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Assessing Benefits of Information Process Integration in Supply Chains

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Abstract

Business process integration combines the information needed for product and service delivery within the supply chain and support the management service value offering in the supply chain. In this study, we show how the improved digital integration and automation of information flows enhance the speed of the purchasing and supply chain processes and thus provide cost savings by reducing the amount of manual work required by organizations. This study provides a novel framework for structuring a business process model that is based on global standards. The presented case study illustrates the method for evaluating the business impact of supply chain process digitalization and provides novel approach to estimate both operational and financial performance improvement of digitalization.

Keywords: Supply chains, Business processes, Standards, Monte Carlo simulation

1. Introduction

Digitalization has proven to provide multitude of both opportunities and challenges in the supply chain and it can be argues to be the most important megatrend in improving supply chain value creation performance. In here, the information integration and electronic business processes play a significant role. The information exchange and manual processing of information form a major part of the administrative tasks involved in the business processes of supply chains. Digitalization can bring vast amount of opportunities of increasing performance of both the efficiency and accuracy of these operations. [1] [2]

Information exchange and integration play a vital role in supply chain performance [3][4]. Information integration not only enables improvement of the information exchange and business process performance but also enables the use of analytics and modelling in a supply chain level and increases the availability of essential information. Indeed, for example Tesco has saved millions through using supply chain analytics in their retail chain [5]. As the impact of speedier supply chain operations has been calculated to be 2-5% of

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organizational turnover [6], the performance it can bring to the whole supply chain processes can be considered significant. Indeed, currently IT integration improvements are expected in 82% inside organizations and 77% in supply chain level [7], which demonstrates the scale of change in the supply chain processes.

Supply chain digitalization has transformed the value creation and can have eroding effect on the traditional, institutional value creation forms, when new digital-based forms of value creation take more control [8]. It is important for the organizations to identify the new forms of value creation and how those impact on the whole supply chain. As the integration of supply chains is getting denser, the information has become more essential element which ensures uninterrupted co-creation of value towards the end customer. While many studies have focused on the benefits from value co-creation in supply chains [9] [10] the role of information integration in this is still less explored. Few studies have however proven how information integration can improve both the operational and financial performance of supply chains [4] [11].

The impact of digitalization has received vast attention in both the academic and managerial literature, while the evidence of the real impact in organizations and supply chain has been scarce [12]. Furthermore, less attention has been paid to the development of novel methods to analyse the value of external integration and the ability to scale the performance at the supply chain level or even the business ecosystem level [13]. Hence, this paper studies the impact of information integration in supply chain processes. More precisely, we will analyse the impact of digitalization in supply chain using Monte Carlo-simulation method, through the whole supply chain.

2. Supply chain process integration and information systems

Mentzer et al. [14] define the supply chain management as “a systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across business within supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole”. In terms of SCM activities, van Hoek [15] argues that the aim of supply chain management is organizational integration and coordination of flows of goods, information and funds, where ICT has a critical role. The author emphasize that the supply chain have to be built for meeting customer demands and expectations. Organizational integration and flow coordination only come second following the guidelines of responsiveness and customer expectations.

Visibility in supply chains, accurate and real-time information flow among partners is essential for smoothly proceeding functions, such as transportation and other related logistics activities. Even though ICT and electronic data interchange are widely identified and acknowledged as significant elements for inter-firm processes, productivity and performance in supply chain [16][17][18][19][20] [21] [22], there still occur obstacles for deeply automatized transactions between supply chain stakeholders. The main barriers to deploy ICT technologies in supply chains are high investment costs, incompatibility of software/hardware and lack of awareness of ICT benefits. [23] [24][25]). However, due to development of integration standards and technologies in supply chain information exchange it is expected that these models will become more popular in various industries.

Collaboration and information exchanging with the partners involved is the basis for supply chain existence. In order to be competitive and successful, supply chain operations and processes have to be organized in effective and reliable manner, that requires changing from managing individual functions to integrating activities into key supply chain processes. Information technology has been a crucial element for supporting process integration and development of supply chain management [18][26][27]. In integrated processes, information gathering, sharing and exchanging among the participants is essential. Especially in supply chain, information flow must be exact and real-time. Information technology enables to process more information, more accurately and frequently, from more sources over the world [26].

