Key Capabilities to Thrive at the Nexus of Supply Chain Management and Digitalization

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Abstract: *Supply Chain Management (SCM) is of crucial importance for organisational success. In the era of Digitalization, several implications and improvement potentials for SCM arise, which at the same time could lead to decreased competitiveness and could endanger long-term company success if ignored or neglected. From a practitioner's point of view, several key capabilities are becoming necessary at the nexus of SCM and Digitalization. This paper applies a mixed method approach of practitioner interviews and focus group workshops to elaborate these key capabilities. The main results of the paper indicate that the relevance of Digitalization for SCM is realized in practice. In the form of four key capability groups, a set of fourteen concrete capabilities is condensed: 1) creation of visibility and transparency, 2) advanced data exploitation, 3) strategic consideration of exogenous trends and 4) acceleration of technological transformation. The main contribution of this paper is an empirically grounded basis for future research projects focusing on Digitalization in SCM and an overview of the capabilities required at the nexus of SCM and Digitalization from practitioners' point of view.*

Keywords: *Supply Chain Management, Digitalization, Digital Transformation, Value Networks*

1 Introduction

Digital Transformation is imperative for society, economy and politics. The ongoing process of digitalization and the technological developments driving it, equally affect individuals and organisations. From an organisational point of view, this change offers many potentials for improvement at different stages and in different areas, one of these being Supply Chain Management (SCM). Based on the definition provided by Mentzer et al (2001) Supply Chain Management is defined as the management approach concerned with systemically dealing with strategic coordination of traditional business functions and the tactics across these within an organisation and across partner organisations along the supply chain, with the aim of improving long-term performance not only of the individual organisation, but also of supply chain as a whole. Despite this rather elaborate definition of SCM, there are several issues with the notion of "chain". Especially against the background of the current, highly dynamic, increasingly networked and growingly complex, economic environment, the next evolutionary step in the area of digitalization seems necessary. Mentzer's et al. (2001) definition of SCM clearly states the holistic claim of not only focusing on individual companies and chains but also of integrally considering network structures as a whole. The creation of a system-wide total optimum is defined as the aim of SCM. Nonetheless, current Supply Chain Management practices are often conducted in the form of isolated, functional activity blocks and the focus on supply, production and distribution logistics still seems to be the common practice. The traditional view of Supply Chain Management in economic practice is still characterized by the chain-paradigm and the predominant focus on integrating customers, suppliers, partners and OEMs in more or less isolated, sequentially lined up blocks of activities. This approach to SCM has worked more or less satisfactory in the past, but has increasingly led to problems and inefficiencies in current, increasingly complex economic environments (Strandhagen et al. 2017; Ponte et al. 2018). Significantly increased coordination effort and coordination intensity is just one effect of increased network complexity, which in turn results from higher environmental dynamics and network intricacy. A rising amount and variety of endogenous and exogenous logistics parameters as well as the heterogeneity of their interrelations lead to intricate systems, which e.g. manifest themselves in the form of highly individualized products and services or the growing importance of sustainability related issues. At the same time, higher environmental dynamics lead to shorter life cycles of nodes and edges in enterprise networks. Long proven network structures and relations are no longer stable and are subject to disruptive change and network dynamics (Wehberg, 2016). Traditional SCM approaches and capabilities won't be able to tackle these challenging developments (Kersten et al. 2017; Strandhagen et al. 2017). The shift from a traditional supply chain to a digital Supply- or Value Network-paradigm has already begun (Ponte et al. 2018) and the need for new approaches and the corresponding capabilites is recognized in industry and academia (Hearnshaw and Wilson, 2013; Lee and Vachon, 2016).

