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MONITORING OF AUTONOMOUS COOPERATING LOGISTIC PROCESSES IN INTERNATIONAL SUPPLY NETWORKS

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ABSTRACT
The main contribution of this paper is to achieve measurability of the management approach of Autonomous Cooperation (= AC). This is a necessary basis for its application to business logistics and to management in general. For the practical context a measuring instrument allows International Supply Networks (= ISN) to be appraisable concerning possible effects of AC. Therefore in the following a monitoring concept of autonomous cooperating logistic processes will be presented regarding its different sub-components and discussed concerning its present options and limitations.

THE NECESSITY TO OPERATIONALIZE THE MANAGEMENT APPROACH OF AUTONOMOUS COOPERATION FOR ISN
International Supply Networks could be understood as an assembly of certain logistics networks (Sydow 2002, p. 10-11) alternatively supply chain webs, which are interlinked with each other. This means single firms are involved in different supply chains building up networks and such supply chain networks again compete among each other on the global market (Seebauer 2003, p. 62; Lambert et al. 1998). From such a perspective logistics management has to cope with an increasing complexity and dynamics regarding its systemic structures, as well as its processes and its coordination (Hülsmann and Berry 2004). Logistics management actors have to face higher requirements, especially in the form of intensified co-operations in logistic processes (e.g. through the integrated, company-transcending use of information and communication technologies) (Herzog et al. 2003, p. 1-2). This development of globalized logistics is even pushed, especially by the phenomena of "hyper-competition" and "hyper-linking" (Tapscott 1999; Siegele 2002). Hyper-competition results especially from an increasing world-wide intensity of rivalary among competitors and the risk of products, which could e.g. substitute presently existing services (Porter 1980). The second phenomenon occurs in the form of companies as international players (Hülsmann and Berry 2004), e.g. such as multinational service logistics providers. As there is an increasing number of actors involved in ISN between whom information processes have to take place, it becomes more difficult for the affected centralized planning unit to coordinate the immense exchange of data for an effective decision-making as well as efficient conducting of logistics activities (Hülsmann and Grapp 2005, pp. 243).

From a system-theoretical perspective balancing flexibility and stability of ISN seems to be necessary to cope with complexity and dynamics (Luhmann 1973, p. 173). On the one hand organizational flexibility is needed to respond to the occuring changes and diverse environmental conditions such as technological progress (Sanchez 1993, pp. 251) by opening the logistic system´s borders (i.e. handle service goals, e.g. to deal with orders received). On the other hand the absorbed complexity can only be compensated if stability is ensured by closures of the respective system (i.e. hold up supplier-buyer-relationships, e.g. to produce high quality in well-known structures). This process of stabilization is consequently needed for a permanent adaptation (Hülsmann and Wycisk 2005, p. 8) as well as the cited flexibilization and thereby maintenance e.g. of the ISN-existence.

For realizing flexibility and stability in ISN it is assumed, that the concept of AC could contribute to improve planning and managing capacities by balancing these opposing demands. This expectation is based on the assumption, that by reducing the quantity of systems and sub-systems they operate independently towards decisions and gain more flexibility. Sub-systems (e.g. local manufacturers) get a general direction (i.e. by ISN-Management) for its decision-making and can flexibly decide within a predefined decision frame, which could be realized and manifested in organizations by processes of delegation and decentralization (Kappler 1992, p. 273). Because complexity is absorbed by an increased quantity of such decision units it is reduced to a partial complexity. This ensures stability as less coordination work is needed and failures remain in the sub-system (Hülsmann and Grapp 2005, pp. 243).

However, to definitely increase the effectiveness and efficiency of managerial decisions for any company first of all it is necessary to find out its individual and optimum degree of AC. This necessity lies in the fact that AC can either have positive and negative effects. Only on the basis of the optimum degree of AC specific technological, informational and communication-related and management measures could be deduced and implemented adequately in ISN. Therefore in this paper a measurement instrument alternatively monitoring concept will be presented and discussed regarding its basic components and different functions.

MONITORING CONCEPT OF AUTONOMOUS COOPERATING LOGISTIC PROCESSES & APPLICATION IN INTERNATIONAL SUPPLY NETWORKS

Former research has focused on the abstract contributions of the approach of AC (e.g. Hülsmann and Grapp 2005, pp. 243). But for the adequate establishment of this conceptualization its contributions will only be manageable if they are measurable (Drucker 1954). Before the measurement instrument alternatively monitoring concept will be explained it is necessary to define its basic requirements that determine its design.