The global supply chains are complex and consists of numerous participants, there exists a risk that manually transmitted information and data become distorted. Automatized information exchanging eliminates human errors, makes processes visible to others thus enabling information, generated by the SC partners, to be available to all participants in the integrated processes. [28] [29]. In addition, distortion of demand information in supply chain causes Bullwhip phenomenon (originally described by Forrester [30]). There non-transparent supply channel, information delays and distortion grow inventories and costs causing inefficiency in processes [31].

Several studies have exposed the impact of IT on management and decision making inns supply chains and logistics. Chiu [32] emphasized the importance of IT as an enabler for successful logistics management. Similarly, Angeles [33] suggested, that for any management system, information and reporting systems are crucial, as they support decision making based on the collected data. These elements incorporate the designing and planning of information systems, coordination and control, as well as cross-organizational coordination. Information technology enable integration of activities in logistics supply chain.

Information technology enable integration of activities in supply chain and supports supply chain process integration from suppliers to customers, including logistics and finance. During these developments, new technologies, methods and applications have emerged facilitating a faster response to customer demand, a better adaptation to market needs, as well as new practices in different

phase of processes. In addition, companies are increasingly utilizing e-business applications, e.g. electronic auctions, electronic catalogues and customer relationship management applications to enhancing their business processes along the whole supply chain. [34]; [18][26]. According to Gunasekaran and Ngai [28], e-logistics and the outsourcing of logistics business processes can be seen as subsets of a wider external supply chain and logistics market. They define e-logistics as the transfer of goods and services using Internet communication technologies, such as EDI (Electronic Data Interchange), WWW (World Wide Web) and e- mail.

Integration of transactional supply chain processes require standardized information sharing practices for implementation. EDI Electronic Data Interchange (EDI) means "the computer-to-to computer exchange of business information electronically, in a structured format between business trading partners" [25]. In other words, EDI enables the direct transfer of data in standardized format allowing integration of inter- organizational processes. The standards for EDI-connections include Edifact, UBL and RosettaNet which all support a wide range of electronic supply chain processes. These truly automatized information flows eliminate the need to enter data manually and, consequently, decrease human errors. [29]. The studies of Ferguson et al. [25] and Murphy and Daley [24] presented the key benefits of EDI, such as Quick access to information; Better customer service; Reduced paper work; Better communication; Increased productivity; Improved tracing and expediting; Cost efficiency; Staying ahead of competitors; Accuracy and; Improved billing. As the main EDI barriers proved to be High setup costs; Incompatibility of hardware/software, Lack of standard formats; Lack of customer sophistication; Lack of awareness of EDI benefits; Customer education/training; Customer resistance and Corporate culture. Interestingly, Murphy and Daley [24] study in logistics found that both, forwarders (3PL companies) and their customers rated quick access to information as the most important benefit of EDI. Similarly, improved billing proved to be the least important benefit for the both.

As described in the literature presented above, process integration is basic arrangement for effective supply chain performance and competitiveness. Collaboration and process integration in logistics require accurate and real-time information exchanging. Information technology and electronic tools, especially EDI, enable truly automatized and effective information exchanging. The researches have shown that EDI reduces human errors and operating costs, amongst the other benefits. On the other hand, high investment costs of EDI, as well as lack of standard formats and incompatibilities of software prevent companies to deploy this technology. Electronic business process management involves investments and capabilities to establish end-to-end interoperability between systems [35]. According to transaction cost (TCE) perspective the firm economizes on transaction costs through the selection of the governance model that minimize the transaction costs in the supply chain relationships [36]. The TCE framework emphasizes cost minimization aspects of transactions in the decision making [36]. Here, the investments and capabilities needed for building interoberability between electronic business processes are justified by cost savings of the governance model. In our empiric research, we are interested in benefits that are potentially achievable through automatized information exchange primarily in supply chain processes. Anyhow, we suggest that this integration has essential impacts, not only on different processes but broader, systemically functioning supply chain as a whole.