Despite the variety and plethora of Supply Chain Management (SCM) research, little attention has been given to actual challenges as well as to concrete key capabilities arising at the nexus of SCM and Digitalization from practitioners' point of view. Hence, the research question underlying this paper is as follows: what are the key capabilities required from an organizational point of view to harness the potential of digitalization in SCMs? Due to the limited availability of comparable, empirically grounded material focusing on practitioners' point of view, the main element of this paper is an empirical study following the methodology presented in section 2

2 Methodology

The research methodology of the paper comprises a set of practitioner interviews and focus-group workshops to collect research needs at the nexus of SCM and digitalization from practitioners' point of view. Focus groups are an acknowledged research technique and have long been applied in various research settings (Brandtner et al. 2015a). Focus group studies aim at analysing clearly defined areas or set of issues (i.e. the focus) by means of group discussions (Stewart et al. 2007, Brandtner et al. 2015b). The interaction between members of a focus group is a central element and source to collect information, which would be difficult or impossible to be elaborated in classic one-to-one expert interviews (Morgan, 2013). Encouraged by a moderator, a small group of people shares ideas and thoughts on open ended predefined questions. A typical focus group, as defined in literature consists of three to twelve participants, depending on the source of literature (Tracy, 2013, Krueger and Casey, 2009).

In the current paper, three focus group workshops where conducted. The first workshop included 2 groups of 12 participants, the second one 11 participants and the third one 10 participants. Each time, different organisations (in total more than 20) where included, ranging from retail, metal industry, automotive sector and IT-sector to logistic service providers, waste management, fast moving consumer goods and infrastructure providers. Hence, a wide range of different industries and service sectors could be included in the focus group study. A senior researcher respectively a professor was responsible for focus group moderation. Additionally, collaborative notes where taken by the moderator and the group using flipcharts and whiteboards. Besides that, a second observer took notes.

The aggregation of results was done based on the qualitative content analysis (QCA) approach proposed by Mayring (2000). The development of a structured coding scheme and the analytic procedure of QCA further increased the validity of research results and allowed for a category definition as near to the documented focus group results as possible (Brandtner, 2017). The key capabilities were deduced tentatively, were step-by-step revised and where necessary reduced respectively combined. Additionally, the technique of peer debriefing was applied in the course of QCA, which also contributes to research validity (Thomas and Magilvy, 2011).

3 Results of focus groups and interviews

The final list of capabilities derived from the conducted focus groups and interviews is described in the following paragraphs. Each of these represents a potential starting point for adapting existing or developing new capabilities respectively for developing new solutions and deriving new research projects and endeavors:

- **Mapping and analysis of Supply Chain network structures**: This includes the capabilities and tools required to visualize network structures and partners, the relationships between these partners, central players and hubs or the deviations between actual and target states based on control charts.
- **Identification of criticalities in networks**: This includes the ability to evaluate supplier, customer or material criticality in comparison to other network parts or players, to analyse network elements in regard to their vulnerability to e.g. supply restrictions or to evaluate their susceptibility to environmental impacts.
- **Creating transparency in critical network paths**: This includes the identification of blind spots in critical network paths and the resulting need for additional data integration and its realization in the form of e.g. sensor based systems or the identification, development and provision of supporting data analysis methods and tools if existing data is not exploited sufficiently enough.
- **Creating near real-time transparency of physical flows**: This includes the skill-set enabling the identification of conceptual requirements for sensor based solutions applicable to close blind spots in critical network paths and their implementation in defined demonstrator settings, processes or transport infrastructures.
- **Identification of patterns in Supply Chain network and logistics data**: This includes e.g. the analytic know-how required for the identification and analysis of demand patterns, usage patterns, order patterns, transport patterns, storage patterns, damage patterns, seasonal patterns, system patterns, location patterns, service patterns, infrastructure patterns, supplier patterns, customer patterns, pattern-triggering events respectively general similarities & connections in data.
- **Unveiling actual drivers of complexity in SC networks**: Based on e.g. pattern analysis, this includes the capability to identify the actual drivers of network complexity resulting in e.g. out-of-stock situations or the need for express deliveries. It also subsumes e.g. the evaluation of network partner performance based on deeper insight, the identification of critical and non-critical players (customers, suppliers, service providers etc.) adding high levels of complexity, the provision of data based decision basis for deriving network adaption requirements or the quantitative basis for justifying decisions made in the context of e.g. supplier quality evaluation.
- **Analysis and evaluation of alternative reactions to network events based on data aggregation and analysis**: This includes the abilities required for e.g. the simulation of possible reactions to abruptly changed customer demands or seasonal variance,

