol to the petrol stations from a few large warehouses.The business process modelling and redesign project was initiated by the petrol company in order to reduce operating costs, shorten lead times and improve stock management. The project started with the formation of a project group consisting of members of the petrol company, the transport company and consultants. The first step of the project was a workshop for the project group in which the members were acquainted with the project goals and methodology. After the workshop, key business process groups were identified by discussion and brainstorming. One of the most crucial processes was the procurement process.

The main goals are similar to the usual SC goals: to offer good service to the final customer, while keeping costs and lead-times low. As both the prices and quality of petrol in Europe are regulated, the main quality indicator is the number of stock-outs. The main cost drivers are therefore: number of stock-outs, stock level at the petrol station and process execution costs (work, transport etc.). The main problems on the strategic level were slow and costly flow of information, unavailability of full information, human limitations preventing the decision-maker from using all available information and the inclination to seek for local instead of global optima.

Based on the mentioned problems, several improvements are proposed. The main change is that the processes at both companies are now integrated and the supplier takes responsibility for the whole procurement process. More details about the case can be found in [17; 43]

C. Supply chain risks

Supply chain risk management has become a key concern for organizations, which is even further emphasized by the current economic and financialcrisis. The complex mix of heterogeneous

collaborators in supply chains increases the complexity of the risk profiles of inter-related components within these networks [5] and suitable strategies to manage information risks in supply chains are needed [12]. The risk of disruptions caused by both factors within SC and outside environmental forces is a topic of increased importance. Supply chain risk management is therefore a field of escalating importance and is aimed at developing approaches to the identification, assessment, analysis and treatment of areas of vulnerability and risk in SCs [26]. Various trends that enhance exposure to risks, such as the increased use of outsourcing, globalisation (see e.g.[25]) reduction of the supplier base; reduced buffers, increased demand for on-time deliveries or shorter product life cycles [28] are increasing the importance of SCRM. The sources of risks can be from suppliers', customers' or internal environment [41]. Due to the raised level of complexity andunpredictability of future events the keyelements for a robust and resilient supply chain are a strategy and a structure aligned with the actualbusiness context, a dynamic and comprehensive approach to risk management, and collaboration among companies in the same supply network[10]. Several strategies for managing supply disruptions exist such as the backordering strategy, the upgrading/downgrading strategy, the compensation strategy, and the mixed strategy [37].

The recently developed model [44]sheds more light on the prediction of suppliers' connected risks. It is based on the premise that different suppliers (and their second and third tier suppliers) operate in different markets and environments; therefore their turbulence and the forces influencing a supplier also differ. While a certain supplier strategy (e.g. ordering large batches to decrease procurement costs or single-source suppliers with long contractual commitments) may be acceptable in a non-turbulent environment, it may be detrimental in a more turbulent one (e.g. in the presence of quick technological advances such as microprocessors or large commodity price swings). Considering all of this, the same supplier attributes, strategy and structure may pose considerably different risks of disruption.

In order to distinguish between the different kinds of risks, the sources of uncertainty were separated into two different constructs [44]: endogenous uncertainty and exogenous uncertainty: the source of uncertainty/risk is from outside the SC. The current approaches only offer a limited estimation of the risk of supplier non-performance. The proposed approach enables the estimation of the risks and helps the company to make a more informed decision as to how much risk it is willing to take and which risks will it mitigate (either with dual/multiple sourcing or with the change of supplier).Although most researchers would agree that supply chains are inherently risky, one issue remains relatively unexplored; that is: a practical perspective to improve supply chain robustness and resilience in order to deal with unexpected events[10].

III. Case study: Risk management in an automotive industry

The application of the framework can be best described with a case from automotive industry. Recently, automotive companies have been experiencing supplier-related disturbances on a frequent basis. The company in this case (more details can be found in [44]) conducted a supplier risk assessment for selected commodity groups (castings, shocks, steering gears and aluminium wheels) in an attempt to mitigate the supplier-connected risks.