3. Empirical study

In order to make an in-depth investigation into nature and information value of supply chain processes, we have built a case study and research framework that covers both the information model design elements of the electronic supply chain processes and the measurement and analysis of the monetary value of the B2B integration leading to the automation in the processes We applied a mixed methods approach to the case study. Yin [37] stated that case studies are used when there is a need to understand complex social phenomena in a holistic manner. Furthermore, the case study research strategy is often associated with, but not restricted to, descriptive or exploratory research. In order to conduct an empirical case study of the integration of information in the selected supply chain process, we first had to define a standard model of supply chain processes. In the first step, we investigated the main standards developed for supply chain integration including GS1/RosettaNet, OASIS/UBL and UNCEFACT/EDIFACT. Based on the literature review and existing manuals, with the help of the Expert Group, we first constructed the collaborative business process model based on major standards. The studied business process model had 48 transactions divided in five process groups connected mainly to the purchase-to-pay and logistics transactions between buyers and suppliers as an example shown in Table 1. This model ensured that data would be collected methodically in a heterogeneous business environment in which business process standards had not been used previously in the design of supply chain integration. The research process consisted of the case selection, data collection from focus groups and the evaluation of simulations of the benefits of the integration of information about the supply chain. Finally, we discuss the implications of the results for business environments. The phases of the research are described in the following sections.

We selected a case study of 40 companies in the bio-refinery industry, previously known as the paper industry. The key managers of 17 organizations were recruited and agreed to participate in the focus group. The companies were members of a consortium that operated in 36 countries, and they were active in global business networks as buyers, suppliers, logistic partners or ICT partners. These conditions formed a unique challenge to designing research and development project settings and outcomes to fit international

requirements. The research project was executed over three years. The selected group of companies corresponded to the structure of companies in the industry sector. The bio-refinery industry is an interesting area of empirical research because the economic value of the business is high, and the business conducts various types of business-to-business services and product transactions on a global scale.

Table 1. Studied supply chain purchase to pay process

Catalog to quatation	Order to invoice	Service order to invoice	Logistics order to invoice	Invoice to pay
Find a new supplier Request for catalog Process Request for catalog Create Catalog Process Catalog Create Request for Quoatation Process Request for Quotation Create Quotation Process Quotation	Create Purchase Order Process Purchase Order Create Order Response Process Order Response Create Change Order Process Change Order Create Cancel Order Process Cancel Order	Working Hour Report Create Service Done Notification Process Service Done Notification Create Service Approved Report Process Service Approved Report Reclamation material or hours	Create Capacity Availability Request Process Capacity Availability Request Create Shipping Order Process Shipping Order Create Shipping Order Change Process Order Change Create Order Cancellation Process Order Cancellation Create log Documents Process Delivery Report Process Delivery Report (LSP) Create Invoice Process Invoice	Process Invoice (PO) Invoice workflow and archive Create Invoice Reject Process Invoice Reject Create Invoice Reminder Create Payment Process Payment Create Remittance Advice Process Remittance Advice

The research process uses various data collection methods applied in five different phases. We first selected as the buyer the focal companies (tier 0) that represented the focal supply chain actors. We then asked the focal companies to select the most suitable suppliers (tiers -1) to be included in the study. Table 3 summarizes the volumes of the transactions of the 40 companies used in our case study. The transaction volumes shown in percentages indicate that the volume of Catalogue is 3%, Quotation 8%, Orders 230%, Deliveries 103% and Services 3%, compared with the transaction volumes of the invoices. This table presents the purchasing-to-pay major process transactions, and it shows that there were four times more business transactions than invoices (not including payments and cross-border custom transactions). Table 2 also shows the volume of electronic transactions currently used in different processes, which leads to the understanding of the potential explained in this study.