unforeseeable critical events as e.g. earthquakes or terrorist attacks and to possible future scenarios on a strategic network level. In order to enable this, complex simulation-supporting network models have to be developed and possible measures have to be mapped in suitable optimization scenarios as input source for these models.

- **Enabling predictive actions for future network events**: This includes e.g. the analytical know-how for the prediction of customer demands, seasonal changes or of future bottlenecks in terms of e.g. out of stock or out of transport resources. These predicted future events can either be alleviated by means of e.g. adapting stock levels, transportation resources or changed quantity structures, or they can be reinforced in terms of desired future situations. Possible future events to reinforce could e.g. be the possibility to decrease stock levels or transport kilometers based on e.g. alternative sourcing, warehousing or routing strategies.
- **Evaluation and analysis of use-cases for applicant-distant future SC network technologies**: This includes the technological and SCM-knowledge required for the analysis of radical technologies (e.g. Blockchain or Deep Learning) in regard to their specific application fields in SC network structures, the quantitative evaluation of their impact on SCM key figures and the definition of the specific value added along and across internal and external network stages. Based on clearly defined and evaluated use cases, further decisions whether and at which stages a technology is applicable and reasonable can be made.
- **Strategic roadmapping of future SC network technology implementation**: This includes the strategic know-how for roadmapping the concrete next steps and projects required to create the organisational basis for implementing future network technologies in specific use case settings. Depending on the individual maturity of the respective organisation, this may also include the creation of interfaces at system levels, the adaption of specific process steps in accordance with aimed at improvements or the general organisational willingness to share data in distributed ledger systems.
- **Prototypical development and demonstration of future SC network technology use cases**: This includes the ability to develop and / or adapt new / existing technology-based solutions to specific use cases where implementation requirements from an organisational point of view are already given. The aim of these demonstrator-elements should be to prove the practical feasibility and the economic viability of these still applicant-distant technologies.
- **Identification and evaluation of trend-based implications on SC network structures**: This includes the capabilites required for 1) the identification of disruptive events (i.e. technological trends, socio-demographic trends (e.g. workforce shortage, ageing society, etc.), changing customer demands and service requirements (e.g. product-service bundling, order behavior, lot sizes etc.) or political and environmental trends (e.g. e-mobility, sustainability, etc.)) and 2) the evaluation of the specific impact of these trends in terms of their implications on SC network processes, value propositions, product-service combinations, future criticalities and structural network issues. The result of this should include e.g. quantitatively described scenarios of possible future events and trends with a long-term orientation and their potential, quantified impacts on Value Network design.
- **Definition of strategic scenarios as input for network simulation and optimization**: Based on the trends and disruptive events identified and evaluated in the form of quantitatively described scenarios, this capability block includes the preparation of optimization scenarios for simulation models of network structures. The

goal should be to identify the actual, predicted implications of specific trends on complex network systems by taking into consideration critical paths and network key players. The results of simulation could enable organisations to e.g. evaluate the relevance of certain partnerships (customers/suppliers/service providers), the profitability and reasonability of different e.g. hub locations or warehousing infrastructures or the impact of product-service bundles on strategic and tactical network levels.

- **Identification and conceptualization of potential network adaptions**: This includes the skills to identify strategic action fields based on the scenarios evaluated and tested. Possible results should include e.g. product-service bundling, strategic approaches to customer segmentation based on their network relevance, redesign of supplier network structures, the identification of possible joint-ventures respectively of mergers & acquisitions activities or the simulation-based identification and evaluation of possibilities for outsourcing and integrating third-party logistic service providers.

