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ENHANCING LEAN SUPPLY CHAIN MATURITY WITH BUSINESS PROCESS MANAGEMENT

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Abstract: *In today's global market the main focus of competition is not only between different companies but also between supply chains. Technological changes and organizational improvements are important for effective supply chain management (SCM), however, the main cause of SCM improvements is not the implementation of an information system (IS) itself, but rather a change and an integration of business processes. The paper summarizes the most important concepts of SCM and specifically concentrates on the importance of business process management (BPM) in supply chains, because full advantages can be realized when business processes in the supply chain are well defined, integrated and managed. The main purpose of this paper is to show that successful SCM calls for the maturity of supply chain processes in all involved companies and at the supply chain level, which can be realized by using effective BPM methods. A necessary condition for growing of SCM in terms of supply chain process maturity levels is an inter-organizational information system development and process renovation. Yet, BPM should not be considered as a one-time project of IS implementation and process change, but as a permanent process performance measurement, analysis and continuous improvement of the supply chain processes. The concepts are illustrated with a case study of fuel supply process.*

Keywords: *supply chain management, process maturity, process integration, business process redesign, business process management, case study, fuel supply process.*

1. INTRODUCTION

In today's global market the main focus of competition is not only between different companies but also between supply chains. As the satisfaction of the final customer is of utmost importance for the successfulness of the whole chain, effective management of those processes is crucial. It is not sufficient to have efficient processes within a company, synchronized operations of all partners and integration of processes in the supply chain are required [54].

Many new organizational concepts and technological solutions have been developed in recent years, however, only a few companies use them strategically in a supply chain to achieve full competitive advantage, while many others develop and implement inappropriate e-business solutions [8]. Business processes are critical components of almost all systems that support enterprise-level and business-critical activities [57]. Practical experience has shown that the root cause therefore is not technological problems but is linked to organizational and process aspects [20].

Today, many companies strive to improve business processes that are extended across different organizations, however, the existing BPM methods designed to be used inside organizational boundaries [57] have to be adapted and used at the supply chain level. The main purpose of this paper is to show that successful supply chain management (SCM) calls for the maturity of supply chain processes in all involved companies and at the supply chain level, which can be realized by using effective BPM methods. SCM and BPM are interrelated, because process integration is a prerequisite for the management of entire processes in a supply chain that are performed in several connected companies. The preliminary condition for processes integration is that they are well defined and mature, and that organizations are process oriented. The integration is carried out by using inter-organizational information systems [39], but other aspects of BPM, like organizational changes, have to be applied as well. That leads to higher process maturity and to better SCM process performance.

The structure of this paper is as follows: the next section analyses the main concepts and challenges of SCM. The maturity of supply chain processes and its connection with supply chain performance is presented in the third section. Fourth section analyzes the role of BPM in SCM for enhancing the maturity of supply chain processes. Section five illustrates the theoretical findings with a case study from oil industry, while in the last section the main findings are summarized and discussed.

2. SUPPLY CHAIN MANAGEMENT

A supply chain is a network of connected and interdependent organizations mutually and cooperatively working together to control, manage and improve the flow of materials and information from suppliers to end customers, as defined by the Supply Chain Council [47]. It not only includes manufacturers and suppliers, but also transporters, warehouses, retailers and customers [39]. Supply chain flows are both forward and backward; products usually flow forward, while information flows backward and forward [45].

In [53] strategies and methodologies for designing supply chains that meet specific customer expectations are discussed. Three different types of supply chains are defined:

- A lean supply chain, which employs continuous improvement efforts which focuses on eliminating waste or non-value steps along the chain.
- An agile supply chain, which responds to rapidly changing, continually fragmenting global markets by being dynamic, context-specific, growth-oriented, and customer focused.
- A hybrid supply chain, which combines the capabilities of lean and agile supply chains to create a supply network that meets the needs of complex products.

Besides, a framework for categorizing the supply chain types according to product characteristics (standard, innovative and hybrid products) and stage of product life cycle (introduction, growth, maturity and decline) is developed. The authors of [53] claim that standard products that tend to be simple and have limited amounts of differentiation should be produced by a lean supply chain. The most promising result of an effective lean supply chain management is long-term cost reduction via product or process reengineering by forming closer relationships with key suppliers [7]. For innovative products that may employ a new and complex technology, the agile supply chain is more suitable in the early phases of the life cycle, and the lean supply chain in mature and decline phases. On the other hand, for hybrid products, which are complex, have many components and participat-

ing companies, the hybrid supply chain is appropriate. In this paper the prevailing part of the discussion refers to a lean supply chain.

According to the definition of supply chain management (SCM) by the Global Supply Chain Forum, SCM is "the integration of key business processes from end user through original suppliers that provide products, services, and information that add value for customer and other stakeholders" [5]. It is the approach to designing, organizing and executing the processes in the supply chain [53]. In [54] SCM is defined as "the management of the interconnection of organizations, which relate each other through upstream and downstream linkages between different processes that produce value in the form of products and services to the ultimate consumer". As we can see from all the above definitions, integration of business processes in a supply chain is one of the main characteristics and objectives of SCM.

