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Information and communication aspects of logistics operations and their significance for managerial decision making

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1 Abstract

This paper outlines the problematic of information and communication aspects of logistics operations and their significance for managerial decision making from the systems model point of view. The systems model view supports understanding in a holistic and interdisciplinary way when doing research of complex organizational systems such as supply chains. We analyze the stages in decision making in an organization that is a part of a supply chain using the systems thinking framework's five phases A-B-C-D-E. Our analysis clarifies what factors are influencing decisions in complex supply chains. The second part of the paper looks at decision making from the Data-Information-Knowledge-Wisdom Model point of view outlining the relationship between hard and soft inputs to the decision-making process. Our analysis contributes to a better understanding of the significance of information in managerial decision making in supply chain operations. The third and last part of the paper is a case study the design to research the decision making process in four manufacturing companies in Norway in the light of the A-B-C-D-E and Data-Information-Knowledge-Wisdom systems models.

2 Introduction

Decision making is considered by some authors (e.g. Hittmár (2006), Král (2001), Zeleny (2005)) to be the core of management of organizational systems. The statement is also supported by a study conducted by Turban (2006), which states that managers find decision making to be the most important of all practical activities they make while managing their organizations. The decision problems are complex nowadays, especially in global multi-echelon supply chains (Willems, 2008). Therefore, decision support systems based on computer technologies play an important role in the decision making in the field of logistics and Supply Chain Management (SCM). Logistics operations, which are carried out in a company and also among the company and its supply chain partners, are significant source of data for those systems. Technological advances in information systems facilitate decision making, because the data and information are available accurate and in real time (Farahani, 2011), which contribute to reducing level of uncertainty involved in decision making. However, despite enormous advancement in the development of enterprise data and information systems and sophisticated Business Intelligence systems, computer-based technologies still remain just a supportive tool for decision making. This is because many

decision problems, mainly the problems of semi- or unstructured character typical for tactical and strategy level of management, are not solvable without participation of humans who include factors such as experience, intuition, context of a situation, negotiations, etc., in the decision making process. Moreover, for some decisions like the ones based on negotiations, increasing the amount of information will only help to some extent to support the decision. The inherent equivocality of a negotiation cannot be eliminated more information. Equivocality is defined as the ambiguity inherent in the task caused by conflicting and inconsistent interpretations and expectations (Daft, Lengel and Trevino, 1987). Equivocality cannot be eliminated by getting more information. These are some of the reasons, why knowledge management issues have been in the forefront lately. Knowledge is necessary for making right decisions on the company level and for aligning the decisions with higher system levels like supply chains in our case. We denote the factors contributing to human knowledge creation for soft inputs to the decision making process, while data and information processed by computer based information systems are denoted hard inputs. Humans can handle both soft and hard inputs, while machines can handle hard inputs only. The necessity of soft and hard inputs combination is underlined by study (Giunipero, 1999), which reveals, that purchasing managers utilize approximately the same amount of hard inputs in the form of data and information processed by computer technologies, as the soft ones in the form of managers' tacit knowledge in decision making.

In logistics, decision problems and situations are different from other functional areas of a company, like e.g. marketing or human resources. One of the reasons is the fact that logistics operations are considered transformation in time for storage and transformation in space for transportation. This is in contrast to, for example, manufacturing operations, which are transformations of form (Tilanus, 1997). Moreover, logistics operations are realized not only in a company, but also among the company and its supply chain partners. The spatial character of logistics operations and necessity to communicate and collaborate with other organizations contributes to the high complexity of decision making in supply chains. This again, contributes to a high level of uncertainty in the decision making on tactical management level in logistics.

This paper outlines the problematic of information and communication aspects of logistics operations and their significance for managerial decision making from the systems model point of view. The systems model view supports understanding the topic in holistic and interdisciplinary way, and is recommended by some authors (e.g. Gharajedaghi (2006), Haines (1998), Král (2001)) to grasp the whole context when doing research of complex organizational systems (such as supply chains). One of the tools that help to adopt the systems thinking mindset is the systems thinking model's five phases A-B-C-D-E. This model use a backward thinking approach starting with the definition of desired outcome in phase A, working backwards to define suitable performance indicators for feedback in phase B, examine all inputs in phase C, examine how inputs are transformed to desired outputs in phase D, and finally in phase E changes in external factors defining the context for first four phases are examined. A description of the model and its application to the decision making process in supply chains are described in Chapter 3 *Managerial decision making in the context of the A-B-C-D-E systems model*.

The second part of this paper looks at the issue from the Data-Information-Knowledge-Wisdom (D-I-K-W) model point of view. Based on this model we outline the relationship between hard and soft inputs to the decision making process. This contributes to a better understanding of the significance of information for managerial decision making affecting logistics operations. A description of the model and its application to the decision making process in supply chains are described in Chapter 4 *Managerial decision making in the context of the D-I-K-W model*.

2.1 Definition of terms used

Operations can be defined as a value adding conversion of inputs into outputs (Slack, 2010). In a manufacturing company, operations can be classified into three categories based on their character (Král, 2001):

- manufacturing operations (physical character)
- logistics operations (locational character)
- information-communication operations (informational character)

In practice, each type of operation is often inter-connected with the other types of operations. The classification serve our analyses of the relation between the three types of operations.

