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AUTONOMOUS CO-OPERATION IN INTERNATIONAL SUPPLY NETWORKS - THE NEED FOR A CHANGE FROM CENTRALIZED PLANNING TO DECENTRALIZED DECISION MAKING IN LOGISTICS PROCESSES

Michael Hülsmann[1], Jörn Grapp[2]
University of Bremen
[1] michael.huelsmann@uni-bremen.de, [2] grapp@uni-bremen.de

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ABSTRACT
Presently, Supply Chain Management is on the verge of being replaced by the management of International Supply Networks (=ISN) in the course of globalization. Thereby, complexity and dynamics in logistics systems and processes are increasing due to higher requirements towards management. These demands essentially result from the necessity of balancing flexibility and stability. One approach to cope with these demands in ISN is autonomous co-operation whose possible contributions will be discussed in this paper.

EARLY DEVELOPMENTS & FUTURE REQUIREMENTS IN BUSINESS LOGISTICS
Analogous to its chronological development, business logistics can be systemized by a concept of different stages (Göpfert 2001, p. 348; Weber 2002, p. 102-103; Weber and Blum 2003, p. 226-228). Logistics advanced from a stage describing its basic functions in the 70s to today's notion of an integral concept of management in regard to the company-transcending value-added system and its logistics processes in a flow system perspective with every intra- and inter-system activity known as supply chain management (=SCM) (Arndt 2004; Corsten and Gabriel 2004; Werner 2002; Busch and Dangelmaier 2004). But the development of logistics conceived as SCM (Weber, Dehler, Wertz 2000), cannot be considered finalized. There are several driving forces that produce an ongoing change which in turn leads to a simultaneous redefinition of logistics in adaption to the changing conditions. One example is the establishment of virtual companies to improve supply chains as well as global logistics co-operations and alliances or the development of an increasing number of complex intra- and inter-related logistics processes (Herzog et al. 2003). In literature, authors name similar driving forces which advance the change within the notion of logistics in regard to its development (Arndt 2004, p. 8-24; Corsten and Gabriel 2004, p. 19-31).
Another stage of development might be appropriate from today's perspective of economic globalization and worldwide integration of added value. In this stage, complexity and dynamics further increase because SCM also has to take into account intercultural aspects as for example the individual preference structures of different markets (Mentzer 2004, p. 6). This world of diversity and change is represented by three typical phenomena of "real-time-economies" in terms of "hyper-linking", "hyper-competition" and "hyper-turbulence" (Tapscott 1999; Siegele 2002) which lead to higher complexity and dynamics of logistics systems, as well as of their processes and the involved management (Hülsmann and Berry 2004).

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MANAGEMENT OF SUPPLY CHAINS OR INTERNATIONAL SUPPLY NETWORKS

SCM is originally based on the value chain of Porter (Porter 1995; Porter 1999). This concept implies the integration of all company's activities. It focuses on intra- as well as on inter-related contexts of logistics systems. However, this view beyond the supplier and the buyer scheme shows that management practice has to deal with not only a simple chain but a rather complex and dynamic network as a result of multiple and often changing inter-relations between all actors involved in logistics processes. Consequently, the concept of SCM is presumably insufficient for describing today's organizational structures of logistics. Based on its characteristics and against the background of the mentioned factors, it can be assumed for further development of business logistics within its self-conception and its functional layout, that future stages will be coined by an increasing integration in the structure (i.e. concentration of the actors by mergers & acquisitions), intensified co-operations in the processes (i.e. through the integrated, company-transcending use of information and communication technologies) and at the same time growing diversification of the business profiles (i.e. qualitative-functional, quantitative and spatial expansion of business activity) of all value added systems (Herzog et al. 2003, p. 1-2). In this context, the term logistics network appears to be more precise. It is not only meant as a model of the material and information flow, but as a logistics system in a complex, dynamic and company-transcending context of co-ordination. Companies are legally seperate but economically to a greater or lesser extent dependent on each other. In contradiction to the idea the term "chain" might evoke, a large number of inter-organizational relations exists between these entities, eventually leading to additional complexity and dynamics (Sydow 2002, p. 10-11). Planning and co-ordination processes are confronted with an increasing and for the most part changing quantity of information, which causes difficulties for the management in ISN that has to make a rational decision (i.e. on the basis of complete information, which is necessary for its decision-making processes). First, it has been ascertained that the concept of SCM is an insufficient perspective in the context of modern logistics. Secondly, the term "logistics network" actually arose in order to meet the needs of a new perspective of the globalized world. But yet, a final step which combines these two outlined notions needs to be established as in the future different logistics networks and complete supply chain networks will be interwoven with each other. Companies are involved in different supply chain networks which again compete among each other on the world market (Seebauer 2003, p. 62; Lambert et al. 1998). These networks of supply chains shall therefore be characterized as ISN. Thus, it may become apparent that a perspective of modern logistics as ISN implies additional complexity and dynamics in regard to its inter-organizational structures of logistics.