A prerequisite for effective SCM is long-term contracts, partnership and established e-business connections between the companies in the supply chain. To realize that, one of the common applied methods is vendor-managed inventory (VMI), where the supplier has full information about the inventory state and future needs of the retailer and is therefore responsible for timely deliveries. The supplier identifies the procurement need and starts the process of fulfilling it. Similar approaches are sometimes described as co-managed inventory (CMI), distribution requirements planning (DRP), and continuous or efficient replenishment planning (CRP/ERP) [31].

Supply Chain Council, an independent non-profit organization, developed the cross-industry standard for SCM named The Supply Chain Operations Reference-model (SCOR) [47]. It was designed for effective communication among supply chain partners and can be used to describe, measure and evaluate supply chain configurations. SCOR is based on five distinct management processes: Plan, Source, Make, Deliver and Return.

2.1.1. Measures of SCM successfulness

The most important measures of SCM successfulness are the final level of service, customer satisfaction and supply chain performance and competitiveness. However, as these are difficult to measure or use as a guideline to monitor improvement, more operational measurement methods and indexes were developed.

In [26] a comprehensive process measure a classification model is proposed (Figure 1). In this model the results of a process can be seen twofold: the object out is the result of the process' activities (transformation) and represents the immediate results of delivery, whereas the outcome is the long-term result which evolves over time and is usually not completely under the control of the value chain participants. As the object out is the short-term result of the product delivery, it can be usually measured directly and immediately. On the other side, outcome is more difficult to define and measure.

As the process measure model is suitable for process-oriented organizations, it can be well used as a framework for metric system development for an entire supply chain.

On a more operational level the key performance indicators may be total costs, quality and lead times in the supply chain [37]. Survey of performance measures [2], [3] showed that cost and customer responsiveness dominate as the most often mentioned measures. A survey of top management showed

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survey of top management showed that throughput, lead-time, and utilization are considered among most important [48].

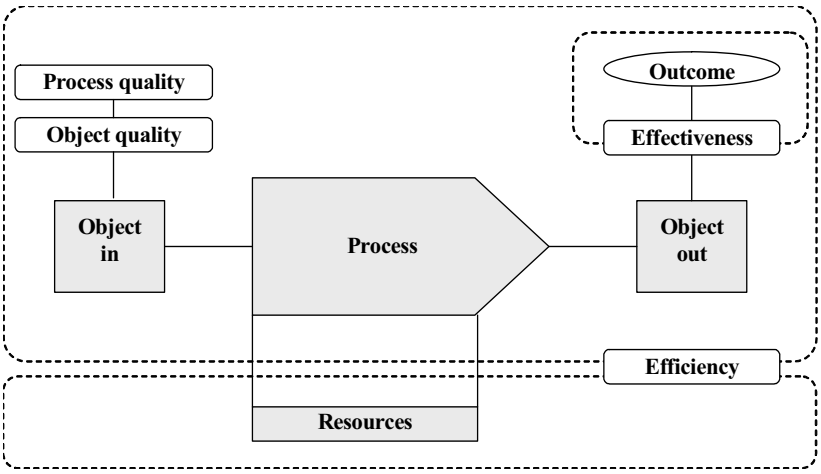

Figure 1: The process measure model [26]

Different performance measures can be classified in resource (e.g. cost, inventory), output (most importantly customer service) and flexibility measures (ability to respond to changes in the environment) [37]. Similarly [5] emphasizes the importance of measuring the inputs (time, costs) and outputs (quality, reliability and innovativeness of the products/services) of the process. Composite measures, which include all of the above, are productivity, efficiency and utilization of resources.

Another possible classification of process measures can be found in [26]. The classification based on the above presented process measures model (Figure 1) consists of two groups of measures (Figure 2): measures of the process itself and resource measures. The first group is related to the effectiveness of the process, while relating performance measures (object and process quality) to resource measures allows evaluation of the efficiency.

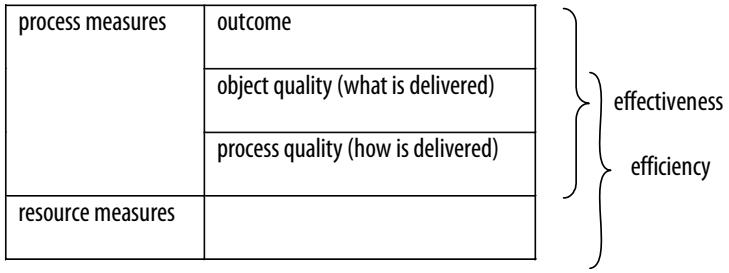

Figure 3: Process measure classification [26]

As shown above, different authors emphasize slightly different aspects of those measures. However, the common conclusion from the above-summarized findings can be that achieving high customer satisfaction with low costs, combined with flexibility to react to unforeseen changes, is crucial. While the final customer is mostly interested in the total quality and effectiveness of the supply chain as a whole, changes in a single company should also be studied. A company is unlikely to participate in an integration project if it does not bring benefit to that company as well.

The performance measures should be integrated across different departments and all companies in the supply chain [1], [25]. Otherwise the concentrated effort towards the realization of those goals is not possible. Ideal performance measures would both facilitate the improvements and enable the measurements of achieved results. A common approach to predicting and measuring the effects of SCM is the use of simulations; see [4] for an example of simulating the effect of business process renovation and [50] for a coherent review of literature about this topic.