2.1.1 Manufacturing operations

Manucturing operations deals with physical (material) flows and are the part of conversion process. Manufacturing operations convert material inputs (utilizing other forms of inputs such as facilities, machines, human work) into outputs in form of physical products (Král, 2001). Manufacturing operations are closely related to logistics operations that ensure materials to be in the right place in the conversion process at the right quality and quantity at the right time. From logistics operations point of view, manufacturing operations are internal customer for logistics operations. Logistics operations ensure suitable customer service level for manufacturing operations as an internal customer.

2.1.2 Logistic Operations

The logistic operations are often inter-connected with other types of operations. In a supply chain logistics operations are carried out in time and space along a basic conversion process. The process starts by taking order from a customer and ends by finished product delivery to the customer. The conversion process relates to the whole value chain and it comprises both intra-company and inter-company business processes. Depending on the part of the conversion process, logistics operations handle raw materials, components, work-in-progress or finished goods. Logistics operations are the following (Farahani (2011), Klapita (2001), Král (2001)):

- Transportation
- Material handling and manipulation
- Storage
- Protective packaging and identification
- Customer service of internal or external customer

Logistics operations include activities and processes of non-productive nature without which conversion process could not be carried out (Král, 2001). In Porter's value chain, logistics operations are considered to be a part of primary activities, which should be run at optimum level if an organization is to gain any real competitive advantage (Porter, 1985). In common business practice, logistics operations usually cross several functional departments. Therefore, the logistics function can be considered as cross-departmental function which creates opportunities for business process integration and improvement.

2.1.3 Information-communication operations

Information-communication operations (or shortly information operations) relate to communication and data or information handling and processing (Král, 2001). Information-communication operation can be seen as conversion process of input data or information into output data or information in various forms (spoken, paper, electronic). Inputs and outputs related to information-communication operations create information flows in a company. Information-communcation operations are often inter-connected with logistics operations and manufacturing operations that deal with material flows in a company. Handling goods receipt document is an example of information-communication operation – the document from a supplier is an input that is further processed either automatically by a computer system or manually by a responsible person. Updated purchasing-order information is an output of the information-communiation operation.

2.1.4 Supply Chain

A supply chain can be defined as a network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer (Mangan, Lalwani and Butcher, 2008). The supply chain of a production company can be divided into four areas: supplier network, internal supply chain, distribution network and end customers (Figure 1). Logistics operations are realized within:

- The procurement process between the internal supply chain and the supplier network
- The transformation process of the internal supply chain
- The distribution process between internal supply chain and the distribution network
- The distribution process between distribution network and the end customers

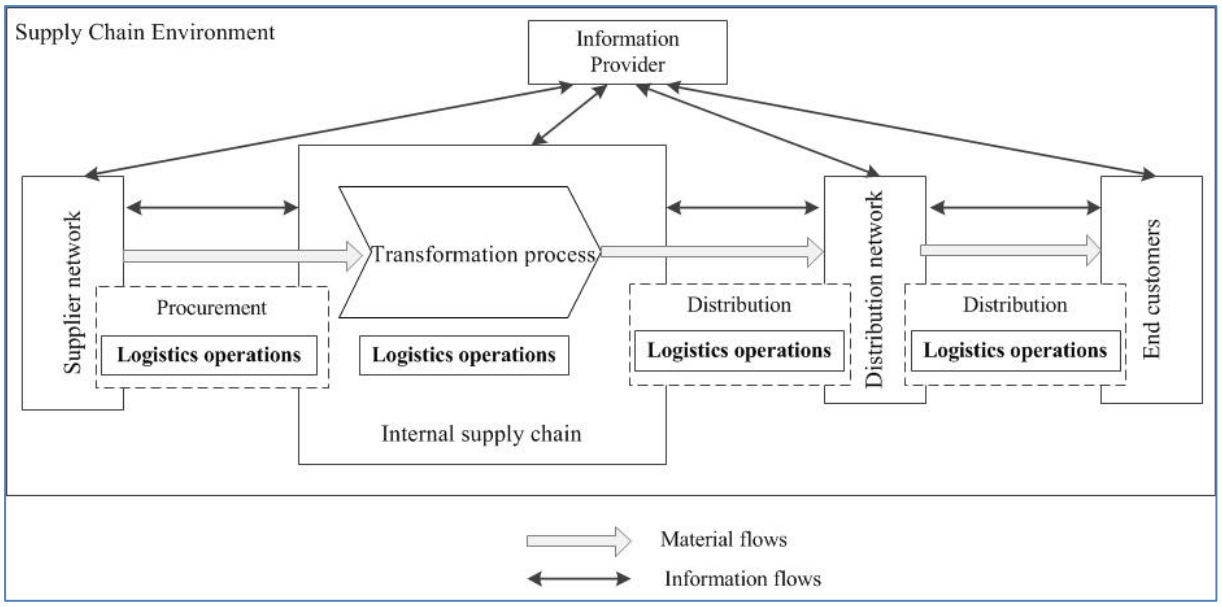

Figure 1. Logistics operations in a supply chain

As for the structure of a complex supply chains, Helgheim et. al. (2010) remarks the changing structure of supply chains by the introduction of new actors. In their working paper they outline the role of technological intermediaries as third party information providers in global supply chains.