Besides general design requirements there exist specific ones e.g. from measurement theory such as the need for validity or reliability (Kromrey 2000). The general requirement for the measurement instrument is, that on the one hand it should allow deduction of the degree of AC. On the other hand it is necessary to construct a consistent measurement system in which economic indicators will be integrated, in order to identify the realisability and the contributions to the objectives of AC. However dynamics of a logistic system and its processes have to be assumed (e.g.

real-time economy), which cause not just a static optimum of AC. It can be assumed, that the degree of AC varies over time. This is why a continous monitoring is needed for the measurement of the degree of AC on all levels of ISN, e.g. for the L1: "decision system" (management), L2: "information system" (information and communication), L3: "execution system" (material and goods flow) (Herzog et al. 2003, pp. 124).
The developed monitoring concept so far consists of three sub-components:

1. **Polarisation Graph** (visualization)
2. **Scoring Model** (measurement)
3. **Temporal-spatial Measurement of Validity** (relativisation)

Polarisation Graph

In the polarisation graph the main characteristics from the definition of AC can be found: "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 and Windt 2005). The deduced characteristics (C1 to C5) are C1: Decentralized-Decision-Making, C2: Autonomy, C3: Non-Determinism, C4: Interaction and C5: Heterarchy. They stand for each of the illustrated dimensions.

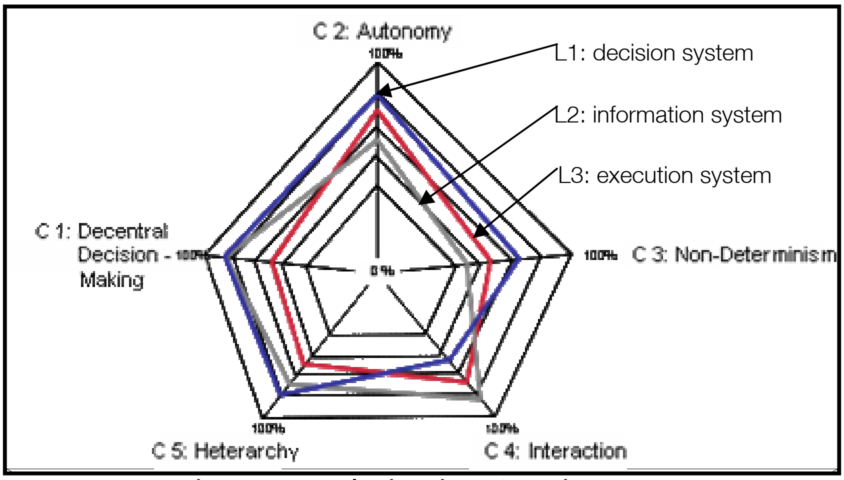

Figure 1. Polarisation Graph

The polarisation graph visualizes the degree of AC based on its different characteristics named above. On a scale form 0 to 100% a higher percentage indicates relatively more AC and a lower percentage indication stands for relatively more external coordination in logistic processes. This means, that a comparison of different logistic processes and levels of a production logistic system is assumed to be possible regarding their individual degrees of AC. Finally, the sketched area between all scopes respectivley dimensions representing each characteristics of AC symbolizes the aggregated degree of AC of a single production logistic system level

(L1 to L3).
How could this visualization of AC in the polarisation graph be interpreted for ISN? As a practice-orientated example a logistics service provider of the automotive industry shall be chosen for illustration. In this context a globalized car production and distribution has to be assumed. Logistic processes, transportation and technical processing of millions of cars have to be coordinated in a service-orientated ISN that consists of many locations worldwide. (Koch 2006, p. 6). The degree of AC could be determined related to a specific point in time for each logistic system level of the respective ISN. In this case each logistic system level includes in a cross-sectional perspective on the different worldwide dispersed companys the relevant elements belonging to L1 (i.e. aggregated local management units), L2 (i.e. aggregated elements of local information and communication technology structure) and L3 (i.e. aggregated local production plants, machinery, persons). That means ISN-Management could identify how autonomous its different service partners operate in an aggregated view on its logistic organizational structures. It could be interpreted if presently the service partners are more coordinated by ISN-Management (tendency to more external coordination = low degree of AC) or whether single companies at certain locations decide and act more locally (tendency to more AC = high degree of AC).