2.1.2. Supply chain management challenges

While the separation of supply chain activities among different companies enables specialization and economies of scale, there are many important issues and problems that need to be resolved for successful and efficient supply chain operation – this is the main purpose of SCM. Most of those problems stem either from uncertainties or inability to coordinate several activities and partners [51].

One of the most common problems in supply chains is the so-called bullwhip effect. Even small fluctuations in the demand or inventory levels of the final company in the chain are propagated and enlarged throughout the chain. Because each company in the chain has incomplete information about the needs of others, it has to respond with the unproportional increase in inventory levels and consequently even larger fluctuation in its demand to others down the chain [11]. There are many practical examples from various industries that support this finding [54], [33], [34].

Another problem is that companies often tend to optimize their own performance, disregarding the benefits of a supply chain as a whole (local instead of global optimization). Sharing of information can obviously be a problematic issue as the companies in a supply chain may not be prepared to share their production data, lead times, specially when those companies are independent of each other [50]. Indeed, the lack of trust between business partners is one of the main hindrances to collaboration in the supply chain context [19], [1]. Additionally, human factors should also be studied: decision-makers at various points in a supply chain do usually not make perfect decisions (due to the lack of information or their personal hindrances). Those problems are also interconnected as employee reward systems often focus simply on growing the sales or on gross margins [31]. A detailed review of other SCM related problems can be found in [18].

In recent years numerous studies have emphasized the importance of information sharing within the supply chain (e.g. [1], [23], [24], [44]). Indeed information sharing is a prerequisite for successful operation of a supply chain [28]. Information should be readily available to all companies in a supply chain and business processes should be structured in a way to make full use of this information. The difficulties of formulating and adopting a new process, the lack of cooperation between vendors, and the difficulty of interorganizational coordination present the major difficulties in SCM. Supply chains that will be able to find better answers to these challenges will achieve a considerable competitive advantage.

2.1.3. The role of IT in supply chain integration

Internet and e-business offer many possibilities for effective information sharing that enables a seamless flow of transactions in a supply chain. They can also facilitate relationships by their ability to transfer information [55]. Newly developed relationships can drastically change the underlying business processes and different new approaches emerge, like computerized point-of-sale (POS) systems, material requirements planning (MRP), manu-

facturing resource planning (MRP II), enterprise resource planning (ERP), etc. (see [51] for more details).

The efficiency of supply chains can generally be improved by e.g. reducing the number of manufacturing stages, reducing lead-times, working interactively rather than independently between stages, and speeding up the information flow [37]. It was shown that electronic data interchange (EDI) could reduce swings in inventory and safety stock levels. The simulation results showed that (among other improvements) the standard deviation of the stock level could be reduced by 64% [36].

In [33] the analysis of the impact of the Internet on company business operations, in particular on procurement and fulfilment process, is given. Four case studies regarding large Italian companies (Aprillia, Carraro Group, Ducati, and Fischer Italia) are considered and compared and an evolutionary model for e-business strategy is proposed. The model shows how IT can evolve from being an instrument which coordinates company processes through five stages: traditional communication tools, internal integration, Web-based communication tools, XML Web-based platform, and integrated enterprise.

In [39] integrated supply chain architecture is proposed that combines the benefits of ERP systems with traditional SCM applications. The paper proposes architecture based on Internet and wireless technologies that provides for the flow of information by bridging the gap between SCM systems and other applications.

In [54] the role of IT is analyzed in the sense of development of inter-organizational IS, defined as collections of IT resources, including communication networks, hardware IT applications, standards for data transmission, and human skills and experiences. This development can be categorized into four phases, from paper-based documentation, through development of EDI, and integration of information systems to strategic partnerships. The authors conclude that although IT improves the flows of information and allows better communication between parties, organizational and system factors such as process definitions and legacy systems are also important.

It should be noted that the use of information technology, networks and e-business applications alone is not a solution to all supply chain problems and is not sufficient to realize the benefits. Even more: the most often quoted problems of online purchasing are not related to technology but rather to logistic and supply chain problems [17], [54]. This is even truer for traditional companies that are usually even less prepared for new e-business related challenges.

Electronic linkages (and consequently better flow of information) in the value chain have fundamentally changed the nature of inter-organizational relationships [32]. The barriers to the adoption of inter-organizational information systems do not lie primarily in the technology but in business processes. The key issue for successful SCM is integrating business processes, such as purchasing and customer relations, regardless of disparate computing platforms, applications and operating systems [54]. Even in the most successful companies there are few processes that are fully integrated [30]. Optimization of a supply chain is therefore based on fully integrated business architecture and technology infrastructure of supply chain entities.

Implementing an information system facilitates information sharing and coordination between partners and enables global optimization of a supply chain. Only sharing of information enabled by inter-organizational information systems will not lead to improvements, the coordination of activities is crucial as well [10]. Redesign of the whole supply chain and examination of the linkages between internal and external functions are required. Appropriate business processes are a prerequisite for the strategic utilization of information, otherwise sharing of information can only lead to an overload of information without full benefits for anyone involved.

3. THE MATURITY OF SUPPLY CHAIN PROCESSES

To cope with the challenges organizations, especially those that wish to successfully manage their supply chains, have to accept process-based management principles. The process paradigm implies a new way of looking at organizations based on the processes they perform rather than on the functional units, divisions or departments they are divided into. The perceived need for such shift in organizational design stems from the fact that despite the changes in contemporary economic and social environments, management values and principles from the industrial revolution still determine the organizational structure of many modern firms.

