RESEARCH IN LOGISTICS & PRODUCTION

CURRENT APPROACHES IN COMPLEXITY MANAGEMENT – PRACTICAL AND THEORETICAL IMPLICATIONS FOR DISTRIBUTION NETWORKS

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Abstract In the up to date competition, the optimal degree of complexity severely influences the success of distribution networks and therefore the success of the entire company. Nevertheless, it seems that up to now, limited research has been done on distribution network complexity. Therefore, this paper deals with current theoretical and practical approaches of complexity management in distribution networks. Methodologically, first an in-depth literature review is conducted, highlighting the existing complexity handling tools in different areas. Since this analysis shows that no approach specifically copes with the requirements of distribution networks, exploratory expert interviews are carried out. Comparing the findings shows that neither literature, nor industrial practice investigate or institutionalize complexity management in distribution networks. Thus, this paper provides opportunities to close this gap. On the one hand, a framework which can be used to elaborate suitable complexity management strategies for distribution networks is presented. On the other hand, the relevant areas of distribution networks are narrowed down in order to create a basis for developing a comprehensive method for complexity management in distribution systems.

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1. INTRODUCTION

In order to satisfy customers' requirements, manufacturing firms need to meet the complexity challenge adequately. For production systems, several authors have already dealt with the issue of complexity management. Also the adoption to supply chains or value adding networks has been accomplished within the last years (Blecker & Kersten, 2006); (Meepetchdee & Shah, 2007); (Wildemann, 2010). However, literature lacks the focus on complexity management of distribution networks.

For being able to deal with the complexity of distribution networks, it is necessary to implement a complexity management process. This is even more striking, as many companies do not trust in their abilities to deal with complexity successfully (Jagersma, 2008, p. 238). Nevertheless, complexity management instruments, which are used in practice, mostly just refer to partial aspects resulting in local optima. Therefore, it is important to develop a holistic approach that covers all complexity related issues of a distribution network. Before a holistic methodology for complexity management in the distribution can be developed, criteria which are required in order to successfully elaborate a useful method, need to be defined. In this context, the target of the present paper is to give an overview of the state of the art of complexity management in distribution systems in theory and practice (Kersten, Grussenmeyer & Lammers, 2011, p. 10).

The article is structured as follows. First, a short literature review on complexity and its impacts on distribution networks is conducted. After that, a deeper study of the literature shows current approaches and strategies of complexity handling that can be applied to the distribution context. The following part describes how expert interviews were carried out dealing with practical experiences of complexity in the practice of distribution management. After a gap analysis, opportunities for developing an integrated methodology of evaluating and handling complexity management in the distribution context are identified.

2. LITERATURE REVIEW

2.1. Complexity-related Literature

We define complexity as "characteristic of a system, which is determined by the number and diversity of elements, their relationships as well as their variance over time" (Luhmann, 1980, p.1064); (Ulrich & Probst, 1995, p.61); (Kirchhof, 2003, p.8); (Bozarth et al., 2009, p. 80). This definition is consistent with the system theoretical perspective on complexity that is mostly used in the context of business administration (Koeppen, 2008, p. 9).

The whole complexity management process can be divided into four parts: Analysis, Planning, Method Definition and Implementation (Raue, 2002, p. 41). The analysis contains the identification and the subsequent evaluation (Frizelle & Woodcock, 1995, p. 26). This is carried out according to the complexity definition, determined earlier. Subsequently, the targets need to be defined in the planning procedure. After this step, the methods to handle the complexity and to reach the determined complexity targets are defined. These handling methods will be regarded more in depth within the next paragraphs. The implementation process is not part of this paper.

For complex, but stable system structures Müller-Stewens and Lechner (2005, p. 566) recommend regulation strategies. Instable system structures can only be handled by self-organization (Paetow & Schmitt, 2003, p.13). Wildemann (1999, p. 75) provides an overview of different regulating strategies called *complexity reduction*, *complexity control* and *complexity avoidance*. Nevertheless, a more detailed approach can be generated by combining the risk management systematization Pfohl (2008, p. 66) with complexity considerations (Fig. 1).