Scoring Model

This sub-component serves to measure the degree of AC. In this model the constitutive characteristics of the definition of AC are transferred into specified indicators and measurands for each level of a production logistic system. A morphological box contains the description alternatively operationalization for the different characteristics on every production logistical level (Windt et al. 2005) This shall be exemplified concerning the characteristic "decentralized decision-making", which has to be understood as a specific local management on the level of the "decision system" (management). In a next step local management as a specified characteristic will be transfered into indicators as for example like "decisions in a specific process". For every single indicator measurands will be developed, such as in the example: quantity, frequency or value of decisions (Orth 1995). Then, the sum of all weighted measurands stands for the points score of the particular indicator. Finally, the sum of all weigthed indicators stands for the weighted points score of the specific characteristic for the particular level of the production logistic system, which can be transferred into the above shown polarisation graph.

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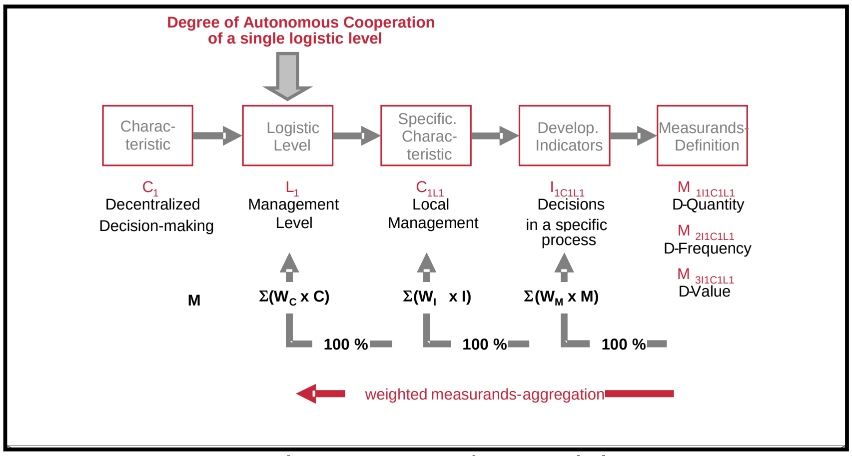

Figure 2. Scoring Model

For the application of the scoring model in ISN practice a software-based question sheet to evaluate the relevant data has to be filled out. In this sheet for every decision unit involved in the coordination of logistic processes of ISN all actors alternatively service partners have to be included regarding certain individual measurands. The kind of measurands differs in the considered individual production logistic system. A measurand could e.g. refer to how many decisions are necessary in the process of developing a logistic strategy, which shall be about the diversivication of production capacities for manufacturing a specific type of car at one location (=decision quantity). Such a measurand and other selected ones will be weigthened and aggregated in the general way shown in the explanation part of the scoring model.

Temporal-spatial Measurement of Validity of AC

For the relativisation of the determined degree of AC a temporal-spatial measurement is necessary to evaluate the respective measurement result regarding its validity in complex organizational structures and referring to continous organizational changes. Because of the characteristic of dynamics in a system (Hülsmann and Wycisk 2005, p. 4) it is assumed that the calculated values of the scoring model cannot be considered as absolute. Therefore the degree of AC has to be measured repeatedly. Furthermore, the degree of AC can be the same for certain characteristics in different systems. However, the relevance of the respective value differs with an increasing temporal and spatial validity. (Example: $t1 > t0 = t2$)