A process is a set of one or more linked procedures or activities that collectively realize a business objective by transforming a set of inputs into a specific set of outputs (goods or services) for another person (customer) by a combination of people, methods, and tools [49], [57]. Procurement and fulfilment are the key processes in a supply chain and with the onset of the Internet those, which have to be first and foremost redesigned and reorganized [33].

To analyze the understanding of processes of a company and a supply chain the concept of business process orientation (BPO) can be used. The concept denotes an organization that, in all its thinking, emphasizes processes as opposed to hierarchies with a special emphasis on outcomes and customer satisfaction [30]. An empirical investigation was conducted [30] to study and explore the relationship between BPO and enhanced business performance. The research results showed that BPO is critical in reducing a conflict and encouraging greater connectedness within an organization, while improving business performance.

BPO is connected with the process maturity concept [14] that was designed as a reference model of the stages that organizations go through as they move from immature to mature in their process orientation. The SCM maturity model [27] is based on concepts developed by researchers over the past two decades and implies that a process has a lifecycle that is assessed by the extent to which the processes are explicitly defined, managed, measured and controlled. The purpose of the model is to assess at which stage the organization and/or the supply chain is and to assist in developing a road map to help them where they want to go.

A SCM maturity model is illustrated in Figure 3. The model conceptualizes how process maturity relates to the SCOR framework. It had been developed upon the process maturity model [30] and defines the following SCM maturity levels:

- **Level 1 – Ad hoc**: The supply chain and its practices are unstructured and ill-defined. Processes, activities and organizational structures are not based on horizontal processes, process performance is unpredictable. SCM costs are high, customers satisfaction is low, functional cooperation is also low.
- **Level 2 – Defined**: Basic SCM processes are defined and documented, but activities and organization basically remain traditional. SCM costs remain high, customer satisfaction has improved, but is still low.
- **Level 3 – Linked**: This level represents the breakthrough. Cooperation between company departments, vendors and customers is established. SCM costs begin decreasing and customer satisfaction begins to show marked improvement.
- **Level 4 – Integrated**: The company, its vendors and suppliers cooperate in the process level. Organizational structures are based on SCM procedures, SCM performance measures and management systems are applied. Advanced SCM practices, like

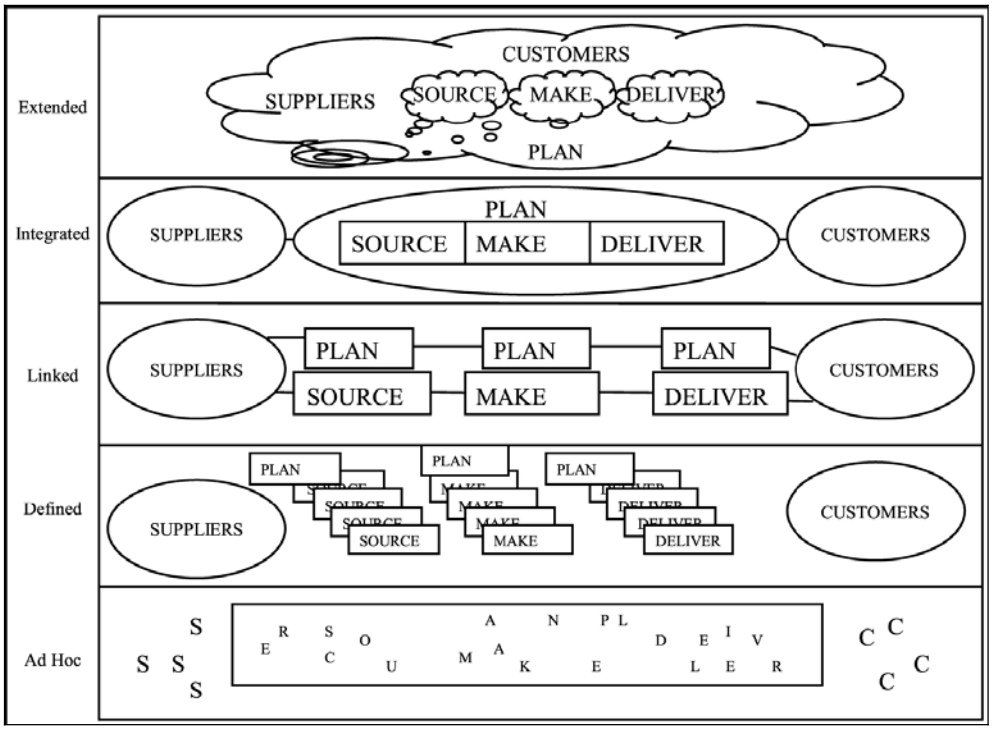

Figure 3: Supply chain processes maturity model [27]

collaborative forecasting with other members of a supply chain, form. As a consequence, SCM costs are dramatically reduced.

- **Level 5 – Extended**: **Competition** is based on supply chains. Collaboration between companies is on the highest level, multi-firm SCM teams with common processes, goals and broad authority form.

In [27] the relationship between supply chain processes maturity and overall supply chain performance is examined by a survey among organizations that were members of the Supply Chain Council. The research showed that SCM process performance is strongly related to supply chain processes maturity. Additionally, the research indicates that direct process measures like cycle times and inventory levels are also related to the maturity of supply chain processes.