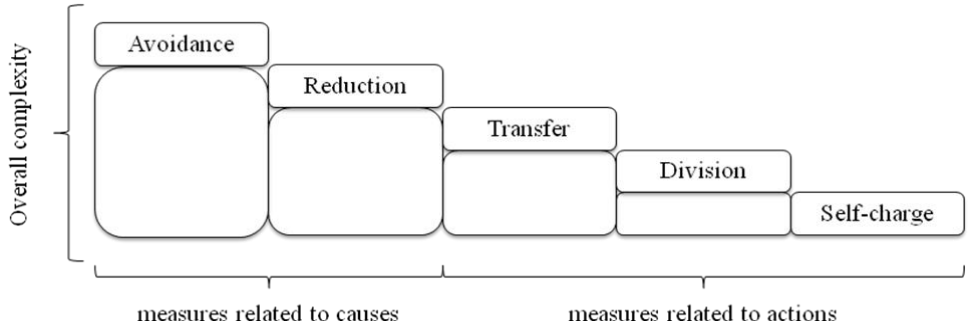

Fig. 1 Complexity regulation strategies (Kersten, Grussenmeyer & Lammers, 2011, p. 11)

Avoiding complexity implies that companies try to not let complexity emerge in the first place. This mainly takes place in product and process development on a long-term view (Child, 1991). Reduction refers to the already existing complexity. Those reduction approaches provide opportunities to decrease the complexity, like e.g. tail cutting (Mahler & Bahulkar, 2009). Transfer and division as regulation strategies are closely related to each other. By transferring, the company tries to outsource the complexity. If this is not possible, methods to divide complexity into two or more companies can be applied. The last regulation strategy is self-charge. Here, all other methods cannot be applied and therefore, the company has to control the remaining complexity on its own.

2.2. Distribution Networks

According to Specht and Mieke (2007, p.17), Supply Chains consist of "industrial chains, which are built by several organizations with economic relations that target the production of goods and the delivery to the customers". The activities of a supply chain can be divided into primary and secondary activities (Porter, 1985, p. 40). The distribution belongs to the primary activities and deals with "all storage and transportation tasks of goods to the customer including all related information, steering and controlling activities" (Schulte, 2009, p. 455). The distribution is the link between the production and the customer (Arnold et al., 2008, p. 405).

Since distribution affects all "business related activities, which belong to the physical and/or economic authority-to-dispose-transfer from one economic organization to another" (Specht, 1998, p. 3), it can be separated into sales and physical distribution (Skjott-Larsen et al., 2008, p. 131). The present paper will focus on the physical distribution.

2.3. Complexity in Distribution Networks

Related to the complexity definition described earlier, suppliers, producers and distributors, as well as their manifold relations to each other in distribution networks can be considered as elements and relations of a system (Pathak et al., 2007, p. 548). Therefore, the distribution can be described as a complicated system. As it additionally evolves over time, a distribution system can be called complex, referring to the definition stated in part 2.1.

An analysis of Geimer and Schulze (2005, p. 99) shows that complexity combined with high costs is not industry-specific, but existent over all networks. Extraordinary success is only possible if distributors are capable of dealing with complexity in global supply networks (Krumm & Schopf, 2005, p. 45). Therefore, competent complexity handling becomes a strategic success factor for networks (Heitmeyer-Große & Wiendahl, 2004, p. 6).

3. COMPLEXITY MANAGEMENT OF THE DISTRIBUTION IN RESEARCH AND PRACTICE

3.1. Complexity regulation strategies

A deep literature review shows that existing complexity regulation strategies can be organized according to the risk management approach introduced earlier. For each area of complexity regulation – avoidance, reduction (both related to causes) and transfer, division, and self-charge (related to actions) – several methods exist.

Ten of the most frequently mentioned handling strategies related to causes and actions are listed in the two tables below:

Table 1 Complexity Regulation Strategies – Related to causes

Strategy	Literature
Centralizing and standardizing of research	Anderson et.al. (2006)
Components and process communality; product bundle	Blecker & Abdelkafi (2006), Anderson et.al. (2006)
Concentration	Hoole (2005)
Examining substitution possibilities	Wildemann (1999)
Keep it simple philosophy, lean thinking	Jagersma (2008), Roever (1991a)
Modularization of logistics, processes or products, including module/ system procurement	Mayer (2007), Blecker & Abdelkafi (2006), Anderson et.al. (2006), Wildemann (1999)
Platform strategies	Wildemann (1999)
Standardization	Wildemann (1999)
Tail Cutting	Mahler & Bahulkar (2009)
Target definition and strategy	Ashmos et.al. (2000)

Table 2 Complexity Regulation Strategies – Related to actions

Strategy	Literature
Higher prices for higher complexity	Anderson (2006), Roever (1991b)
Component families	Blecker, Abdelkafi (2006)
Neural structure, cell design, Post-bureaucratic world	Espinosa et.al. (2007), Größler et.al. (2006), McKenna et.al. (2010)
Definition of interfaces and facts	Franke (1998)
Segmentation of Customer	Hoole (2005)
Information systems ERP, warehouse mgmt system	Jagersma (2008), Faber et.al. (2002)
Postponement, delayed differentiation or order penetration point	Jetzke (2007), Größler et.al. (2006)
Partition of activities and transfer of organizational tasks to suppliers	Pfohl (2008), Schulte (2009)
Outsourcing of development services	Schuh et.al. (2010)
Network procurement	Wildemann (1999)

The overall result of the literature analysis is as follows: seven different methods for avoidance, twenty-two methods for complexity reduction, two methods for transfer and six methods for division were analyzed. Furthermore, 15 different methods have been identified for the self-charge complexity handling in companies.