The objectives were twofold: first, to assess all the criteria that contribute to supplier risks and, second, to implement mitigation steps with identified suppliers. The assessment was conducted as a combination of interviews and online surveys that allow organisations to assess a large group of suppliers within a short timeframe. Online surveys measuring characteristics and the SC structure (location, transportation routes etc.) were completed by selected supplier key

informants. Risk analysts also rated the supplier's market and technology turbulence and its exogenous uncertainty.

Two suppliers are chosen as an example: Fenton (names are fictional, all other data are real) was in a low turbulent environment; Jupiter, on the other hand, had a similar performance rating but was in a highly turbulent environment. In addition, Jupiter was the single source of certain parts which considerably increased the impact of any potential disruption. The potential risk was too high for the focal company. Therefore, mitigation plans were put in place and an investment was made in qualifying back-up suppliers for Jupiter.

Soon after this, Jupiter lost a large customer which greatly changed its financial position. This caused Jupiter's financial backers to withdraw, resulting in its collapse and liquidation. The back-up suppliers were notified and within one week the production was transferred to those suppliers. Without a consideration of turbulence, the mitigation of this risk may not have been a high priority and an expensive disruption would have been the outcome.More details about the case can be found in [44].

D. Supply chain frameworks and standards

In order to design processes efficiently and effectively more and more organizations use available industry standards in the form of reference models [21]. Different frameworks and standards (SCOR, GS1, MMOG/LE, ISO 9001, ISO 14001, BS OHSAS 18001, BS 25999, ISO/IEC 27001, etc) have been developed. The organizations are facing the challenge which one to implement and to what extent. The adoption of frameworks and standards causes standardization of business operations that is in contradiction with agile supply chain strategies and lean business models. From the business model point of view the most relevant is the Supply-Chain Operations Reference (SCOR) model that was developed by the Supply-Chain Council (SCC) to assist organisations in increasing the effectiveness of their supply chains, and to provide a process-based approach to SCM [39]. The SCOR model provides a common process oriented language for communicating among supply-chain partners in the following decision areas: PLAN, SOURCE, MAKE, DELIVER and RETURN.

SCOR is a top-down analytical method that helps organizations break out of the box and see where they fit into the SC. SCOR provides three-levels of process detail. Each level of detail assists a company in defining scope (Level 1), configuration or type of supply chain (Level 2), process element details, including performance attributes (Level 3). Below level 3, companies decompose process elements and start implementing specific supply chain management practices. It is at this stage that companies define practices to achieve a competitive advantage, and adapt to changing business conditions.

As a framework it also facilitates inter and intra supply chain collaboration, horizontal process integration, by explaining the relationships between processes (i.e., Plan-Source, Plan-Make, etc.). It also can be used as a data input to completing an analysis of configuration alternatives (e.g., Level 2) such as: Make-to-Stock or Make-To-Order. SCOR is used to describe, measure, and evaluate supply chains in support of strategic planning and continuous improvement.

Researching the link between frameworks or standards and supply chain performance is scarce. Lockamy & McCormack [23] have studied the link between SCOR planning practices and supply chain performance and shown that the supply chain planning practices related to process integration, collaboration, teaming, process measurement, process documentation and process ownership have been shown to be important to supply chain performance, but lack broad implementation by supply chain partners. This suggests that integrated supply chain management may be more difficult to operationalize in practice than the popular supply chain

press or consultants would have one to believe. This study also suggests is that some of the best practices proposed as mechanisms for improving overall supply chain management performance may not have the degree of impact often presented in the literature. Some best practices help to improve supply chain performance only in specific decision areas.

IV. Case study: SCOR in the manufacturing company

Global manufacturer of air conditioning, refrigeration, and heating equipment and parts was growing, delivering new products to the market. Business growth was both organic and from acquisitions. Company soon realized that the growth and numerous acquisitions resulted in heterogeneous business models, business processes and IS support. Heterogeneity started to affect their business reflecting in increased lead times and operating costs. Company's strategy is to globally increase competitiveness through supply efficiency and cost reductions where suppliers develop active partnerships with the company to enhance volumes and expand business opportunities.