Similar investigation was conducted in Slovenia and Croatia at the end of 2005. The results [41] showed that most companies have their processes defined and documented to some level, which is in fact one of the most important aspects of process orientation. However, based on our previous research [40] where it was shown that many companies are documenting their processes as a part of quality standard acquisition requirements this result needs to be considered carefully. This could be confirmed by the finding of the same investigation that process terms such as input, output, process and process owner are not used widely in studied organizations. This shows that employees do not perceive their organizations as process oriented. Clearly it is not enough for the processes to be defined and documented »on paper«, they must actually be implemented and work must progress as defined in process models. For that to happen employees need to adopt the process way of thinking and become familiar with the processes in which they participate. It is also worth noting that information systems development is frequently based on business processes

which can probably be attributed to the fact that ERP solutions are gaining their importance and are being implemented more and more often. Of course, solely the implementation of an ERP system does not make an organization process oriented. Similarly, original investigation [30] revealed that the process documentation may be constructed by the project team and remained within the team and not shared with the organization, which is often the case with technology-driven BPO efforts.

A process maturity measurement instrument can also be used to determine an organization's current position [30] and for prescriptive purposes in process improvement efforts by indicating which maturity measurements are deficient [27]. Some suggestions how to raise the level of BPO and supply chain processes maturity are given in the next section.

4. ENHANCING SUPPLY CHAIN PROCESS MATURITY WITH BUSINESS PROCESS MANAGEMENT

Process maturity is the foundation for process-oriented organization and supply chain integration as processes themselves take the central role in it. To be a BPO organization with mature processes, a company needs to work as a team and all the functional areas of the business need to be properly integrated, with each understanding the importance of cross functional processes. A more detailed description of a business process-oriented organization or a horizontal organization as the author refers to it is given by [35]. The basic principles of a process-oriented organization describe its fundamental characteristics, which are:

- The work is organized around cross-functional core processes.
- Process owners or managers that take responsibility for the core processes, are important.
- The work is organized in teams, because teamwork encourages creative solution seeking to the problems that an organization faces on a daily basis.
- Hierarchy is decreased by eliminating non-value-added work and by giving team members, who are not necessarily senior managers, the authority to make decisions directly related to their activities within the value chain.
- Integration with customers and suppliers for tighter and more effective relationships.
- Changing the organizational design is a daunting and complex undertaking.

The plausibility of successful restructuring increases by following some implementation principles, like empowerment of people, use of information technology to help people reach performance objectives and deliver value proposition to the customer, promotion of creative thinking and flexible responding to new challenges, measurement of end-of-process performance objectives (which are driven by the value proposition), as well as customer satisfaction, employee satisfaction, and financial contribution, building a corporate culture of openness, cooperation, and collaboration, a culture that focuses on continuous performance improvement and values employee empowerment, responsibility, and well-being.

SCM initially emphasized local optimization of each supply chain activity, or more specifically, lowering of costs and increasing the level of services at each stage [45]. However, the connection of existing processes in different companies is rarely possible without thorough redesign, realignment, simplification and standardization of current business processes. As the ultimate customer perceives the output of an entire supply chain as a

unique product and/or service a similar transition to that inside companies from a functional to process view, also from inter-organizational linkages to truly integrated and managed inter-organizational processes has to be done at the supply chain level. Inter-organizational processes have to be designed in a way that a supply chain can react to the changing needs of their customers, to new business models of their competitors, and opportunities afforded by new technologies [54].

Regardless of the industry, the number of companies involved or the technological solution used for integrating a supply chain, the fundamental of SCM is to manage and integrate business processes, as discussed in the previous sections. The redesign of processes must not only include internal organizational processes, as an organization is just one entity in a value system carrying out processes which extend beyond the boundaries of the organization. Therefore the traditional business process redesign is now extended to what is usually referred to as business network redesign [32].

However, the integration of business processes in supply chain is not smooth. On the contrary, it is difficult because integrated supply chains usually develop initially as "chained pairs" of activities, and are later broadened to multi-stage or fully integrated chains. The activities, processes, risks, and cost are often differentially defined by each activity. Ultimately, these differences create a complex web of both formal and informal relationships among the entities of a supply chain, all of which must be satisfied by the overall balancing of interests [45].

The transition from inter-organizational linkages to process-orientation takes many forms. Business process (re)design is one of the most common forms of organizational change [42]. Business process redesign integrates the radical strategic method of business process re-engineering [15] and more progressive methods of continuous process improvement (CPI) with adequate IT infrastructure strategies. It is a strategy that critically examines current business policies, practices and procedures, rethinks them and then redesigns the mission-critical products, processes, and services [38]. It is also a method of improving the operation and therefore the outputs of organization [21]. It means analyzing and altering the business processes of the organization as a whole and requires careful change management. In SCM terms an important aspect is to guide process renovation with the idea to simplify and improve processes in a way that they can be more easily integrated with other companies.

In the 90s, process renovation focused on internal benefits such as cost reduction, the downsizing of a company and operational efficiency, which are more tactically than strategically focused. Nowadays, e-business renovation [4] strategies focus on the processes between business partners and the applications supporting these processes. In [32] the importance of electronic commerce in enabling the redesign of both the internal and external organizational processes is analyzed.