This literature research shows that several strategies for complexity regulation have been developed already within the last years. These strategies offer a broad range of possible applications. However, the analysis shows a lack in strategies specifically related to distribution complexity. No strategy was explicitly elaborated for this specific use.

3.2. Complexity management in industry

The research question which emerges from the literature analysis is formulated as follows: "How does industry comply with the necessity of a well performing complexity management in distribution networks?" Since this research paper aims to investigate a new phenomenon, it can be exploratory (Yin, 2003, p. 23). Expert interviews are said to be a validate method to gain knowledge systematically (Kvale, 2008, p. 5) and without manipulations by the observer (Meredith, 1998, p. 443), because the focus is the penetrative understanding of a phenomenon and its context (Cavaye, 1996, p. 229). Thus, in-depth interviews provide a more powerful methodology than other techniques such as large-scale surveys.

The interviews have been carried out with eight different companies of different branches (Table 3).

Table 3 Interview experts

Company	Branch	Interviewee
A	Maritime Supplier	CEO
B	Chemical Industry	CEO
C	Medical and Security Industry	Head of Transport & Warehouse Mgt.
D	Assembly Technique Wholesaling	CEO
E	Clusterdevelopment	Cluster Manager
F	Haulage Contractor	CEO
G	Wholesaling backery products	Head of Logistics
H	Haulage Contractor	CEO

A study protocol to conduct the research has been defined. In particular, the semi-structured interview guideline consists of questions capturing the existence of complexity management in the business units of the interviewed persons and then, subsequently the executed regulation strategies for a holistic and useful complexity management according to each expert. Later, the qualitative data (interviews) have been systematically coded to aggregate the relevant results for this study.

Even though the experts generally neglect a separate complexity management for their distribution, several individually used strategies can be extracted from the interviews. An alphabetical overview of all distribution-related strategies men-

tioned during the interviews is given. These strategies are assigned to the complexity regulation methods presented earlier [Avoidance (*A*), Reduction (*R*), Transfer (*T*), Division (*D*), Self-charge (*S*)] according to the fields of application mentioned by the experts. As soon as several companies use the same tools, they are aggregated. The following table shows all mentioned strategies:

Table 4 Complexity Regulation Strategies in Distribution

Strategy	Experts	Regulation
ABC / portfolio analysis	F, H	R
Best Practice	E	S
Bottleneck analyses	D	R
Central strategy development	C	S
Centralization of logistics	C, D	R
Clear definition of interfaces	A, C	S
ERP systems and reporting	A, C, D, F, H	S
Functional matrix organization	C	S
Inventory and need management	B	S
Knowledge data base	D, F	S
Meeting structures	A, F, G	S
Outsourcing of distribution	A, B	T
Packaging	D, F	A
Process management	A, B, C, D	S
Process visualization	C	S
Standardization	C, G	A
Strategic cooperation	D	S
Target definition	D	S
Time management	H	S
Value adding activities	C, E	R
Value benefit analysis	E	S

As the conducted interviews show, companies already deal with the complexity of their distribution networks. However, it is striking that most of the mentioned strategies are only used by one or two companies. Furthermore, the majority of the explored strategies deal with the activity of *self-charge*. This indicates an incomprehensive dealing with complexity. Only very few strategies can be identified that belong to the *activities related to causes.* This shows that even though complexity regulation in the avoidance and reduction approaches is more powerful, it is not sufficiently used in practice.

4. DISCUSSION

4.1. Gap Analysis

The literature review on state of the art complexity research shows that many different methods for evaluation and regulation already exist. Nevertheless, it is striking that for distribution networks there are no specific complexity regulation methods. Various evaluation and regulation methods focus on product development processes (Schlick et al., 2007, p. 144), production (Foster & Gupta, 1990), procurement (Wildemann, 1999), the whole company (Ashmos et al., 2000) or the superior supply chain (Blecker et al., 2005). However, none of the evaluated regulation strategies copes with the specific requirements of distribution networks. Furthermore, complexity management is often not yet institutionalized in industry. Companies, dealing with their complexity use methods which have not been developed for the specific requirements of distribution networks.