Table 2. Process transaction volumes and electronic penetrations

Transactions in (millions)

	Turnover	Employees	Catalog	Quotation	Order	Delivery	Services	Invoices	Total
Case study 40 companies									
Tier 0	27 497 M€	116378	0,003	0,063	1,086	0,338	0,536	0,862	2,887
Electronic			10 %	10 %	1 %	1 %	6 %	100 %	
Tier -1	32 531 M€	130000	0,041	0,066	4,498	2,161	0,001	1,633	8,400
Electronic			5 %	2 %	10 %	30 %	1 %	45 %	
Total	60 029 M€	246378	0,044	0,129	5,583	2,499	0,537	2,494	11,287
Percentage per Invoicing *			3 %	8 %	230 %	103 %	3 %	100 %	

We established the focus group workshops for the collection of information about manual process lead times and the potential of digital automated processes. Lead time was used as the primary measure for the quantification of process flow efficiency in the simulation. We used the process activity maps to collect data from different phases of the process. The participants in the focus group evaluated the minimum, median and maximum lead times required for each step in the process when conducted manually and they also gave an estimate about automated process lead times. The case business process model had 48 transactions (shown in Table 1) and these processes are categorized into five different process scenarios or process groups based on major activities in the supply chain transactions Catalogue-to-Quotation, Order-to-Invoice, Logistics-to-Invoice, Service-to-Invoice and Invoice-to-Pay. The assigned expert measures were used as input values for the simulation. Example input datasheet for the process simulation model is illustrated in Table 3.

We used Monte Carlo simulation software to calculate the lead time flows with variations. A Monte Carlo method is any method that is based on computational algorithms that rely on repeated random sampling to obtain numerical results. Typically, simulations are run many times in order to obtain the distribution of an unknown probabilistic entity. Monte Carlo methods are mainly used in three distinct classes of problems: optimization, numerical integration and the generation of draws from a probability distribution. Stanislaw Ulam and John von Neumann invented the Monte Carlo method in the late 1940s. Monte Carlo calculations are based on repeated sampling to determine the properties of a phenomenon (or behaviour) [38]. The Monte Carlo simulation is a stochastic method that is used to assess the interaction of several uncertain variables. The Monte Carlo simulation (i.e., probability simulation) is used to understand the effects of forecasting models. The variables are not based on certainty but on the valuations of expertise from which we drew an estimate. However, this estimate contains some inherent uncertainty because it is an estimate of an unknown value. The key feature of a Monte Carlo simulation is that based on how the ranges of estimates are created, the model estimates the likelihood of the resulting outcomes. In the Monte Carlo simulation, based on the range of estimates, a random value is selected for each task. The model is calculated based on this random value. The result of the model is recorded, and the process is repeated. A typical Monte Carlo simulation calculates the model hundreds or thousands of times, and each time it uses different randomly selected values. By running the simulation, the results describe the probability of various results in the model. As in any forecasting model, the simulation will only be as good as the estimates made. It is important to note that the simulation represents only probabilities, not certainty. However, the Monte Carlo simulation is a well-known and valuable method to use in forecasting an unknown.

Table 3. Example input datasheet for the process simulation model

	Scenario	Min	Median	Max	Automated (min)	Automation rate %	Frequequ	Cost [EUR/min]
Find a new supplier	Catalog	60	240	420	30	50 %	2500	66
Request for catalog	Catalog	6	30	54	1	10 %	60000	16
Process Request for catalog	Catalog	2	5	8	1	5 %	60000	2
Create Catalog	Catalog	8	15	22	1	5 %	60000	8
Create Purchace Order	Ordering	4	20	36	0,6	1 %	6155750	12
Process Purchace Order	Ordering	1	2	3	1	10 %	6155750	1
Creat Order Responce	Ordering	4	8	12	1	10 %	6155750	4
Process Order Responce	Ordering	7	10	13	1	10 %	6155750	5
Create Capacity Availability Request	Logistics	20	25	30	1	30 %	3444250	11
Process Capacity Availability Reseipt	Logistics	10	20	30	5	30 %	3444250	7
Create Shipping Order	Logistics	5	15	25	5	30 %	3444250	4
Process Shipping Order	Logistics	10	20	30	5	30 %	3444250	7
Process Shipment Notification	Service	18	30	42	6	10 %	3444250	14
Reclamation material or hours	Service	12	60	108	12	20 %	32912,5	24
Create Shipment Delivery Report	Service	1	6	11	0,6	1 %	3444250	3
Working Hour Report	Service	5	40	75	1	6 %	658250	23
Process Invoice (PO)	Payment	6	30	54	1	40 %	2500000	11
Invoice workflow and archive	Payment	6	15	24	0,6	50 %	2500000	5
Create Invoice Reject	Payment	12	60	108	0,6	1 %	250000	37
Process Invoice Reject	Payment	5	20	35	1	30 %	125000	8