Nowadays the most promising method for process improvement is business process management (BPM) that combines business process redesign with the automation of activities and workflow systems. It is a blend of process management, usage of workflow management systems and applications integration [43]. It is about taking control of processes all the way to customer and includes the capabilities to discover, design, deploy, execute, interact with, operate, optimize and analyze processes [57].

While BPM enables a shorter cycle-time and lower costs of transactions, it also means the reduction in inventory levels (safety stock) for all companies in a supply chain without increasing the danger of stock-outs. However, [5] proved by the use of mathematical modelling that costs are decreased only by 2% due to a better flow of information, while the majority of benefits of using IT is the consequence of shorter cycle times and smaller production series. Similar findings are presented in [45], where the benefits of shorter cycle

times are emphasized. It can be concluded from the above findings that only a better flow of information between participating organizations, which is usually enabled by integrated information systems, has a relatively small contribution to improved successfulness of SCM. All practices and elements of BPM (Figure 4) have to be used in order to significantly increase the maturity level of a supply chain, which can also be seen from the case study presented in Section 5.

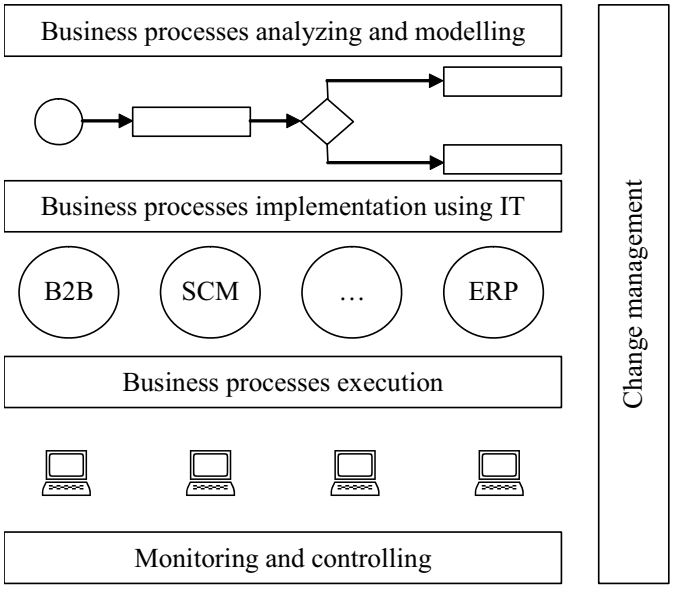

Figure 4: Business process management [4]

For efficient and effective achievement of the first levels (e.g. level 2 and 3) of business processes maturity in a supply chain, the existing processes have to be fully understood and documented. Models of business processes play an important role in different phases of business process (re)design regardless of the methodology used [9]. Business process modelling and the evaluation of different alternative scenarios for improvement by simulation are usually the driving factors of a business renovation process [4]. Techniques that provide for the modelling of business processes, evaluation of their performance, experimenting with alternative configurations and process layouts, and comparing between diverse proposals for change, are highly suitable for organizational design [12].

Many different methods, techniques and tools can be used for the modelling of business processes in order to give an understanding of possible scenarios for improvement. The most promising technique is Business Process Diagram (BPD) that is a part of Business Process Modelling Notation (BPMN) standard developed by the Business Process Management Initiative (BPMI) [56]. The technique is supported by a majority of contemporary BPM tools and is used in the case study presented in the next section as well.

However, for the higher levels (e.g. lever 4 and 5) of supply chain maturity business process modelling and redesign of processes is not sufficient. Metrics are not to be used only for analyzing current supply chain practices and benchmarking in the business process redesign project. Supply chain processes have to be constantly measured and controlled. Constant improvements, tuning and re-tuning of the integrated processes are required. As competition is based on supply chains at the level 5 (extended), common process management for the entire supply chain has to be established.

Permanent tracking of supply chain measures and continuous tuning of processes enable some strategic advantages besides the advantages at the operational/tactical level.

Quicker identification and response to long-term changes in demand patterns, improved customer service, better and quicker response to unexpected events and also introduction of new products or services are much easier in the new model. As evident from the previously described process measure model [26] the effectiveness of the process can be achieved and evaluated only by the long-term measurement and continuous improvement of processes.

Process monitoring and controlling consists of the following phases (adapted from [26]):

1. Collection of data
2. Compilation (structuring and quantitative treatment)
3. Presentation and communication
4. Analysis (identification of problems and opportunities)
5. Action (planning and realization of improvements)

Currently used IT that supports supply chain management well supports the transactional level of the supply chain (improved flow of information and collection of measurements). It can be seen from the discussion above that the main benefits of IT lie in business process integration and improvement, which can be only achieved by a careful and permanent analysis of a supply chain. For the second, third and fourth phases of process monitoring and controlling business intelligence at the entire supply chain level can be applied. Business intelligence (BI) is understood here as a managerial philosophy and IT tools used to help organizations manage and refine business information with the objective of making more effective business decisions [28]. Thus, multi-firms collaborative business intelligence could extensively support the entire set of BPM practices, with the emphasis on business process renovation and continuous improvement.