Since the company sees itself as a SC, they realized that they will have to strengthen the IS support throughout the SC – aligning the company, acquisitioned companies as well as suppliers. But they soon realized that launching unified IS support in many different locations under time pressure with different process definitions would be impossible.

In order to seize the benefits of unified IS support, they used SCOR to create a common language inside SC support. Apart from providing a common process oriented language for communicating among supply-chain partners, SCOR was also used as a reference in performance measurement in SCM.Although the company found SCOR highly valuable they realized that all business activities are not subject to SCOR. Customer relationship management, research and technology development and product development are not covered by SCOR and had to be developed internally by the company.

E. Performance measurement in SCM

A well known-saying is that: 'You Can't Manage What You Can't Measure'. Therefore all frameworks and research efforts emphasize the importance of performance measurement.Improving supply chain performance has become one of the critical issues for gaining competitive advantages for companies. A systematic approach to improve accomplishment of key performance indicators (KPIs) in a supply chain is needed. Such an approach should identify crucial KPI accomplishment and propose performance improvement strategies for decision-makers in a supply chain [4]. A distinctive characteristic of supplychainperformancemeasurement is that the measurement system should span the supplychain, including metrics with interdependencies that cross the borders of organizations[14].

Many researchers have stressed the importance of using the right measures and metricsto manage a SC efficiently and effectively and have developed them from differentperspectives[36]. Before investigating different performance measures it is important to note that performance measures have to be closely connected with strategy, business model and also the objectives of a company/SC [2; 3].

Performance measurement focuses on two connected but still separable areas, namely the measurement of performance of each supplier and the measurement of supply chain as a whole. The classic metrics for supplier performance measurement are replenishment lead time, on-time performance, supply flexibility, delivery frequency, quality, viability, information coordination capability etc. [7]. According to the recent survey the most important measures are quality of

delivered goods, on time delivery and flexibility of supply [19]. Since balanced scorecard is in general one of the most widely used models for performance measurement its application to supply chain area has also been proposed. Such an example is presented in [30] who derived the objectives for SCM from financial, customer, business process (both internal and external) and learning and growth perspective. As shown performance measurement is closely connected with process redesign outlined in the previous section.

One of the increasingly popular approaches for both measurement of effectiveness and prediction of changes due to redesign of supply processes is the use of simulations. They enable the preparation of the models of current and desired state and can be used to estimate the risks of different events [6]. In connection with business process modelling (see section 2.2. of this paper) they can be used to compare different configurations of business processes.

V. Case study: Estimation of e-procurement benefits and risks

A typical example of the use of business process simulations as a tool to estimate current performance and predict the impact of potential further changes is presented in [45]. There a rigorous methodological approach to the analysis of e-procurement benefits is presented. Business process simulations are used to analyze the benefits of both technological and organizational changes related to e-procurement. The approach enables an estimation of both the average and variability of procurement costs and benefits, workload and lead times. In addition, the approach enables optimization of a procurement strategy (e.g. approval levels).

Discrete-event simulations were used to analyze different scenarios. The reason is that the adoption of rigorous business process simulation methodologies enables one to evaluate different configuration of process chains in realistic settings and to estimate the expected pay-offs resulting from re-engineering/IT incorporation [15].The probabilistic distribution of lead times for all four scenarios is shown in [45]. For example the organizational changes (the difference between scenario 2 and 4), mainly the increase in approval levels bring the most considerable decrease both in the average lead times and also in the number of transactions with exceptionally long lead times (e.g. over 10 days).

