Contradictions between Strategic Management and Operational Decision-Making – Impacts of Autonomous Processes to Decision-Making in Logistics

Nadine Dembski[1], *Ingo J. Timm*[2]

University of Bremen
Collaborative Research Center (SFB 637) on
Autonomous Cooperating Logistic Processes
[1]nadine.dembski@uni-bremen.de
[2]i.timm@tzi.uni-bremen.de

ABSTRACT

The development of logistics in globally distributed and highly dynamic supply networks requires new approaches to conduct efficient and effective logistic processes. Autonomous logistic processes seem to be a promising approach for designing these progresses. This paper proposes an integrated organisational and managerial approach to enable decision-making in practical applications.

INTRODUCTION

Nowadays, logistic processes are subjects of a high variety of change drivers depending of the development of the market situation. The role of the consumer is increasing significantly and continuously such that products have to be more and more individualised and customized resulting in a rapid change from seller's market to buyer's market. This development is leading to the atomisation of deliveries and in consequence to an enormously increased transport volume (Aberle, 2003) as well as a rise of delivery frequencies. The increase of complex internal and external logistic processes needs to be allowed by managing logistic processes, especially, if goods are produced in global supply chains.

These trends and recent changes in logistics lead to complex partially conflicting requirements on logistic planning and control systems. In consequence, currently available strategies, methodologies, and tools lack limited efficiency. An emerging approach in research may be found in the analysis and design of adaptive logistic processes including the ability for autonomy. The vision of autonomy in logistics is to enable processes to interact co-operatively for individual as well as global optimisation. From the management perspective, this requires the delegation of decision-making competence within logistic processes. In consequence, the management is losing influence on local decisions. To compensate this loss of control new instruments and logics are needed for ensuring reliable process behaviour.
In a standard approach to logistics, local entities are making decisions on the basis of pre-defined set of rules, short-term objectives of the enterprise, and current information about their environment. To meet the new requirements of modern logistics (cf. introduction), new ways of designing, implementing, and managing logistic processes are needed. Therefore, the German national science foundation (Deutsche Forschungsgemeinschaft) is funding a Collaborative Research Center on "Autonomous Logistic Processes – A Paradigm Shift and its Limitations" (SFB 637). Autonomous cooperation 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 cooperation is the achievement of increased robustness and positive emergence of the total system due to a distributed and flexible coping with dynamics and complexity.[1]

This approach allows for highly adaptive or flexible networks of logistic processes. Nevertheless, there are several implications to organisations and their internal decision-making. One of the key challenges may be found in the heterogeneous levels of decision-making within autonomous processes, i.e. handling contradictory requirements. With a higher

[1] Current working definition for "Autonomous Cooperation" (Selbststeuerung) with the CRC as summarized by K. Windt and M. Hülsmann in 2005.

level of autonomous cooperation in organisations decision-making becomes faster and more flexible, but it is also leading to a loss of control for the management.

PROBLEMSTATEMENT

The dominating paradigm "strategic fit" does not fulfil the above mentioned requirements of managing it adequately anymore (Hülsmann and Berry, 2004). In this context there is an increasing application of autonomous operational decision-making observable (Freitag et al., 2004). The consequences of applying autonomous processes in logistic are manifested in the fundamental-contradiction of autonomous processes: The rise of decentralized processing of information is positively affected by aspects like flexibility, adaptivity, and reactivity to changing external influences whilst maintaining global goals dynamically. However, these advantages are leading to a loss of control for the strategic management, i.e., it is difficult to determine if a decision on the operational level is consistent with the strategic management.

This gap between operational decision-making and strategic management has to be bridged for ensuring reliable decision-making. Thus, achieving a suitable solution involves organisational (e.g., information and knowledge flow) as well as managerial (e.g., handling contradictions) aspects.