In the analysis, the activity lead times were modelled as triangular distributions, which are commonly used when the expert is able to evaluate the minimum, maximum and the most likely value of a variable. We restricted the usage of extreme cases by applying the general rule of excluding 10% of the upper and lower boundary cases. The Monte Carlo simulation method was applied in the analysis. It randomly selects values from the distribution and uses several iterations to complete the analysis. The number of iterations in the model was selected as 10,000. The frequency of each process in the case supply chain and automation lead times were also evaluated. The lead-time evaluations were made by two different groups of experts, one presenting the original equipment manufacturers (OEM) and the other representing the suppliers of those companies. Using two different focus groups provided a good source of information for the simulation. The simulation model consists of the evaluated time distributions of conducting processes in the supply chains of the case industry.

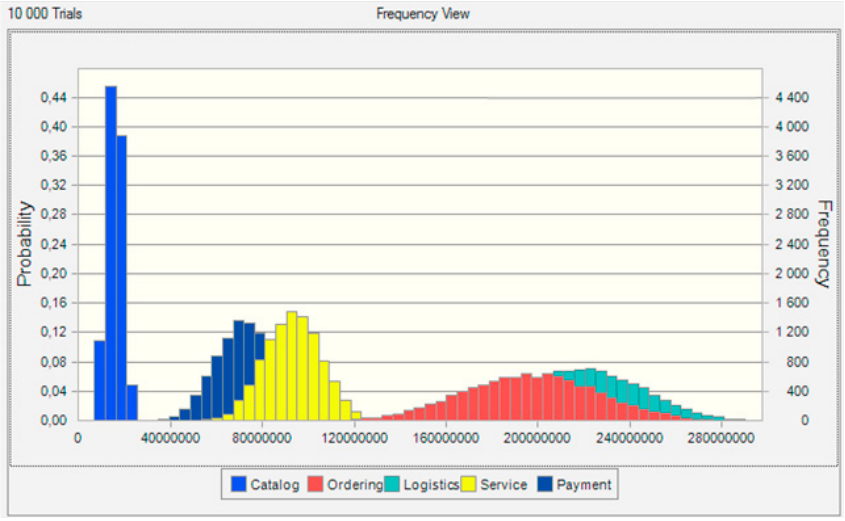

Figure 1. Value potential of different supply chain process scenarios (in EUR)

The simulation results showed the large potential of automation to produce financial benefits, which caused by time savings in the processes. The average hourly rate was determined according to Finnish statistics on the bio-refinery industry. It was estimated at 37.50 EUR/h, which is high in comparison to international rates. The total potential of the integration of the supply chain was 598,390,330 EUR. The potential for different process groups is illustrated in Table 4. As the figure shows, the largest potential was identified in the Logistics-to-Invoice (mean value of 218,783,290 EUR) and Order-to-Invoice (mean value of 196,945,491 EUR) process groups. These two process scenarios seemed the most lucrative areas of investment for supply chain companies. The graphical presentation of the simulation results provided in Figure 1. The relatively low potential of the Catalogue and Payment groups is explained by the high penetration rate of the automated processes payment (Invoice-to-Pay) and relatively low frequencies of Catalogue transactions (Catalogue-to-Quotation) compared to other process scenarios. The simulation results are described in Table 5.