4 Development of key-capability categories

As explained in section 2, the analysis of results and the aggregation in key capability groups is done based on the QCA approach by Mayring (2000). Additionally, the technique of peer-debriefing (Thomas and Magilvy, 2011) is applied. The following figure provides an overview of the four main key capabilities groups 1) creation of visibility and transparency, 2) advanced data exploitation, 3) strategic consideration of exogenous trends and 4) acceleration of technological transformation and the respective capabilities as presented in section 3:

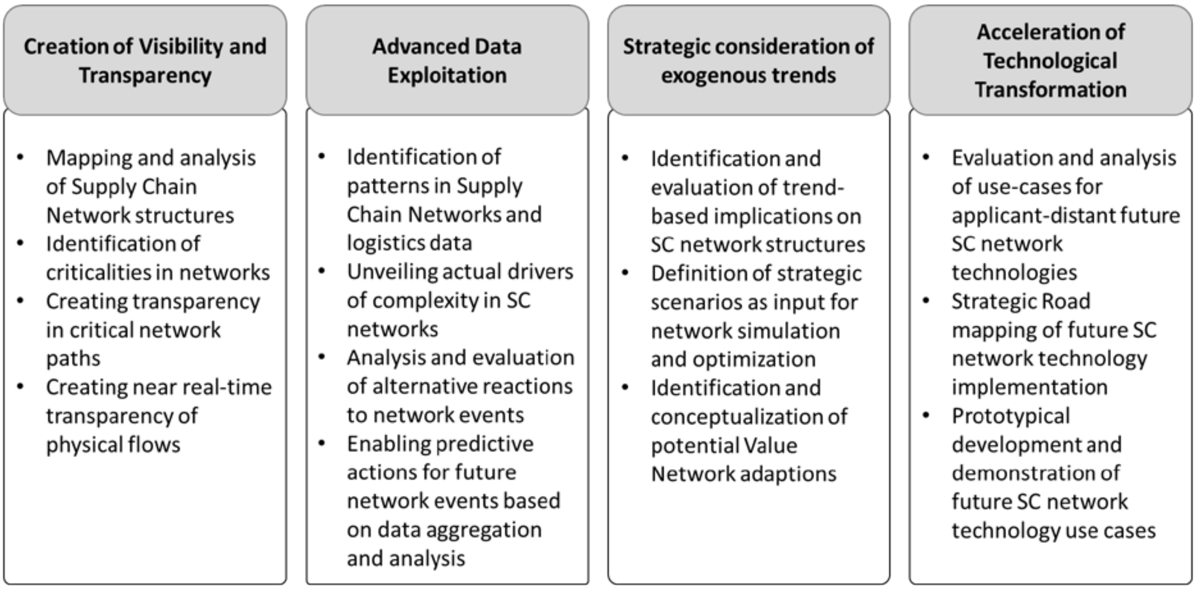

Figure 1: Overview of key capability groups and respective capabilities

Subsequently, these four key capability groups are described in detail.

4.1 Creation of Visibility and Transparency

According to a recent, large-scale survey with over 600 SC professionals from 17 countries, only 6 % of companies have full visibility over their SC. 15% of participating organisations are limited to internal visibility on the production process only and for nearly two thirds of organisations (62%) visibility is limited to direct customers (ex production to customers) and to suppliers of their suppliers (from suppliers of suppliers to production). Creating SC visibility is one of the top three goals of SCM in 2017 and continues to increase in relevance (Geodis 2017). The focus group and expert interview participants agreed that visibility and transparency provide the basis for well-informed and data-supported decisions on operative, tactical and strategic levels and is a crucial requirement for firstly data exploitation (in the course of e.g. near-real time route planning, warehouse-management or flexible order fulfilment). Furthermore, visibility and transparency is a prerequisite for better data exploitation (in the course of e.g. the recognition of demand patterns, transport patterns and seasonal fluctuations in a predictive manner or the evaluation and simulation based optimization of SC decisions).