2.1.5 Supply chain management and logistics

Supply chain management is a set of synchronized decisions and activities utilized to efficiently integrate suppliers, manufacturers, warehouses, transporters, retailers and customers, so that the right product or service is distributed at the right quantities, to the right locations and at the right time in order to minimize system-wide cost while satisfying customer service level requirements (Král, 2001).

Logistics is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods, services and related information from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements (Lambert and Stock, 1993). SCM is a wider, intercompany, boundary-spanning concept in comparison to logistics, which is considered to be a part of SCM (Mangan, Lalwani and Butcher, 2008). Both SCM and Logistics cover a wide variety of different scientific disciplines and are by nature an area of interdisciplinary (Solem, 2003).

The definitions mentioned above are not entirely consistent, especially regarding of the separation of logistics operations from information-communication operations. For the purposes of this paper, information-communications operations are considered to be a part of logistics operations, since logistics comprises management of material flows as well as related information flows. As for SCM, in this paper it is understood in wider manner as inter-company concept and logistics as its part, which is more focused on particular company in a supply chain.

2.1.6 Managerial decision making

In the field of logistics, many kinds of decisions are made on all management levels (operational, tactical and strategy). There are many definitions of managerial decision making in general, the following are considered to be sufficient for the purposes of this paper. Managerial decision making is a sequence of activities, by which a problem as a subject of solution is identified and analyzed, the possible solutions are provided and the most suitable of them are chosen according to set criterions (Hittmár, 2006). It is a process that results in particular decision and its realization. Turban (2006) defines a decision as a non-coincidental choice made from two or more alternatives and he adds, that decision making can be looked at from two perspectives: problem solving and opportunity seizing. In relation to decision making, Zelený (2005) underlines multi-criterion character of decision making and states, that decision making is real only when there are at least two criterion based on which the decision is being made.

Current literature offers several views of managerial decision making process. Some authors (e.g. (Hittmár, 2006) or (Giunipero, 1999)) provide a model of the process, which consists of following linked activities:

- Problem identification and goal setting
- Information analysis
- Variants determination
- Criterion determination
- Variants assessment and selection
- Realization of the selected variant and results monitoring

Král (2001) presents similar decision making model and calls it a normative model. The author mentions, that the general model is characteristic for program decision making. That is decisions made on daily, weekly or monthly basis that has its specific typology and routine. However, Král continues, that on strategy and tactical management level the decisions are mostly non-program and they are difficult to be described by a general model, because such decision making processes occur sporadically (once per few years), or they are unique decision problems. The A-B-C-D-E systems model by Haines (1998) offers a point of view at decision making as outlined in Chapter 3 Managerial decision making in the context of the A-B-C-D-E systems model.

2.2 From logistics operations to business intelligence

When performing logistics operation, events related to the operation occur which usually include one or more transactions, as well. The event, which is one of the consequences of logistics operation, is not necessarily related to a transaction. A transaction is carried out at the moment when an object of the event changes its owner (external owner outside a company or internal owner within the company). From information-communication technology view, transactions are captured and processed by Transaction Processing Systems (TPS). However it is important to realize, that in many practical cases not every transaction is actually captured by the system. This issue will be investigated in the case study in Chapter 5.

It is necessary to recognize, which transactions and what data and information that are related to the transactions that are relevant for particular decision problems. This enable decision

makers to avoid the situation when transactions fundamental for the decision making are not captured, and they can avoid information from transactions useless for managerial decision making. Otherwise, it could lead to lack of relevant information needed for making right and timely decisions. On the other hand, companies are required by law to register trade transactions in their accounting system. For example in the most used transaction processing system by SAP, all trade transactions are registered in the financial accounting module. In addition to this, most companies registers a range of internal operations that are not required by law. These are for the purpose of for managerial control, and they can be at a very detailed level. In SAP this is handled by the financial controlling module.
This leads to a huge amount of data and information that can be used for business analysis purposes. If not structured and analyzed in a suitable manner, the vast amount of data might have a negative effect on the decision making process and its results. The issue of information overload is even more significant in complex supply chains, where the sum of logistics operations is carried out every day by each participating company is huge. Therefore technologies that can provide right information at the right time for right people, such as business intelligence, have been in the forefront for last decades.

2.2.1 Data and Their Sources

Significance of data is well described by Li (2007) who states, that the backbone for effective decisions are data and he briefly defines data as the representation of facts by formalized way appropriate for interpretation and processing. Hittmar (2006) characterizes data in more details as particular images of attributes or features of observed objects regardless of their deeper meaning and other relations. From managerial point of view, data present raw material to produce information, which is one of important inputs to decision making process.
Transactions (or data related to transactions) are one of the most important data sources in companies. Based on the definition of data, transaction data can be considered to be images of observed transaction attributes. To ensure quality of the data, first it is needed to identify the right transactions to observe. Then it is necessary to realize which attributes of a transaction should be observed in order to be relevant for managerial decision making. Consequently it is important to ensure the quality of reflection of accurate attribute values of the real transaction into the form of data.
Besides transactional data, whose creation is related to events happening during logistics operations execution, there are also other sources of data, which are processed and stored in enterprise databases. The data can be related to internal environment of a company (e.g. financial data or human resources data) or to interactive or external environment (e.g. marketing data from CRM systems).