FROM CONVENTIONAL TO AUTONOMOUS DECISION-MAKING

Resuming autonomous processes in logistics, it is assumed, that autonomous decision-makers requires access to strategic objectives with respect to their environmental situation as well as the instruments for handling contradictions between operational decision-making and strategic management. The management is now confronted with the question, how to cope with these contradictions. Therefore, several authors emphasise the need and importance of a systematic management of contradictions (e.g. Peters and Waterman, 1988; Quinn and Cameron, 1988; Mintzberg, 1989; Weick, 1995; Gebert and Boerner, 1995; Fontin, 1997; Müller-Stewens and Fontin, 1997; Grimm, 1999; Remer, 2001; Hülsmann, 2003). The paradigm shift to autonomous processes (cf. introduction) is intensifying this aspect enormously, as the management is losing control of operational decision-making.

In this paper, we will use a truck driver within a haulage company for examples. The haulage company is trying to meet the requirements of global economy by delegating decisions to the actors within processes, i.e. the truck driver gains decision capacity for routing, dispatching and price negotiations. The company has the strategic objectives of profit maximization and long-term customer relationship management. Thus, the truck driver has to decide on accepting an order with respect to the current situation of amount of load, next stop, expected alternative orders, costs, yield, etc.

Decision-making and decisions themselves should be performed rationally and hold to a formal logic, e.g. statistical or economical evidence (Werth, 2004). Generally, there are different approaches of detailing the process of decision-making. Nevertheless, most of these models include a generic sequence, e.g. Klein and Scholl (2004): Defining the decision problem, identification of alternatives, and evaluation and assessment of alternatives[2].

The first step within this simplified decision model is to specify the problem on the basis of internal or external influences. The identification includes historical interpretation of situations as well as expected events. The evaluation of expected events contains risk management. In conventional logistics, the truck driver has to map the current situation (e.g. available offers and costs) to a suitable problem definition, provided by the management.

---

[2] In literature you will find several decision-models with further phases like the real decision and the period after decision (Wiswede, 1995). Kahle (1997) still considers apart from the determination and the realization the control of decisions in his model. The variations between conventional and autonomous settings in performing and controlling actions after decision-making are directly influencing the next decision problem and successively definition of the problem, identification of alternatives and finally the assessment of alternatives. Consequently, this paper is restricted to the core steps of decision-making.

In the second step alternative solutions for the problem are identified (e.g. finding different tours). Generally, this process is divided into retrieval, analysis and formulation of alternatives. Identification of alternatives is using operational objectives from the decision-maker; however, the choice of an alternative is based on a predefined assessment model, i.e., not depending on the driver's deliberation. For the example within conventional logistics, alternatives are derived from the problem definition and adapted to the current situation by operational objectives from the truck driver himself. Finally, it is necessary to evaluate and assess the alternatives considering utility, risks and chances. Additionally conflicts of interests have to be solved on the basis of multidimensional utilities. Considering our example in conventional logistics the truck driver would evaluate and assess alternatives using explicit instructions from the management. These instructions leave no choice for decisions, i.e. they are designed with respect to strategic objectives.

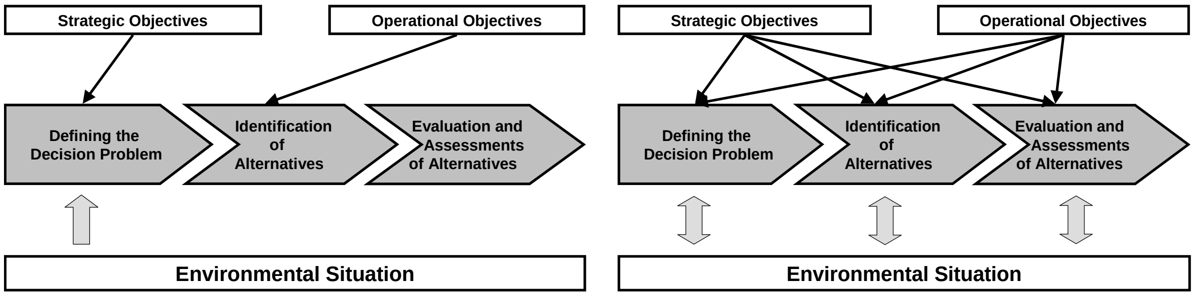

Figure 1. From Conventional to Autonomous Decision-Making.