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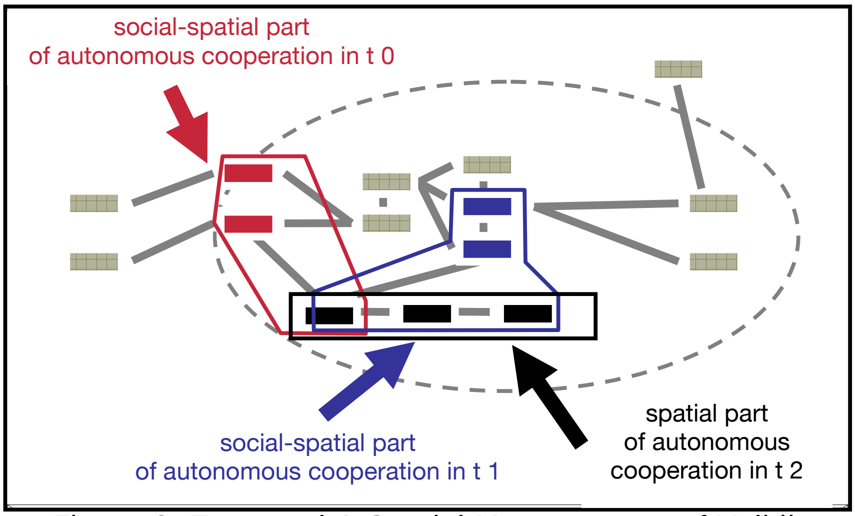

Figure 3. Temporal & Spatial Measurement of Validity

Regarding the temporal validity, on the one hand the scope of validity within a specific process has to be detected. On the other hand the frequency of repetition for the whole production process has to be taken into account. This is why the degree of AC will be measured for different phases in a logistic chain and it has to be determined in which parts of the system alternatively sub-systems it is valid. As typical values measured by the temporal and spatial measurement can be named: process/process intervals as well as frequencies etc..

The shown component for the temporal and spatial measurement of validity of AC is of specific relevance for the monitoring aspect of AC in ISN. A monitoring could serve to achieve transparency of logistic processes by the constant observation of indicators and estimation of their effects (Lombriser and Abplanalp 2004, p. 127). The necessity for a monitoring in ISN results from the fact, that all decisions related to logistic processes take place in a global context with many interdependencies and changes between the cooperating service partners (e.g. additional/less service partners involved in a certain process) over time (Lukka 2005, pp. 60). Because of those dynamics and complexity the degree of AC differs over time and therefore has to be measured repeatedly in certain intervals. Theoretically, a measurement has to be processed as often as the ISN-structure itself changes to allow differentiated decisions for ISN-Management to increase/reduce the degree of AC in ISN by considering the temporal-spatial validity of AC.

OPTIONS AND LIMITATIONS OF THE MONITORING CONCEPT FOR ITS REALIZATION IN INTERNATIONAL SUPPLY NETWORKS MANAGEMENT

In the following the functions of the presented monitoring concept shall be relativised regarding its options and limitations in ISN. For ISN understood as a network of services not only acting but especially thinking in networks is presumed (Koch 2006, p. 6) and represents the qualification for the use of the tool. Therefore, at first a brief consideration of the expected contributions from its application for ISN-Management will be illuminated.

- ISN-Management gains the opportunity to describe its actual degree of AC on all levels of a production logistical system and for each of its global service company partners, in this case including all elements such as persons, machines, technologies involved. The measurement concept thereby contributes to a basic theoretical task of social sience to operationalize terms such as the abstract context of AC in organizations (Hill et al. 1994, p. 39).

- Through the data collection for AC measurement a fundamental basis of information is given to ISN-Management. The more profound it is the better it serves for its decision-making process (Bronner 1999, p. 16) regarding the invention of more or less AC.
- Related to the former aspect the monitoring concept allows to concretely identify economic long-term potentials for ISN, such as organizational logistic potentials. On the information basis named in the second aspect ISN-Management obtains the opportunity to orientate its logistic strategy-building, e.g. it is possible to judge whether a specific technology should be introduced to increase/reduce AC.

Second it shall be illustrated how far the application of the monitoring concept still bears potentials to be further developed in the future.

- Presently, it can still be considered as problematic to make statements on the „monitored“ degree of AC. Actually, a monitoring would have to be executed permanently (ideally for every second of a process), as it is intended by the third component (temporal-spatial measurement of validity of AC). However, this seems at the moment still be burdened with realization problems. A relativisation takes only place in bigger temporal intervals (per shift, day, product etc.).
- Another remaining problem is the complexity of the tool itself. Because it means a huge effort to get all needed data, process it and finally evaluate it. The degree of complexity depends on how detailed the consideration of data is and e.g. how many questions, measurands have to be processed.
- Furthermore, the transfer of the monitoring concept from theory into practice has not yet been realized. This means the tool still would have to be tested in the practical context of a company (Herzog et al. 2003). Additionally, there might be problems with data input, because eventually prejudice from the companies´employees will occur.

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