2.2.2 EIS and DSS

Data from source systems are stored in various types of data warehouses that present a basis for Enterprise Information Systems (EIS). Nowadays modern EIS provide data and information in real time, but for managerial decision making process on middle and top management level, Decision Support Systems (DSS) are more important (Hittmár, 2006). DSS can be defined as computer systems for management level of an organization, which

combines data, analytical tools and model to support decision making related to semi-structured and unstructured problems (Laudon and Laudon, 2002). For managers, DSS are more significant than TPS or EIS, because they can select, process and interpret data and information inputs from EIS according to specific information needs of its users (in order to prevent managers from information overload, which can eventually have negative effect on decision making process and its results (Tingling, 2011)). There are several types of DSS that create a potential for making better decisions. Business Intelligence has been playing a major role in the field of managerial decision support last decade (Eckerson, 2005). Currently, possibilities and opportunities for improving decision making in complex business organizations are extended by Web 2.0 tools and social software applications (Tingling, 2011).

2.2.3 Business Intelligence

Business Intelligence (BI) is an umbrella term used for describing applications specialized on analyzing large amount of data. BI data is typically collected from transaction processing systems like ERP-systems and other enterprise systems like CRM systems, supporting operations. BI systems are organized to optimize information analysis and extraction to support decision making about markets, customers, suppliers and products (Li, 2007). According to similar definition (Eckerson, 2005), BI presents an umbrella term that encompasses processes, tools and technologies needed to transform data to information and information to knowledge and a plan, which ensure efficient business activities. It is described as a set of concepts and methods aimed to decision making improvement by fact-based support systems.

BI is built on data from various activities and processes that are a part of a supply chain. The source data are usually processed and stored in Enterprise Resource Planning systems (ERP) or Customer Relationship Management systems (CRM). However, the source systems are designed as transaction systems optimized to capture and store large amounts of transactional data that are constantly updated. Thus, these are not directly suitable for decision support by a manager himself. Using other tools, like BI that are designed to analyzed large amounts of data gives a manager access to information structured in a way which is relevant for decision making. Therefore, BI is not oriented for basic data processing and realization of production, financial, sales and other transactions (which are processed by common TPS), but it is specialized to provide right and high quality information relevant for decision making on higher management levels. Logistics operations in the context of BI architecture and its standard components are depicted in Figure 2.