The transition from conventional to autonomous decision-making is introducing a paradigm-shift. The core elements in autonomous processes are autonomous decision-makers (e.g. truck driver). In contrast to conventional decision-making, the influence of objectives is not restricted to specific steps of the decision process, e.g., strategic objectives are influencing definition of the decision problem. Interdependencies of strategic and operational objectives as well as environmental situation are leading to stronger impacts on the decision process steps. This is resulting in indifferent dependencies and in consequence, the problem of contradictions is increasing enormously.

The definition of the problem now includes not only consideration of current situation and strategic objectives but also operational objectives of the autonomous decision-maker. Depending on prior decisions as well as individual preferences, strategic objectives have to be balanced. In our example, the truck driver has to balance objectives like profit maximisation of company, preferring highways, avoiding tolls, etc. The change of decision-making within identification of alternatives is also triggered by both decision levels (strategic and operational). The autonomous entity has to consider desired solutions and current environmental situation. If there is no given alternative, the autonomous decision-maker has to deliberate on creative solutions. With respect to the example, the truck driver could be in the situation, there he has accepted more load resp. orders than he could possibly dispatch solely. Therefore, he could think about asking another truck for help. Within the last step of decision-making the autonomous decision-maker has to evaluate and assess the alternatives for selecting a course of action resp. solution for the problem. In contrast to conventional decision-making, there is no evaluation or assessment scheme provided by the management. In autonomous decision-making, the management is defining the context for decision-making but not specifying the concrete process. Thus, significant changes are necessary in this step to enable autonomy. The decision-maker should be able to estimate consequences of actions with respect to operational as well as strategic objectives. In the truck driver example, the truck driver has to decide whether to include another enterprise resp. truck or not. Doing so, the truck driver has to take into account, if the strategic objectives are allowing for inter-enterprise coordination or if the operational objectives could be considered by cancelling an order.

KNOWLEDGE AND AUTONOMOUS DECISION-MAKING

In the framework of autonomous logistic processes, autonomous decision-makers may be designated people contributing in the logistic process or soft- and hardware entities capable of autonomous decision-making. The autonomy of the logistic object such as cargo, transit equipment, and transportation systems may be implemented by novel technologies in the area of software engineering (agents, service-oriented computing), communication (radio frequency identification (RFID)) and wireless communication networks (UMTS). These and others permit and require new control strategies and autonomous decentralized control systems for logistic processes. Here, aspects like flexibility, adaptivity, reactivity to dynamically changing external influences while maintaining the global goals are of main interest. As introduced in the last section, autonomous operational decision-making requires specific strategic management, e.g., sophisticated information and knowledge flows.

In conventional logistics, strategic objectives of an enterprise are not considered within operational decision-making. The innovative approach of autonomous logistic processes involves even the transferring of strategic objectives in decision-making to local interacting entities. Thus, the local entities have to integrate strategic and short-term objectives. This leads to a strong need of knowledge within the local decision-making process. The formulation of strategic objectives is the fundamental approach for any management. These aims fix the long-term development of enterprises and have to be planned, put in a relation to each other and be solidified (Welge and Al-Laham, 2003). Contradictions between strategic and operational objectives are strictly handled by the management in conventional decision-making. Contrarily, the major challenge of autonomous processes may be seen in managing these contradictory requirements locally and autonomously. The delegation of decision competence is in need of high quality knowledge and a specific channel to transfer necessary strategic knowledge.

A simplified pragmatic approach would provide full access to strategic knowledge. Nevertheless, the autonomous acting decision-maker may be subject of this knowledge and could gather information which is not appropriate for his decision problem. In modern economy, the enterprise resp. strategic management is responsible for management of information as a core mission. Furthermore, the decision-maker could be overextended by the amount of unfiltered access to strategic knowledge and its inherently complex interdependences. In our example this means that the truck driver is in need of knowledge from the strategic management, determining the context of his decision problem. The management gains the ability of compensating their loss of control by defining a limited view for the driver on strategic knowledge (e.g. objectives). The challenge resulting from this approach is to identify, analyse, and implement the context-dependent knowledge transfer.