Table 4. Statistical results of different scenarios

Statistics	All	Cataloq-to-quotation	Logistics-to-invoice	Order-to-invoice	Invoice-to-Pay	Service-to-invoice
Trials	10000	10000	10000	10000	10000	10000
Mean	598 390 329,72	15581001	218783290	196945491	73831703	93248844
Median	598 219 743,72	15603097	219067214	196844170	73375111	93238667
Standard Deviation	42 502 548,34	3176532	25427140	28722576	13361459	12130088
Minimum	451 982 579,18	6432454	137731696	104515171	36041904	53596003
Maximum	746 430 897,40	25285615	298995631	293414491	118519383	134184223

The supply network has to invest in integration. During the focus group workshops, we discussed the concept and the pricing models of integration in order to estimate the investment costs of integration. Because of the lack of standards and non-interoperable systems, we estimated the investment costs of using the may-to-many EDI operator business model to illustrate the most expensive integration cost. The investment costs can be divided to the fixed and variable costs where fixed costs involve the initial investments on connection fees and integration fees of processes to the buyers, suppliers and logistics service providers. The estimate for the total fixed investments needed in the case supply network to achieve the automated scenario was 550 000 Eur. Variable costs in case consists of the service provision of EDI operator according to transmitted transactions in the supply network (fee/ transaction) sent by buyers, suppliers and logistics service providers. The annual variable cost were estimated to be 23 MEur in the case of automating 48 processes in the supply network. Based on the result of the scenario it can be estimated that direct effects for digital process automation will be around 1% of the turnover in the case supply network. The measured and simulated potential of the study is related to the savings in the manual work, it can be said that the potential cost savings of digitalization of the supply chain processes could easily reach 2-4% of the turnover when the costs of errors, indirect effects on the faster processes and overall quality improvements of the processes will be taken into account.

4. Discussion and Conclusions

The aim of this study was to investigate the value of digital supply chain investments from the tangible benefits point of view. More precisely we study the operational and financial benefits of digitalizing specific transactional supply chain processes, namely sourcing (catalogue to ordering), purchasing (order to invoice), logistics (shipping order to invoice and financing (invoice to payment) process integration.

Our study has several contributions to the scientific discussion of digitalization impact on business performance. Firstly, the impacts of digitalization can be measured from both the perspective of operational performance, in terms of time savings in executing the tasks, accuracy and avoiding errors in handling the information as well as availability of the data to different supply chain members. Secondly the impacts of digitalization can be measures in terms of financial performance, which can be noticed not only directly but also indirectly through the operational benefits. The overall benefits from digitalization can be estimated to be c. 1-4% from the annual turnover, and as such our results validate the findings previous research of the operational benefits [6].

Recent studies in the literature emphasized the importance of business process integration in the supply chain [16][34], as well as the importance of designing and implementing common standards in a global business environment. The results of the present study showed the potential for the interoperability of a supply chain and information integrated in it. A large selection of business process standards and specifications are used in business environments but because of their diversity, the academic literature has paid scant attention to them. This study constructed and consolidated a common model for the business processes used in a supply chain for both manual and electronic processes and across the major standards. Based on this process model, the supply chain valuation created a comprehensive and meaningful study of cost savings. Because of its international nature and scale, the case study of the bio-refinery industry offers new knowledge to businesses and academics on the current business process integration potential. These results can be scaled to other networks, and they can improve the understanding of cost savings and other benefits. The model also enabled the analysis of the development and investment phases in the supply network, especially in the outsourcing of an information service portfolio. The volume of the data provided a large sample, which, however, was dominated by large firms in one industry domain.

The Monte Carlo method has been validated in the literature, and the tools based on these computational algorithms are suitable for use in the design of case studies. Hence, the design of this study can be implemented in research on various business sectors and data collections to improve the knowledge of this valuable area. The management of end-to-end supply chains is a labour-intensive process. Although internal business information exists in digital form in the IT systems of organizations, information about the external supply chain on a global scale is still integrated manually. Developed economies have given a competitive advantage to emerging economies because of the work involved in exchanging information in the supply chain. Although standards and best practices are in place, according to our findings, the penetration of information integration is still at a low level in most supply chain processes. This finding is in line with those of Evangelista et al. [39]. In future research the focus should be in investigating more deeply the primary and secondary impact of digitalization which would help in determining the ROI from different digital solution more accurately. Therefore, future studies should be extended to cover a large population of business sectors. Small- and medium-sized companies and other industries should be included in future research.