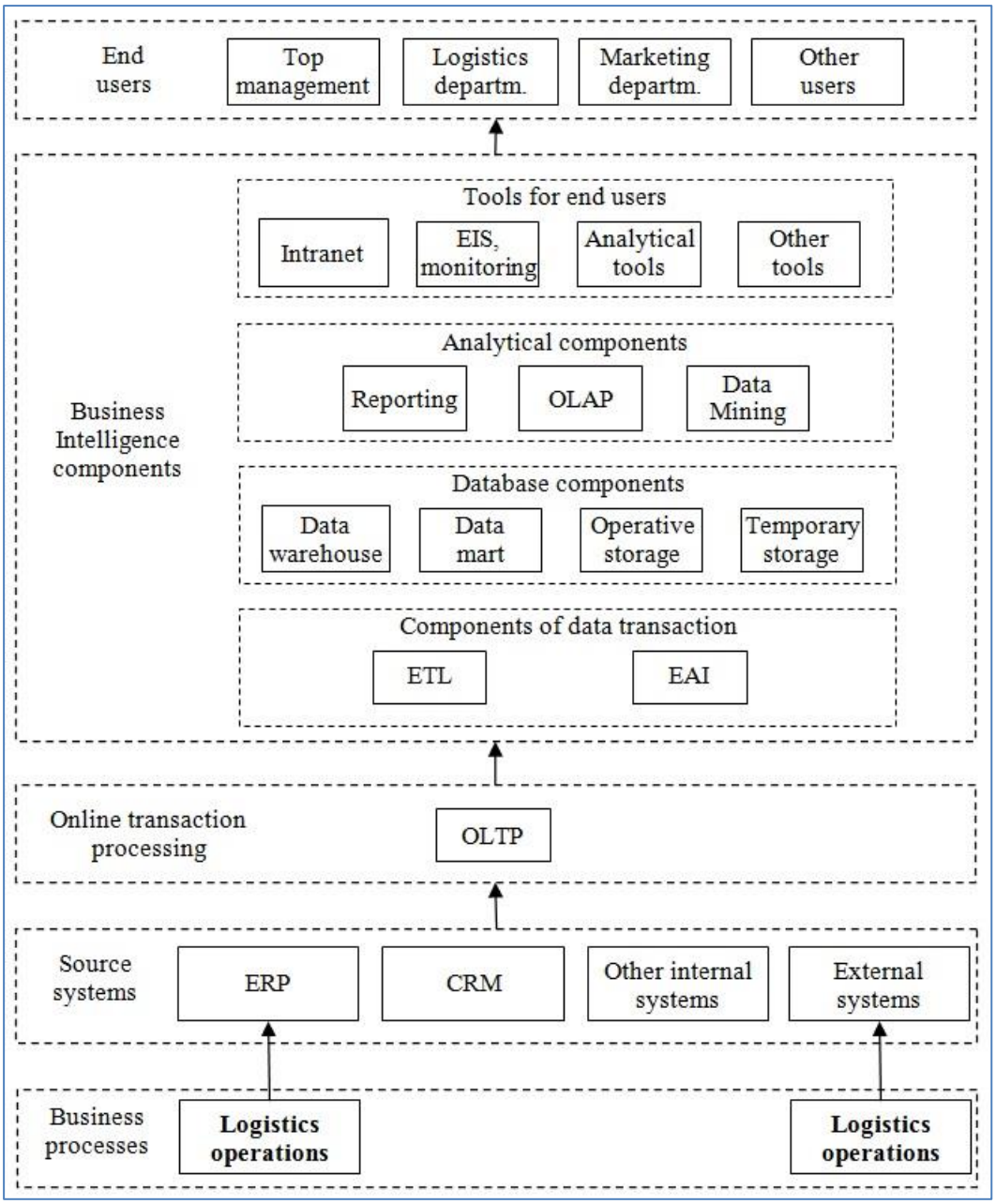

Figure 2. Logistics Operations as a Data Source for Business Intelligence

BI is closely related to other information and communication technologies, from which it gets input data. Typically a TPS system is frozen at a particular time and the data is transferred to a BI system where they are reorganized to suite the intelligence operation. The information quality provided by BI-systems is therefore directly dependant on the quality of the source systems, and their ability to capture the right data in the right way (i.e. data which have a potential to create a real decision support and to capture and process the data in a way, so that they will represent the reality as precise as possible). Logistics operations are a significant source of data for TPS, and some other management information systems (such as Warehouse Management System), which presents the basis for BI. Therefore, logistics operations and related information and communication flows have impact on the quality of BI outputs and consequently on managerial decision making, as well (since the outputs of BI are one of the inputs to decision making process, as shown in Figure 5).

For SCM, BI extended for the whole supply chain comes in the forefront and is called Supply Chain Intelligence (SCI). Stefanovic (2007) in his article about SCI states, that the primary source systems for BI are the internal operational systems, while SCI integrates data from partner and supplier information systems. What truly differentiates SCI from BI is the ability to collect and aggregate data across the value chain (Haydock, 2003).

3 Managerial decision making in the context of the A-B-C-D-E systems model

The nature of managerial decision making in complex organizational systems such as an organization, that is a part of a supply chain, can be approached through systems thinking. Systems thinking has proven deal with complexity in a manner that results in operation being handled effectively and efficiently. Perhaps the most well known case is W. Edwards Deming, the father of quality and the Total Quality Management (TQM) approach. The “T” in TQM means “total” or “entire system,” which was Deming’s approach as a systems thinker. It has lead to the widely recognized quality award; the “Deming Prize” (Haines, 2010).

3.1 Background of systems theory and systems thinking

The systems theory term originated in "General System Theory: Foundations, Development, Applications" by Bertalanffy (1968) based on work done over the previous decades. It can be considered as a method of critical thinking. Since then, systems theory have been developed and used in various ways. We use the paper by Haines (2010) to outline four interrelated concepts that serve as a foundation of systems thinking for our purpose. The first is the hierarchy of living systems: cell, organ, organism, group, organization, society and supranational system. The second is the twelve laws of living systems that point out natural similarities in humans at all levels in the hierarchy of living systems. The laws can also help in comparing best practices with traditional human and organization dynamics. The third concept of systems thinking is the five phases A-B-C-D-E mentioned in the introduction. The fourth and last concept is termed "the rollercoaster of change". It incorporates the physiological reaction to change as a normal and predictable reaction. This paper focus on the first and second concepts. Specifically the three levels that affect decision making in organizations, i.e. organism (individuals), group (functional unit) and organization from the first concept, and the usage of the five A-B-C-D-E phases to analyze factors that influence decision making.

The A-B-C-D-E systems model is a conceptual framework that gives systems thinkers an effective way to view systems (Haines, 1998). In terms of systems thinking, a system is not a static entity but rather a living, ongoing process that requires inputs, provides outputs and gives feedback. The activities associated with such a system constitute the various phases of the A-B-C-D-E systems model. If applied to problem solving, it is first necessary to look into outputs of the system (phase A), next to use feedback (phase B) to examine inputs (phase C), and further to look into the transformation process itself (phase D). During phase A to D it is

needed to scrutinize the problem continuously in the context of environment of the system (phase E).

The phases of the A-B-C-D-E Systems model are characterized as follows (Haines, 1998):

- Phase A is the defining phase, in which goals and outputs of activities of the system (or process) are defined
- In phase B it is established, how the desired outputs will be determined (in terms of measurement and control, by which it is monitored if the desired goals and outputs are really achieved)
- In phase C inputs to the process (throughput, system) are examined
- Phase D comprises detailed examination of the process and the objective of the phase is finding an effective way how to transform inputs to desired outputs (how to get from current state to desired state in the future
- Phase E emphasizes inevitability to concern essential factors that are being changed in environment of the system and adapt previous phases to the factors if necessary.

The model is visualized in Figure 3.