F. IS support for SCM

Final issue in SCM is IS support supply chain operations which is by far an easy task. Information technology is an important enabler of effective supply chain management. Much of the current interest in SCM is motivated by the possibilities that are introduced by the abundance of data and the savings inherent in sophisticated analysis of these data. SC must move from mere cooperation and coordination to true collaboration which requires a foundation of trust and commitment.

The innovative opportunities coming to the fore with e-business have increased the interest in IT. From technological perspective SCM spans over internal as well as external systems, which facilitates information transfer between various organizations. In addition, SCM typically includes many functional areas within an organization and is affected by the way the various groups communicate and interact.

In order to achieve these goals, major issues in IS support are standardization, infrastructure e-business, supply chain components and integration. Standardization is vital for IT since it allows systems to work together and is a key feasibility factor of SCM implementation. Infrastructure is a basic component of system capabilities without which some of the goals cannot be achieved. E-business is an emerging area of business conduct that provides cost-effective way of SCM. Supply

chain components are various systems that are involved directly in supply chain planning. These are typically systems that combine short-term and long-term decision support system elements.

The goal of SCM software is to increase flows through collaboration. However, increasing collaboration is not merely a matter of making a tool available. Participants must be encouraged to use the tool share information to make its use effective. Ruppel [35] compared adoption of three information technologies (i.e. group decision support systems, EDI and e-business) that can be used to improve information flows and the factors that affect their adoption and use. Comparison indicates that the decision to adopt one of these technologies does not guarantee its effective use. Those who wish to champion the use of tools have a complex task to perform not just to foster adoption, but also to encourage successful implementation.

The real challenge of implementation is bridging the gap between IT, process and performance view. Business processes are key integrator providing performance-process-IT relation to elicit the actual impacts [1]. To connect the performance with IT, business processes are acted as mediators between them.

III. CASE STUDY SMART GRIDS IN EUROPE– FUTURE IS SUPPORT IN ELECTRICITY SECTOR

Europe's electricity networks have provided the vital links between electricity producers and consumers with great success for many decades. The fundamental architecture of these networks has been developed to meet the needs of large, predominantly carbon-based generation technologies, located remotely from demand centres. The energy challenges that Europe is now facing are changing the electricity generation landscape. The drive for lower-carbon generation technologies, combined with greatly improved efficiency on the demand side, will enable customers to become much more inter-active with the networks[11].

The electricity sector faces new challenges and opportunities which must be responded to in a vision of the future which include the need to develop user-centric approach, the renewal of electricity networks, the need to assure security of supply with limited primary energy sources, liberalised markets, distributed generation and demand side management [11].

Evidently, times have changed for electricity sector in EU. Above mentioned changes are business drivers that result in changed supply chain strategy and management. The technology will also change considerably mainly due to smart grids. Smart grids are a new concept of intelligent electricity grids, which primarily involves the integration of new information and communication technologies with power transmission lines and distribution cables. From IS support there is a whole spectrum of issues that will have to be met from purely technological to business. From the IT point of view it will be a serious issue to incorporate smart grids into existing IS support since the currently IS supports a completely different business model.. As the grid becomes more intelligent and more complex, the tools to operate it become increasingly important. To be useful, however, those tools must be fully integrated into the existing IS support [34].

IV. CONCLUSION

The paper has tackled a vital challenge to provide a comprehensive review of several inter-connected challenges in supply chain management. Only continuous efforts in each of the mentioned areas assure efficiency and success. Nevertheless, optimal decision making is not possible since the choice set is too complex and generally unknown, due to the large number of possibilities and uncertainties. Therefore SCM »optimization« involves a small number of choices at each step of exploration [22]. We hope that our paper is a small but significant contribution in this quest.

Obviously the paper has some limitations. The choice of the included issues was mainly arbitrarily, based on authors' practical and theoretical knowledge. The presented cases are not a full rigorous cases but rather short vignettes; however references to full cases were provided.

Finally, as the only certainties in today's world are frequent changes it is likely that the challenges of SCM will also change/increase in the coming years. However the main concepts outlined in this paper are likely to remain rather similar.

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