The following example of a textile company in Hong Kong shall serve to illustrate this tendency towards ISN. It is assumed that this company gets an order from an European retailer to produce garments. Considered as a dispersed production network the company may decide to buy a low price yarn from a South Korean producer. But this yarn could be efficiently woven in Taiwan where it has to be transported to. However, the company gets zippers and buttons from a Japanese company etc.. Finally, the best place to stich the garments may be in Thailand. In doing so, the company optimizes each step by operating globally and pulls the value chain apart. Beside the fact that there are different organizations in one supply chain, these are in addition situated in different countries (Natarajan 1999, p. 209).

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SYSTEMTHEORETICAL IMPLICATIONS: INCREASING COMPLEXITY & DYNAMICS

A complex system can be understood as "the existence of many characteristics depending on one another in a section of reality [...]" (Dörner 2001, p. 60). Not the quantity of elements is decisive but the existence of various inter-relations between the elements of the system as well as between the system and its environment (Dörner 2001, p. 60.; Malik 2000, pp. 186). A logistics system in general is an open but mainly a dynamic and complex system (Bäck 1984, p. 137). Its character and quantity determine the systems structure and its behaviour (Isermann 1998, p. 47). In a logistics system, institutions, persons and places are assumed elements amongst which a spatial and temporal transfer takes place (i.e. customers and suppliers). Resources as well as working stock, employees and other immaterials are assumed elements. Logistics processes such as transport processes, storage processes as well as informational processes may be understood as (inter-)relations in logistics systems (Delfmann 1998, p. 309).
The complexity of ISN has to be seen in the context of an inter-organizational network (Sydow and Windeler 1999, pp. 4). In the centre of consideration is the co-operation of organizations as well as their interactions and relations within the network. ISN represent a plaited work of systems (i.e. supply chains) and their sub-systems (i.e. companies) both involved in super-systems (i.e. the inter-organizational network). ISN in this perspective risk to become an ineffective construction as the domination of a centralized planning in such structures is influenced by the cited phenomenon of hyper-linking in decision making processes. This means that information processes today represent an immense exchange of data between all actors in ISN. It is difficult to canalize and to bundle the data, so that it is reduced to the minimum of the absolute decision-relevant package of information. With a rising number of ISN an increasing fragmentation occurs which can rather be managed by a centralized planning since an increasing integration of all logistics activities on the level of physically handling the goods and its interacting elements persists within the ISN-phenomenon. Between different companies i.e. inter-organizational software-sharing and co-designed distribution channels in fast moving consumer goods are typical examples for this development. Many co-existing individual system components and their interdependencies stipulate, as to Luhmann's characterization of relexivity in planning processes (Luhmann 1994, pp. 635), a hyper-complexity which makes a rational analysis and planning in ISN impossible (Hülsmann 2003, pp. 103). Related to ISN the permanent change of environmental conditions leads to hyper-turbulence, which describes the escalating change of modern management (Hülsmann and Berry, 2004).
By taking up the example of the textile company in Hong Kong the systemtheoretical context of complexity and dynamics shall be elucidated. This example shows that more elements (i.e. employees who communicate) lead to a complexity of elements, that more relations (i.e. co-ordination between companies) lead to a complexity of relations and more attributes (i.e. intercultural differences between countries) lead to a complexity of attributes. As a result of the multiple systemic linkages in ISN and of temporal changes, dynamics of the surrounding systems have a decisive additional impact on dynamics in logistics processes (Hülsmann 2003, pp. 193). For example, a change in the production program of the yarn supplier leads to changes in the planning of the buyer.

OPPOSING DEMANDS FOR AN ISN-MANAGEMENT: FLEXIBILITY & STABILITY

The management of ISN has to cope with complexity and dynamics. But in order to achieve this ability, flexibility und stability have to be increased. Integration enables the system to communicate with the environment through mutual inter-relations. Thereby it sustains the existential exchange process of resources (Staehle, 1999, p. 417; Böse,Schiepek, 1989, p. 121). This process of integration is implemented by system openings (Luhmann, 1973, p. 173) during which the system absorbs a part of the complexity of the environment (i.e. information) to achieve the system goals. However, to implement this process in a complex and dynamic environment the system needs organizational flexibility as primary requirement for being able to adequately respond to the changing and diverse environmental conditions (i.e. technological progress) (Sanchez, 1993). Yet, the system does not absorb the entire complexity of the environment but only a portion. System closure is implemented by creating and maintaining a system border. In this way, it constitues itself of the number and intensity of interrelations between the system elements and the environment (Ulrich, 1970, pp. 109; Hill/Fehlbaum/Ulrich, 1994, p. 21). The system borders become more permeable with this increasing degree of flexibility. As this phenomenon has to be compensated, stability is a second requirement for the system's survival in the long-run (Maturana,Varela, 1987, p.50). Finally, it becomes apparent that under the described conditions and changes the management of ISN has to increase its flexibility and at the same time ensure its stability.