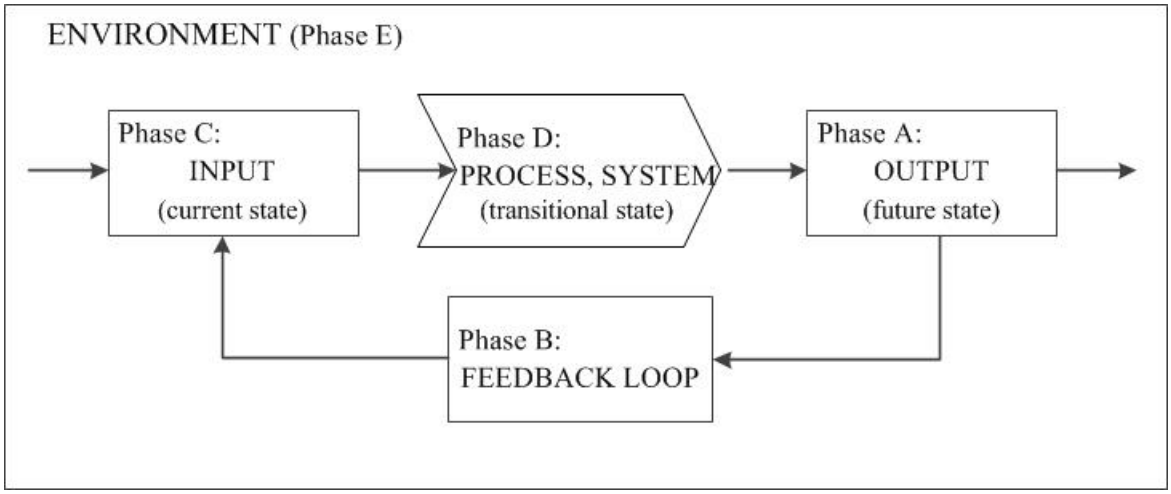

Figure 3. The Conceptual View of the A-B-C-D-E Systems Model (Haines, 1998)

3.2 The systems view of decision making process in environment of a supply chain

We apply the A-B-C-D-E model to managerial decision making process in a supply chain as illustrated in Figure 4. The desired output in this case are accurate and timely decisions and their realization. The overall aim is to ensure that an organization will reach its long-term strategic goals. It is important to realize, that goals of the whole supply chain and goals of its components, in terms of the organizations that create the chain, should be aligned. From the systems point of view, the alignment of the whole system with its components is one of the crucial goals to be achieved in management of the system (referencing a definition of a system, which is a set of components that work together for overall goal of the whole (Haines, 1998).

Feedback loop presents evaluation and control of business processes performance by a set of key performance indicators (KPIs). In the context of a supply chain, performance

measurements related to the Supply Chain Operations Reference (SCOR) model's phases of source, make, deliver and return is suitable as a basis for key performance indicators – KPIs (Supply Chain Council, 2012). SCOR creates highly structured and systematic framework for measurement and benchmarking of business processes in a supply chain (Haydock, 2003). It allows to measure performance of outputs in terms of KPIs for the business processes affected by decisions made in decision making process. Also, SCOR shows whether the outputs are aligned to the overall supply chain strategy. The feedback loop leads to inputs, which further leads to decisions affecting logistics operations whose performance is measured so the operations become an important source of data for further feedback. In case of problems for which the causes can not be identified from the inputs, it is necessary to examine decision making process itself and the environment, too.

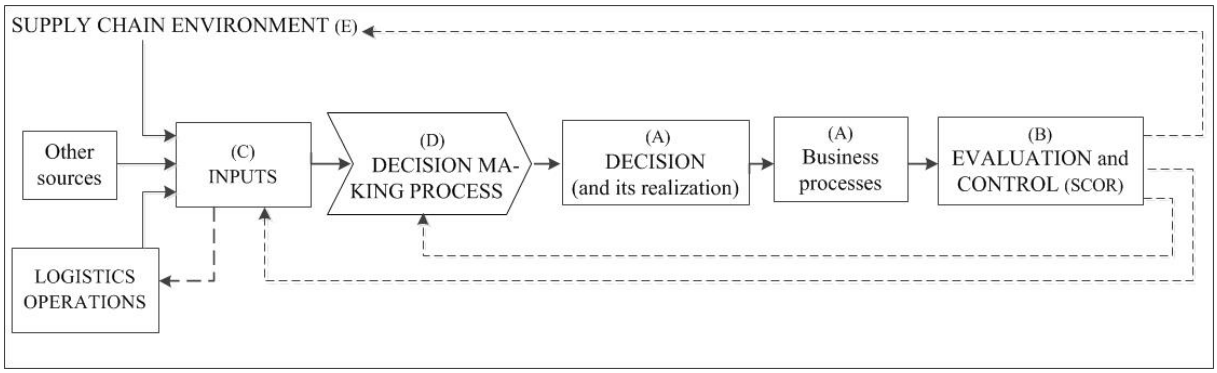

Figure 4. The A-B-C-D Systems Model Applied to Decision Making in a Supply Chain

3.2.1 Inputs

Inputs to managerial decision making process are mainly data and information from information systems of an organization (e.g. Enterprise Information System), and decision support systems (e.g. Business Intelligence, in broader context Supply Chain Intelligence). Soft components of inputs, that are related to personality of manager (factors such as intuition, experience, emotions, feelings, etc.), are also important part of inputs to decision making process. Decision maker's knowledge belong to this group of inputs, as well (however, it is still unclear, what knowledge is and what aspects contribute to its creation).