Nevertheless, the complexity management steps (analysis, planning, method definition and implementation) are generic and can be transferred to distribution networks. For example, within the evaluation methods, the system theoretic approach is a useful method which relies e.g. on elements and their relationships. Thus, it can easily be adapted to network structures. During the evaluation process it is not relevant, which kind of network is evaluated, it could be procurement or a production network. As explained before, distribution can also be considered as a network containing tightly coupled suppliers, producers and distributors. Therefore, it is possible to measure distribution network complexity with a system theoretic approach. Another possibility of analyzing the complexity degree is taking the amount of complexity drivers as measurement for complexity in a system. This also does not depend on the kind of system. The same can be stated about different regulation approaches. They are mostly not limited to one application.

Not only in literature, but also in industrial practice, complexity regulation strategies are not focussing on distribution networks. The detected strategies mostly refer to a symptomatic management approach, which indicates a lack of long-term complexity management in the sense of anticipatory and foresighted behaviour.

4.2. Results

External and internal influences like increasing globalization of value adding activities, increased individualization of the customer demand, shortened product life cycles or new information technologies raise the complexity within a company. This sincerely influences distribution networks because they are the interface between production and customer. As distribution is a critical factor for competition, a complexity management of distribution networks obtains a key function.

This paper deepens the understanding of complexity in distribution networks in general, and more specifically, the complexity handling by using complexity regulation strategies. The most important strategies dealing with measures related to causes (as avoidance and reduction), and measures related to actions (as transfer, division and self-charge) are reviewed from literature. Furthermore, different strategies used in practical existing distribution networks are investigated by the means of exploratory interviews.

The comparison of the strategies in research and industry shows that some of the strategies detected in the literature are already used in practice. However, the gap analysis clearly highlights that all elaborated strategies, both from literature and from practice, are on a very universal level or target primarily other areas within the supply chain. The overall result is that there is lack of a complexity management for distribution networks.

4.3. Implications for further research

As it is indicated in the gap analysis and the results, it is important to develop a complexity management focussing on distribution networks. This might work by adopting existing strategies to the specific requirements of distribution networks.

The management of complexity in distribution networks can be elaborated according to two different parts: (1) drivers and (2) a distribution framework. The drivers of complexity in distribution networks are those factors that have an influence on the overall complexity level of a system (Mayer, 2007, p. 26). A new method for complexity management should directly deal with the distribution aspect. Therefore, it helps to analyze different areas of distribution complexity. One opportunity would be to take the framework developed by Kersten et al. (2011), showing distribution in the broader and the stricter sense.

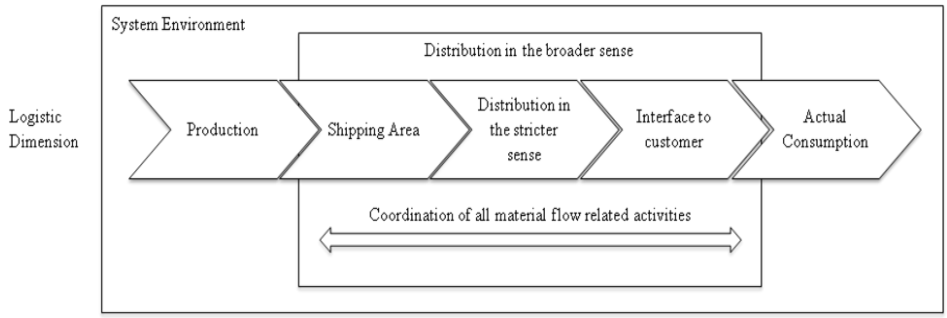

Fig. 2 Distribution in the broader and the narrow sense (Kersten et al., 2011)

In a Supply Chain, the logistics dimension consists of several parts, the production, the shipping area, the distribution, the interface to the customer and the actual consumption. Except from the production and the actual consumption, all included

activities can be referred to as distribution in the broader sense. The distribution in the stricter or narrower sense, however, deals with the physical part of the logistics dimension only (Fig. 2).

For the investigation, the part of the regarded distribution has to be narrowed down. First of all, external environmental factors will not be included in the research. The resulting distribution system contains more information than a distribution network. By modelling the system as a network, irrelevant and unknown information will be excluded. This distribution network complies, as before mentioned, with several activities.

By allocating a set of distribution-specific complexity drivers to the mentioned areas of the distribution framework and an adjacent analysis of their impacts on the degree of complexity, it would be possible to determine how and where complexity affects the functionality of the overall system. In this way, a decision basis for concentrating management activities would be created.

4.4. Final Remarks

Handling complexity in the supply chain is a task of increasing importance for the overall success of the involved companies. Although distribution systems are an important part of the supply chain, specific approaches for complexity management in the distribution have not yet been established in theory and practice. The explorative study presented in this paper generates the motivation to develop a comprehensive method to evaluate and handle distribution complexity by revealing a lack distribution specific complexity management in today's business.

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