Another finding in this key capability group is that especially smaller structures, as e.g. the Austrian economy (i.e. the country where the expert interviews and focus group workshops were conducted) with its limited resources and volumes (in comparison to other European and global companies), can benefit from increased transparency, visibility and provenance of physical and non-physical flow in SC networks. Being limited in terms of volumes and influence on a global scale, operational excellence (i.e. the efficient and effective usage of resources in network systems and lean SC processes and structures) and strategically aligned focus (i.e. a SC network design with customer focused value delivery and the alignment of general corporate and SC network strategy) are essential prerequisites for competing in future markets on a global scale. Although the implementation of visibility and transparency is a challenging task, the participating companies are aware of the importance of taking up these issues by creating data-based transparency, enabling monitorability of critical network paths and providing the basis for a higher degree of data exploitation in complex SC and logistics networks.

The following capabilities were subsumed under key capability group “creation of visibility and transparency”:

- Mapping and analysis of Supply Chain Network structures
- Identification of criticalities in networks
- Creating transparency in critical network paths
- Creating near real-time transparency of physical flows

4.2 Advanced Data Exploitation

Based on the results of the conducted focus group workshops and expert interviews, it was found that not only the level of data utilization across SC stages and networks in current logistics and SCM activities is low, but also the resulting degree of data exploitation. While data utilization in our context is defined as the level of using existing information along SC stages, data exploitation is defined as the degree of generating additional findings and predictive statements and implications based on this data. The utilization of data can be increased through fostering monitorability and e.g. comparing planned and actual flows of goods, information or cash based on control charts. Data exploitation on the other hand requires more complex approaches and more “intelligent” solutions to identify and create additional value added by increased data analysis in the form of e.g. pattern recognition, big data analysis or simulation- and optimization approaches. In accordance with the results of the current paper and also according to other studies, focal technologies, i.e. predictive analytics, pattern recognition as well as simulation-optimization, will play a crucial role in future SCM and logistics (Kersten et al. 2017). The findings of the paper confirm the relevance of descriptive analytics to describe current states of SCs and flows in between them is still high (i.e. data utilization in our context). However, the results also indicate that an additional and even stronger relevance will be placed on additional data analysis (i.e. data exploitation) in the form of predicting future states (predictive analysis) and of evaluating and simulating possible target states and the measures to reach these states (prescriptive analytics).

The following capabilities were subsumed under key capability group “advanced data exploitation”:

- Identification of patterns in Supply Chain Network and logistics data
- Unveiling actual drivers of complexity in SC networks
- Analysis and evaluation of alternative reactions to network events based on data aggregation and analysis
- Enabling predictive actions for future network events

4.3 Strategic Consideration of Exogenous Trends

Besides critical events on operative and tactical level, criticalities and complexity drivers also occur on a strategic level, e.g. in the form of disruptive technologies, changed customer needs as e.g. product-service-requirements, political developments like increased taxes or changed laws, socio-demographic trend as changing workforce or in the form of general megatrends as e.g. e-mobility or same day delivery. Due to increased level of dynamics, short product and process life-cycles or rapidly changing customer demands and needs, most organizations are facing difficulties in systematically handling and managing uncertainty (Brandtner et al. 2014). In general, failures in process, services and product innovation are often due to inefficiencies and weaknesses of organizations to deal with and to contextualize uncertainty. The findings of the conducted focus group workshops and expert interviews confirm the need for new approaches to SCM specifically focusing on uncertainty reduction are needed. Similar to Corporate Foresight in the areas of innovation management and strategic planning (Brandtner et al. 2015b), a “Supply Chain Foresight framework” (processes, methods, tools and responsibilities) with the goal of enabling organisations to establish long-term network foresight capabilities is needed in future SCM. In this context, the results indicate that such a framework would have to include both bottom-up (e.g. operative or tactical, pattern-based events) and top-down starting points (e.g. exogenous trends on strategic level)..