References

[1] G. Büyüközkan F.Göçer, Digital supply chain: literature review and a proposed framework for future research. Computers in Industry, 97 (2018) 157-177.
[2] Singh, A. and Teng, J.T, (2016) Enhancing supply chain outcomes through Information Technology and Trust. Computers in human behavior, 54 290-300.
[3] M. Kim S. Chai, The impact of supplier innovativeness, information sharing and strategic sourcing on improving supply chain agility: Global supply chain perspective. International Journal of Production Economics, 187 (2017) 42-52.
[4] Q. Gu T. Jitpaipoon J.Yang, The impact of information integration on financial performance: A knowledge-based view. International Journal of Production Economics, 191 (2017) 221-232.
[5] Information age. Tesco saves millions with supply chain analytics. April (2013).
[6] A.P. Hameri J.M. Lehtonen, Production and supply management strategies in Nordic paper mills, Scandinavian Journal of Management, 17(3) (2001) 379-396.
[7] European ATKearney, Digital Supply Chains: Increasingly Critical for Competitive Edge. (2015) WHU Logistics Study.
[8] W. Reinartz, N. Wiegand, M. Imschloss, The impact of digital transformation on the retailing value chain, International Journal of Research in Marketing (2019).
[9] J. Vilko, P. Ritala, IAM Value - identification, analysis, and management of customer value in supply networks, Research report, Lappeenranta University of Technology (2016).
[10] L. Aarikka-Stenroos E. Jaakkola, Value co-creation in knowledge intensive business services: A dyadic perspective on the joint problem solving process, Industrial Marketing Management, 41(1) (2012) 15-26.
[11] C.W. Wong, K.H. Lai, T.C.E. Cheng, Value of information integration to supply chain management: roles of internal and external contingencies. Journal of Management Information Systems, 28(3) (2011) 161-200.
[12] A.Q. Li P. Found, Towards sustainability: PSS, digital technology and value co-creation. Procedia CIRP, 64 (2017) 79-84.
[13] V. Hernández T. Pedersen, Global value chain configuration: A review and research agenda. BRQ Business Research Quarterly, 20(2) (2017) 137-150.