In a situation of increased complexity and dynamics, as the example of the company in Hong Kong shows, a centralized decision-making is not able to cope with the opposing demands. In ISN the quantity of information is permanently growing. Decision relevant information has to be filtered out of unnecessary information that is being exchanged between several actors situated in different countries and involved in decision-making processes of logistics processes. A systemtheoretical interpretation shows that flexibility and stability can rather be handled in such a perspective by a central force. If the ISN supra-system increases flexibility through extended system openings it will have to absorb an immense complexity. Consequently, the system is in danger to overcontrol itself. The vast effort of co-ordinating information has to be avoided by increasing stability through system closure. This, however, proves to be difficult as increased flexibility weakens the borders of the system. A central force would therefore lose control of the system, which has to be seen in the context of a "bounded rationality". And an economic unit has only limited capacity to comprehend situations of decision-making depending on individual environmental situations (Schoppe et al. 1995, p. 104).

conditions. Furthermore, the potentiality of handling the described opposing demands The assumption of this paper is now that previous management approaches that are based on centralized planning might not be capable enough to cope with the present and prospective needs in future business logistics. Meeting the demands of the future requires the balancing of stability and flexibility under today’s fast changing internal and external and therewith of guaranteeing the systemic mutability of ISN needs to be analyzed (Seebauer 2003, p. 62).

AUTONOMOUS CO-OPERATION IN ISN: BALANCING FLEXIBILITY & STABILITY THROUGH DECENTRALIZED DECISION-MAKING

The concept of "autonomous co-operation describes processes of decentralized decision-making in heterarchical structures. It presumes interacting elements in non-deterministic systems which possess the capability and possibility to render decisions independently. The objective of autonomous co-operation is the achievement of increased robustness and positive emergence of the total system due to a distributed and flexible coping with dynamics and complexity."

(Hülsmann/Windt, 2005). The core concept of autonomous co-operation is based on the idea that systems cannot only be regulated by an external force, but just as well from the inside of the system itself. In general, this concept means leaving operative decision-making in its sub-systems, -units, and -elements while the individual system components operate independently from centralized decision-making structures. The increased relevance of ISN management implicates the need for intelligent systems with adaptive capabilities on a local level, which however follow central goals such as service levels. Local reactions in response to changes and deviations (i.e. incidents, delays, new orders etc.) may occur (Herzog et al. 2003, p. 5). Co-operation originally denotes the "effort to decrease the difference" (Luhmann 1988, p. 328). Hereby it is referred to the difference between the desired and the status of the system. The goal is to attain a systematic change of the system's autonomous dynamics through co-operation. This relates to different scenarios: conservation of the structure despite its tendency for changes, a spontaneous changing process shall be accomplished or a stable structure shall be altered (Mayntz 1987, p. 94). Co-operation in this context aims at influencing events and interactions more than just punctually. It focuses as well on single organizational units and systems involved in the network (Sydow and Windeler 1999, p. 3). Thus, a contribution to higher flexibility and stability in ISN could be achieved by shifting the responsibility of decision-making and co-ordination to smaller organizational units as well as their relation to other units inside or outside the respective system. It is expected that planning and in particular managing capacities will improve by reducing the quantity of the operating systems and sub-systems. The systems independently operate towards a decision and are flexible enough to compensate complexity and dynamics caused by unexpected changes and to fulfill the long-term strategic goals of the major ISN actors. The total complexity of the system is reduced to partial complexity. This leads on the one hand to higher flexibility as a smaller environmental sector implies the handling of less changes in a narrowed environment with consequently less coordination-work. Due to the existence of various sub-systems the surface of the total system expands and allows to process more complexity. On the other hand stability increases as complexity is absorbed by each of the individual sub-systems. A failure therefore only results in a sub-system failure and helps the total system to gain stability. In addition, even the sub-systems gain in stability given that their smaller surface allows a better integration.

Despite these possible positive contributions of autonomous co-operation, two systemtheoretical risks can be identified. One is the decrease of the total stability due to a diminished identity of the system as a whole caused by sub-system egoism. The second one is the possible decline of the total flexibility since the sub-systems must invest more effort and which so far has not yet been regulated. Moreover, it should be kept in mind that this theoretical conceptualization and its expected effects also receive critical feedback from authors because it implies that problems in autonomous co-operation are solved automatically by means "of the invisible hand" (Bruns-Vietor, 2004). As this leads to a loss of predictable system behaviour, a focused and planned mangement cannot longer be based on general causal patterns of how a system might develop. The approach received further criticism concerning system control (Bea and Göbel 1999), costs (Göbel 1998) and productivity (Jost 2000).

According to the above cited example of the textile company, autonomous co-operation may contribute to a more efficient transaction of its globally organized orders. However, some prejudice against the approach will persist as its effects and expectations cannot precisely be valued. These contradictions consequently result in the need for further research. Furthermore, the pros and contras of the approach of autonomous co-operation pose the question of an adequate establishment of this conceptualization. Only if it the contributions can be measured this approach will be manageable. Therefore a measurement concept has to be developed. On the one hand it needs to identify the degree of autonomous co-operation and on the other hand its benefits and costs.

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