3.2.2 Decision making

The decision making process itself is a throughput phase, by which inputs are transformed to accurate decision (and its consequent realization). In case of structured decision problem, it is possible to depict the process as a sequence of steps. However, many problems solved in the field of logistics and SCM are semi-structured or unstructured and they are difficult to be described by a general decision making model. In that case, decision making process depends on particular decision problem, managerial art of decision maker dealing with the problem and many other aspects related to soft inputs that are typical for human. As was already mentioned, many of those aspects and factors are still not identified clearly.

3.2.3 Environment

In terms of environment, it is important for decision maker to realize, that decision made on enterprise's level, affects the whole supply chain and, on the other hand, the supply chain as a

whole has impact on business processes in all parts of the chain (in all organizations that create the chain).

3.2.4 The A-B-C-D-E model applied to logistics and SCM

The A-B-C-D-E systems model applied to managerial decision making process about business processes in a company that is a part of a supply chain is depicted in more details in Figure 5. The model emphasises logistics operations as a significant source of data and information for the process of managerial decision making on operational and tactical management level. The whole continuum from logistics operations, transaction processing, data warehousing, information analysis and interpretation by sophisticated Business Intelligence systems is briefly described in the next section of the paper. Red arrow with the question mark in the figure outlines some other information and communications aspects of logistics operations that affect managerial decision making in the field of logistics and SCM, but the aspects have not been identified clearly yet.

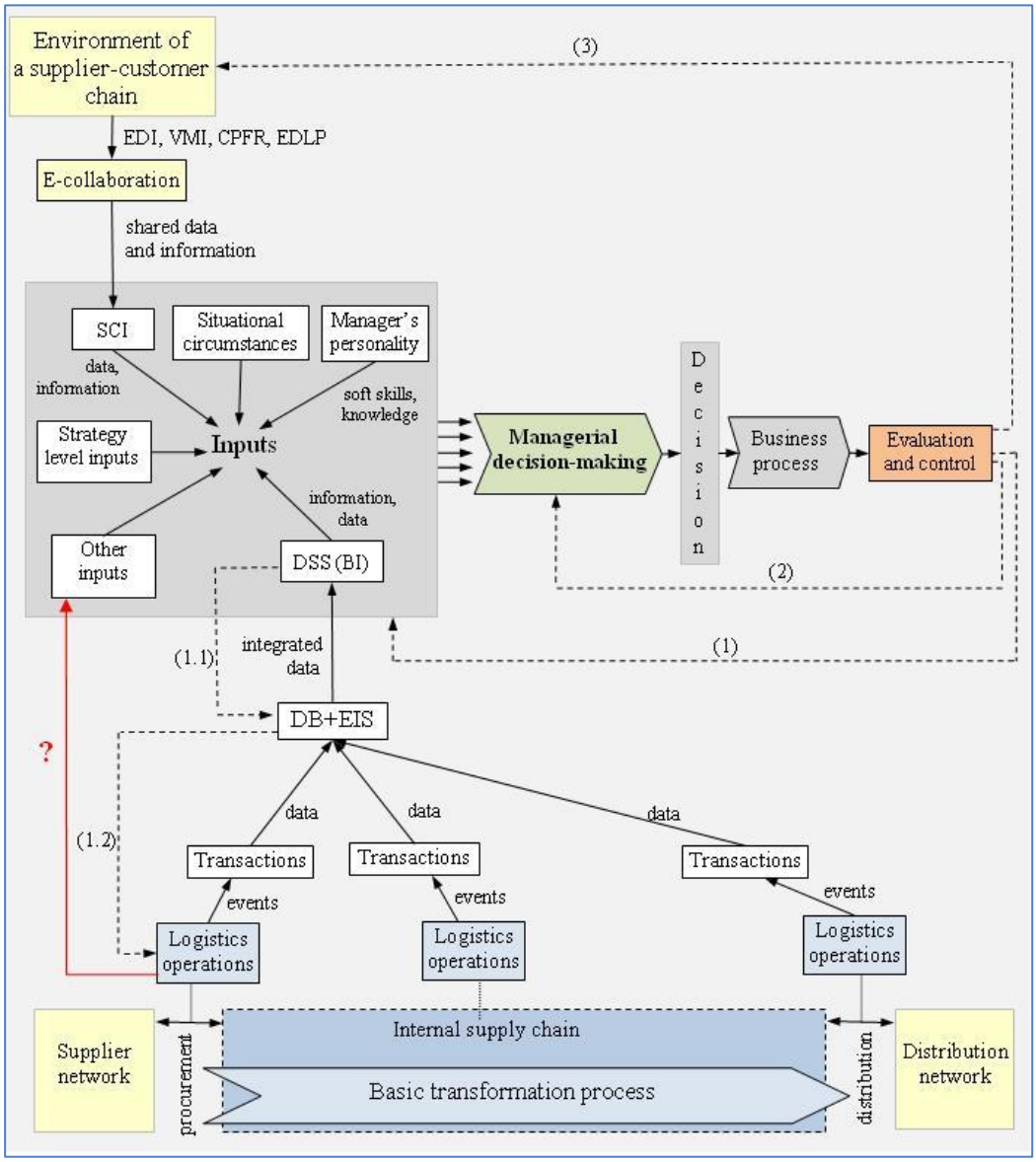

Figure 5. Proposed theoretical framework following a systems view of decision making in the field of logistics and SCM