5. CASE STUDY: FUEL SUPPLY PROCESS

The main concepts of business process management in the SCM context can be illustrated by the following case study from oil industry. By analyzing the case study we want to show which the main problems are, when the processes in a supply chain are not integrated, to identify the key prerequisites and problems when increasing the level of SCM maturity, and to present the consequences (benefits) of inter-organizational business process management.

The case deals with the fuel supply process in which two companies are involved: the large oil company (with more than 400 gas stations) and the transport company transporting fuel from a few large warehouses owned by the oil company. The main goals of the process are similar to the usual goals in a supply chain: to provide the final customer with the best service possible (in this case the low possibility of stock-outs), while reducing the total costs (the costs connected with stocks at the gas station, total transportation expenses and the costs for the execution of this process). Because of the very low profit margins in oil industry [13] it is crucial to keep all costs as low as possible and the reduction of transportation cost has an important role in achieving this effort, because the production and warehousing are usually conducted on a separate place from retail.

Before the redesign of the process, the main decisions were taken at the oil company with the transport company mainly in the operational role. The process started daily by measuring the level of fuel at the gas station. This activity was performed manually by the

employee who used a special stick to measure the level in the tank. The result was then faxed to the purchasing department that analyzed the stock level and approximately estimated the future demand by taking seasonal and cyclical movements, weather etc. into account. If necessary, additional consultations with the gas station personnel were performed. Based on those results, the decision whether to order more fuel was made for each gas station. After that the fuel needs from different gas stations were merged into one order and sent to the transporter who had to fulfil this order with its truck fleet. Some manual optimization of transportation was applied.

The main problems regarding the process were:

- Full information was not available when making a decision, e.g. the purchasing department did not have much information about the truck fleet. On the other hand, the first time the transport company received the information about the fuel needs was when it received the order, and did not have any chance to modify it. Because of that the trucks of the transport company were not fully utilized and the transportation could not be optimized.
- The predictions of future demands were approximate, based on human tacit knowledge, without any methods for demand forecasting.
- Both companies were trying to attain their optimums instead of global chain optimization. Consequently both the inventory levels and transportation costs were considerably higher than needed.
- The communication between various departments and companies, and as the result the flow of information, was slow and costly (using telephones, fax machines).

As majority of the problems were heavily dependent on the inadequate flow of information, it was decided to implement a new supply chain IS specifically designed for oil & gas industry. The selected application offers required functionalities to both involved companies and all departments: inventory management, order management and fulfilment, demand planning, transportation planning, delivery scheduling, and delivery management. Artificial intelligence algorithms are used for forecasting fuel demand, based on the competent information provided by the automated tank gauging systems, and ensure optimal transportation plans and delivery schedules. The application was integrated within the existing ERP system in the oil and transportation companies.

The main changes between the previous and redesigned process (Figure 5) were:

- The measurement of fuel level is now automated and results in the exact information about the stock level.
- The stock levels from all gas stations are instantly available to the transport company.
- The future demand is predicted by using the Continuous Replenishment Program model based on neural networks. The data about past sales, daily and weekly trends, season, prices, promotions, weather conditions, etc. are included in the prediction.
- Based on the measured fuel level and predicted demand the supply needs are automatically identified and possible orders suggested.
- The order is finally confirmed by the purchasing department at the oil company that corrects the order if necessary.

- After that the optimization of transport paths is done by using operations research methods.

Implementation of the supply chain IS was a significant improvement of the fuel supply process from the IT point of view. However for increasing the maturity level of the supply chain and a real breakthrough in terms of supply chain performance the entire supply chain process (see Figure 5) and the roles of the participants had to be changed in a way that the transport company is now not considered as a transporter of fuel but rather as a strategic partner in providing the service to the final customers. It takes almost full responsibility for timely distribution of fuel and also makes some critical decisions.