[14] J.T. Mentzer, W. De Witt, J.S., Keebler, S. Min, N.W. Nix, C.D. Smith, Defining Supply Chain Management, Journal of Business Logistics 22(2) (2001) 1-25.J.J-K. Cho J. Ozment H. Sink, Logistics Capability, Logistics Outsourcing and Firm Performance in an E-Commerce Market, International Journal of Physical Distribution & Logistics Management, 38(5) (2008) 336-359.
[15] R.I. Hoek van, Using Information Technology to Leverage Transport and Logistics Service Operations in the Supply Chain: An Empirical Assessment of the Interrelation between Technology and Operations Management, International Journal of Technology Management, 23 (2002) 207-222.
[16] B.T. Hazen T.A. Byrd, Toward Creating Competitive Advantage with Logistics Information Technology, International Journal of Physical Distribution & Logistics Management, 42(1) (2012) 8-35.
[17] P.I. Jeffers W.A. Muhanna, B.R. Nault, Information Technology and Process Performance: An Empirical Investigation of the Interaction between IT and Non-IT Resources, Decision Sciences, 39(4) (2008) 703-735.
[18] A. Ordanini, G. Rubera, Strategic Capabilities and Internet Resources in Procurement: A Resource-Based View of B-to-B Buying, International Journal of Operations & Production Management, 28(1) (2008) 27-52.
[19] S.R. Croom, The Impact of e-Business on Supply Chain Management: An Empirical Study of Key Developments, International Journal of Operations & Production Management, 25(1) (2005) 55-73.
[20] F. Wu, S. Yeniyurt, D. Kim, S.T. Cavusgil, The Impact of Information Technology on Supply Chain Capabilities and Firm Performance: A Resource-Based View, Industrial Marketing Management, 35 (2005) 493-504
[21] D.J.Closs T.J. Goldsby S.R. Clinton, Information Technology Influences on World Class Logistics Capability, International Journal of Physical Distribution & Logistics Management, 27(1) (1997) 4-17.
[22] D.J. Bowersox P.J. Daugherty, Logistics Paradigms: The Impact of Information Technology, Journal of Business Logistics, 16(1) (1995) 65-80.
[23] P. Evangelista H.Kilpala, The Perception of ICT use among Small Logistics Service Providers: a Comparison between Northern and Southern Europe, European Transport, 35 (2007) 81-98.M.C. Cooper D.M. Lambert J.D. Pagh, Supply Chain Management: More Than a New Name for Logistics, The International Journal of Logistics Management, 8(1) (1997) 1-14.
[24] P.R. Murphy, J.M. Daley, EDI Benefits and Barriers Comparing International Freight Forwarders and Their Customers", International Journal of Physical Distribution & Logistics Management, 29(3) (1999) 207-216.
[25] D.M. Ferguson N.C. Hill, J.V. Hansen, Electronic Data Interchange: Foundations and Survey Evidence on Current Use, Journal of Information Systems, 4(2) (1990) 81-91.P.J. Daugherty T.P. Stank D.S. Rogers, Third-Party Logistics Service Providers: Purchasers' Perceptions, International Journal of Purchasing and Materials Management, 32(2) (1996) 23-29.
[26] G. Neubert, Y. Ouzrout, A.Bouras, Collaboration and Integration through Technologies in Supply Chains, International Journal of Technology Management, 28(2) (2004) 259-273.
[27] D.M. Lambert C.M. Cooper, Issues in Supply Chain Management, Industrial Marketing Management 29(1) (2000) 65-83.
[28] A. Gunasekaran E.W.T. Ngai, The Successful Management of a Small Logistics Company, International Journal of Physical Distribution & Logistics Management, 33(9) (2003) 825-842.
[29] B.J. La Londe, J.M., Masters Emerging Logistics Strategies: Blueprints for the Next Century, International Journal of Physical Distribution & Logistics Management, 24(7) (1994) 35-47.
[30] Forrester JW. Industry dynamics. Massachusetts, Cambridge. 1961.
[31] H.L. Lee V. Padmanabhan S.Whang, Information Distortion in a Supply Chain: The Bullwhip Effect, Management Science, 43(4) (1997) 546-558.L.M. Ellram, and M.C. Cooper Supply Chain Management, Partnership, and the Shipper – Third Party Relationships, The International Journal of Logistics Management, 1(2) (1990) 1-10.
[32] H.N. Chiu, The Integrated Logistics Management System: A Framework and Case Study, International Journal of Physical Distribution & Logistics Management, 25(6) (1995) 4-22.
[33] R. Angeles, Revisiting the Role of Internet-EDI in the Current Electronic Commerce Scene, Logistics Information Management, 13 (2000) 45-57.
[34] F. Wiengarten, P. Humphreys, A. McKittrick, B. Fynes, Investigating the Impact of E-Business Applications on Supply Chain Collaboration in the German Automotive Industry, International Journal of Operations & Production Management, 33(1) (2012) 25-48.
[35] B. Dinter, G. Lahrmann, R. Winter, Information Logistics as a Conceptual Foundation for Enterprise-Wide Decision Support, Journal of Decision Systems, 19(2) (2010) 175-200.
[36] A.H. Tsang, Strategic Dimensions of Maintenance Management, Journal of Quality in Maintenance Engineering, 8(1) (2002) 7-39.
[37] R.Yin, Case study research: Design and methods (2nd ed.), (1994).Thousand Oaks, CA: Sage.
[38] N. Metropolis, S.Ulam, The Monte Carlo Method, Journal of the American statistical association 44(247) (1949) Sep 335-41.
[39] P. Evangelista R. Mogre E. Sweeney A Survey Based Analysis of IT Adoption and 3PLs Performance, Supply Chain Management, An International Journal, 17(2) (2012) 172-186.