KNOWLEDGE CHANNELS

Autonomous processes require context-dependent knowledge transfer for decision-making. However, knowledge on strategic and operational objectives may be per se contradictive resp. conflicting in a concrete situation. To meet the requirements for management of information and knowledge, i.e., definition and implementation of context-dependent knowledge, we are proposing knowledge channels for autonomous decision-makers. The channels are representing a new and innovative approach for bridging the gap between strategic management and operational level. These channels base on an integration of knowledge management as an organisational technique and management of contradictions as a managerial instrument.

The truck driver – in our example – may have to decide on the tour and could receive two offers. In conflicting situations the truck driver has to interact with strategic decision-makers, e.g. the managing clerk who would decide for the truck driver. This approach has been sufficient for logistics in the last decade. Nevertheless, global supply nets are increasingly dynamic and complex and in consequence, this approach is not appropriate anymore. The transition from conventional to autonomous decision-making is changing this process significantly. As discussed in the last section, the truck driver in an autonomous setting would define the decision problem by himself using information technologies. Furthermore, he has to identify, evaluate and assess the alternatives autonomously too. A major challenge arises here as the truck driver does not act in the strategic context automatically and the management is not interested in sharing all strategic objectives with the operational level, e.g. the truck driver. Consequently, it is possible that decisions made are not consistent with the strategic context and potentially even contradictory.

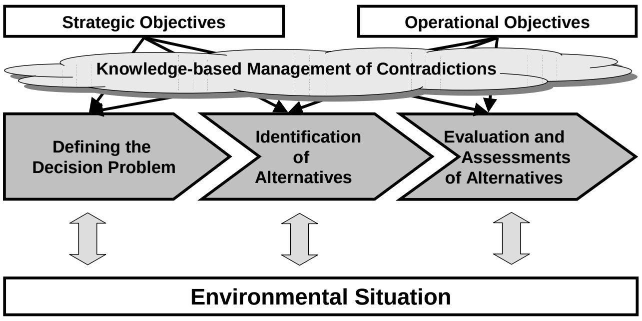

Figure 2. Knowledge-based Management of Contradictions.

In this example, the knowledge channels have to connect autonomous processes with the corresponding enterprises for transferring strategic and operational knowledge to autonomous decision-makers. However, this connection is bidirectional, i.e., the channels also transport feedback concerning current decisions and their consequences from the operational to the management level. The feedback is assumed to be a qualitative or quantitative abstraction of current situations and decisions made, e.g., business ratios as abstraction of individual parameters. Thus, the strategic management gains the ability to respond to critical situations immediately on the basis of current performance evaluations, which are assessed on the basis of local business ratios combined with global performance measures.

Nevertheless this instrument has to resolve conflicts between strategic management and knowledge management with regard to handling the contradictions between operational and strategic objectives, e.g. local entities are retrieving sufficient and necessary information and knowledge but not any further knowledge within the enterprise. However, hierarchies in organisations, i.e., the levels of decision making (strategic, operational) are also used for complexity reduction within single decision problems. A decision-maker is prone to overextension due to the vast amount of information which has to be considered in decision-making. In addition there is a need of classifying knowledge on a strategic level in order to keep valuable information secret with respect to e.g. other negotiation partners.

Analyzing, designing, managing, and controlling of the knowledge channels should take advantage of developments in communication and information technologies. Assisting autonomous decision-makers resp. substituting individual decision processes by artificial intelligence systems is a promising approach to enable highly flexible and adaptive logistics. To validate this hypothesis and to explore behaviour of these systems, it is necessary to model realistic applications, which may be simulated and analyzed properly. Next to simulate the material flows of these nets it is important to integrate the information flows, as especially autonomous processes are depending on data, information, and knowledge within the local environment of logistic processes. Within the collaborative research centre we are performing experiments with high amount of autonomous decision makers as well as the simulation of knowledge management.

CONLUSION

Autonomous logistic processes seem to be a promising approach for handling the logistic development in globally distributed and highly dynamic supply networks. This paper proposes an integrated organisational and managerial approach to enable decision-making in practical applications. The core element is a methodology for integrating knowledge management as an organisational technique (i.e. knowledge channels for bridging the gap