The following capabilities were subsumed under key capability group “strategic consideration of exogenous trends”:

- Identification and evaluation of trend-based implications on SC network structures
- Definition of strategic scenarios as input for network simulation and optimization
- Identification and conceptualization of potential network adaptions

4.4 Acceleration of Technological Transformation

Disruptive technologies as e.g. Blockchain (BC), autonomous vehicles, Artificial Intelligence (AI) or Deep Learning (DL) will comprehensively change SCM processes and will trigger a a variety of new capabilites and skills necessary in this context. However, despite the hype of e.g. BC and its potential for improving processes and enhancing new business models, a recent study showed that it is only known to few logistic experts and even fewer plan to implement or think about implementing it (Hackius, Petersen 2017). Same applies to e.g. DL, which is also considered a potential disruptive technology for SCM. As soon as such technologies have adequately matured, their impact will be enormous (Kersten et al. 2017). These challenges and uncertainties in regard to revealing and delineating the potential impacts of disruptive technologies on future SCM could also be confirmed by the results of the conducted focus group workshops and expert interviews. The derivation of concrete use-cases

and quantified benefits of these still application-distant technologies and the taking of the first steps to pave the way for their implementation are critical capabilities at the nexus of SCM and Digitalization.
The following capabilities were subsumed under key capability group "acceleration of technological transformation":

- Evaluation and analysis of use-cases for applicant-distant future SC network technologies
- Strategic roadmapping of future SC network technology implementation
- Prototypical development and demonstration of future SC network technology use cases

5 Conclusion

The findings of this paper indicate that proactively driving the digital transformation of existing Supply Chains into digitally supported networks of Supply Chains instead of just reacting passively to it is amongst the top priorities of Supply Chain Management experts and practitioners. The traditional view of Supply Chain Management with its predominant focus on integrating customers, suppliers, partners and Original Equipment Manufacturers (OEMs) in more or less sequentially lined up and detached Supply or Value Chains will have to shift towards a more future oriented, digital mindset with customer centric, demand driven and holistic networks of multiple Supply Chains in its core (i.e. digital Value Networks). To actually undertake this shift and to conduct the transition from managing traditional, sequentially-lined up and often opaque Supply Chains to digitally connected, transparent and intelligent Value Networks, certain key capabilities and skills are required in the organisations.

Based on the results of the conducted focus group workshops and expert interviews, 13 capabilities were derived and were further condensed to four main key capability groups. These key capabilities represent the main groups of skills that were found to be of relevance from practitioners' point of view at the nexus of SCM and Digitalization: 1) creation of visibility and transparency, 2) advanced data exploitation, 3) strategic consideration of exogenous trends and 4) acceleration of technological transformation. Furthermore, three main domains or areas were found to influence the future of Supply Chain Management: 1) hardware technologies (e.g. sensor systems, microelectronics etc.), 2) software solutions (e.g. Artifical Intelligence, Simulation and Optimization, Pattern Recognition, Blockchains & Distributed Ledgers, Prediction Algorithms, Deep Learning etc.) and most important 3) the Logistics and Supply Chain Management domain expertise to apply area 1 and 2 in Supply Chain Management respectively Value Network Management application fields. The combination of these areas will provide the basis to actually transform existing Supply Chains into digital Value Networks. We introduce the term "Value Network Management" as one possible approach to enable organisations to master future SC networks by combining logistics and SCM domain knowledge with state-of-the-art hardware and software solutions. The substantial contribution of the papers is the described set of key capability groups, which were aggregated based on practitioners' needs. These groups, the single capabilities and their descriptions represent the basis for deriving specific future research projects from a scientific and for developing a strategic project and skill development-roadmap from practitioners' point of view.

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