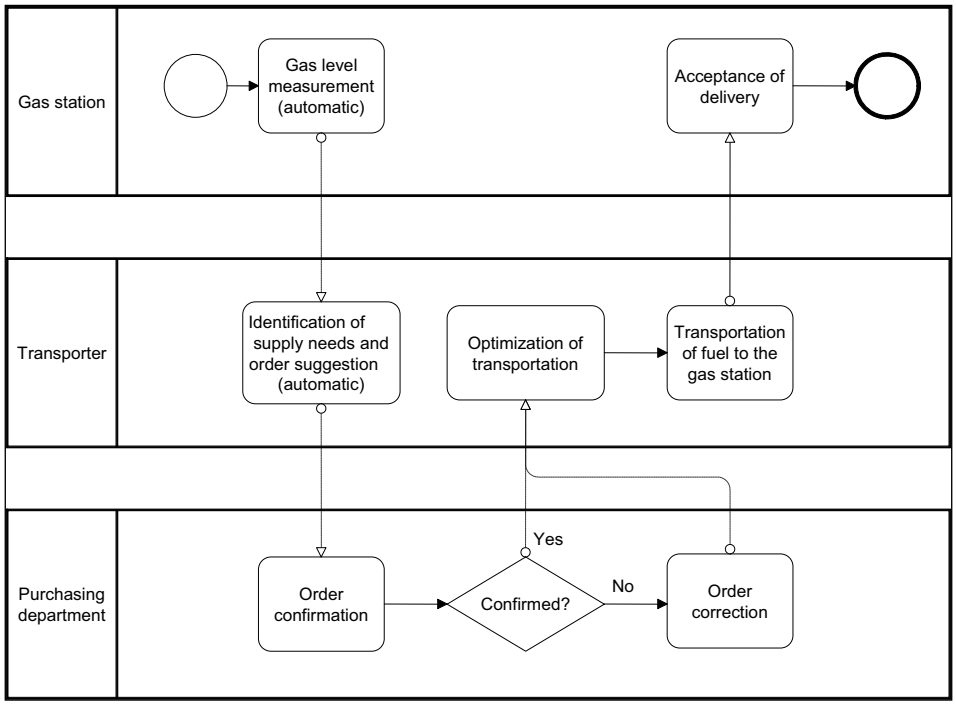

Figure 5: TO-BE model of fuel supply process

As a consequence both companies have advantages. The oil company lowered its inventory costs and the transport company lowered the distribution costs. These benefits are mainly realized in the terms of information sharing and better (i.e. instant) flow of information between the two companies and consequently improved decision making. The stock levels can be better planned and transportation optimized based on the information available to the transport company. The investment had a very short payback period, since it paid back in less than three years [13].

Based on the methodology described in [30] we estimated that the current level of the fuel supply chain maturity is somewhere between three (Linked) and four (Integrated). Prior to changes the maturity of fuel supply process was at the second level (Defined), since the processes were in the major part defined and documented but not truly integrated. The changes that turned the transporter of fuel into a strategic partner were the key for process improvements that led the process to a higher level of maturity. Inter-organizational IS was a requisite for supply chain integration. However, to integrate the two processes into one, it was crucial to implement other changes like long-term partnership between the companies with the required trust development, organizational changes in both companies, and exten-

sive flow of information based on an integrated IS. The process is now well defined, redesigned, and integrated, the cooperation between the two companies involved is at the process level and collaborative forecasting is put into force.

However, all benefits can be sustainable only when the integrated process is continuously managed and changed according to business needs. Both companies involved in the supply chain have to be constantly alert and react proactively to changes in the business environment with constant improvements. Therefore, in order to achieve even higher levels of supply chain maturity additional efforts are necessary. BPM should not be considered as a one-time project of IT implementation and process change, but as a permanent process performance measurement, analysis and continuous improvement of the supply chain processes. The implemented IS provides various reports for important metrics and key performance indicators. This will enable determination of process execution weak points and fine tuning of the supply chain in the future. Metrics have to be selected from all the above mentioned categories: process measures that represent a customer focus and resource measures which (related to the process measures) reflect the efficiency of the process.

While most of the effects of IT implementation, improved flow of information, process integration and renovation can be observed and evaluated in a relatively short period of time, significant impacts of continuous monitoring, controlling and changing the performance of the supply chain processes can be expected as long-term outcomes of BPM. Since currently just a few elements of the monitoring, controlling, and continuous change management are implemented as part of the above mentioned fuel supply chain management, the results of an in-depth analysis of the improved efficiency and effectiveness of the supply chain cannot be given. Nevertheless, some advances in terms of better efficiency (improved values of the process quality measures) are already noticed.

Thus, the achievement of the fourth (Integrated) and even more of the fifth (Extended) level of the supply chain maturity will not be an easy step as some new open questions have appeared. Because BPM should be applied at the supply chain level, intra-organizational process owners and managers have to be appointed. Since this might considerably change the power distribution between the participating organizations, an additional level of trust and collaboration between the oil and transportation companies has to be accomplished.

6. CONCLUSION

It can be seen from the analysis of the case study that business process renovation at the supply chain level brought several benefits to both the companies involved. A simple linkage of processes based on IS implementation could not realize such savings, because the companies could not optimize fuel supply to such extent. The case study shows that radical changes of roles of both companies and of organizational structure in both companies are necessary for considerable improvements of SCM effectiveness. However, the transformation to the fifth level (Extended) is not immediately possible as deep mutual trust is a prerequisite, although the investment in site-specific assets can increase mutual trust between parties (see e.g. [16] for both literature review and further research on the impact of mutual trust on cycle times and supply chain effectiveness as a whole).

A necessary condition for the growing of SCM in terms of supply chain process maturity levels is an inter-organizational information system development. Sharing of information allows for changes of responsibilities of the involved companies, improve customer service, shortens the process cycle times, decreases the utilization of resources, reduces the "bullwhip" effect, improves decision making, which now looks for globally optimal solutions, and reduces inventory costs [51]. The former effects can be very explicit in the case of the fuel supply process. Inter-organizational information systems also support the deriva-

tion of key business metrics that are a prerequisite for an effective business process management with continuous improvement of inter-organizational business processes.

It has to be noted that the supply chain process management issues were presented with two-tier supply chain studies. A majority of the discussion could be easily extended to several tiers. Nevertheless, the companies organized in value chains or networks are usually of different business process orientation maturity level. Accordingly, a serious challenge is to achieve business process compatibility [30] among these companies during the integration. Otherwise, an inter-organizational supply chain process has to be tuned to the lowest level of compatibility.

The implementation of the presented concepts and possible benefits of the integration of a supply chain may vary on the current process maturity level in the participating companies (including the IS maturity) and may differ in various industrial and service branches. Nevertheless, the main supply chain process integration and management concepts, presented in the paper, can be applied with minor modifications regardless of the industry in question.

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