4 Managerial decision making in the context of the D-I-K-W model

The Data-Information-Knowledge-Wisdom (D-I-K-W) model, also denoted the D-I-K-W pyramid, the D-I-K-W string (Zeleny, 2005) or the Model of Information Levels (Hittmár, 2006), can be used as a tool to understand the content of data (D), information (I), knowledge (K) and wisdom (W) and their principal differences and interrelations. Information can be briefly described as a message that reduces receiver's level of entropy uncertainty in decision making. Data is a collection of symbols with no meaning for each, like letters in an alphabet. Putting data in context, like letters forming words, becomes meaningful, i.e. brings information, to some extent when we as humans combine the word with our cognitive knowledge of words in our language. Combining several words forming a context enables them to convey more information when referring to our knowledge from previous experiences. On the contrary, data are just images of attributes of observed objects regardless of their deeper meaning and relations (Hittmár, 2006). In the D-I-K-W Model, knowledge is the next level above information. According to Zeleny (2005), there is significant difference between information and knowledge. He claims that information is symbolic description of an action, while knowledge refers to action itself and is much more focused on purposeful coordination. Information can be stored, transported and processed by computers, while knowledge is a cognitive property of humans. Wisdom is considered to be the highest level in the D-I-K-W Model and is characterized as socially accepted (or verified by experience) interpretation of a purpose (Zeleny, 2005). However despite many attempts, most of the authors agree that it is still quite unclear what knowledge and wisdom actually is and how to define it thoroughly.

4.1 The D-I-K-W model applied to logistics and SCM

We depicted logistics operations in the context of the D-I-K-W Model in Figure 6. We see that logistics operations are clearly a significant source of data, which are transformed to information by various processes, systems and technologies. Such information presents one of the inputs to managerial decision making process. In the case of semi- or unstructured decision problems (typical for tactical and strategy level of management), the information interacts with other types of inputs that are related to humans (such as intuition, creativity, experiences) and creates a basis for knowledge needed for reaching a decision. However, problem solving and opportunities seizing in logistics is also influenced by other information and communication aspects that have impact on knowledge creation in the field. **These aspects are related to information-to-knowledge creation process but they have not been identified and clarified thoroughly so far.**

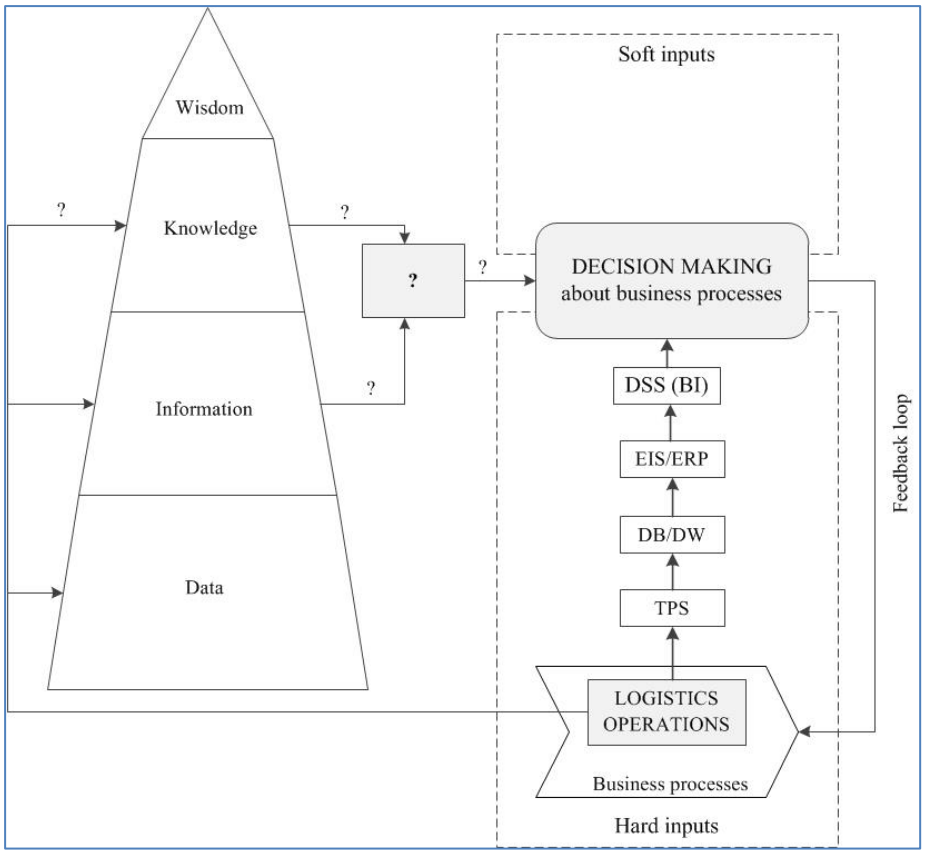

Figure 6. Logistics Operations in the Context of the D-I-K-W Model

4.1.1 Information related to uncertainty and equivocality and decision making

Galbraith (1973) and Galbraith (1974) provides an information processing model that relates the amount of information available to the uncertainty faced by decision makers. Galbraith states that "the greater the uncertainty of the task, the greater the amount of information that must be processed between decision makers during the execution of the task to get a given level of performance". It has become accepted that organizations process information to reduce uncertainty. Firms can reduce uncertainty through better planning and coordination supported by rules, hierarchy, goals and information systems. This is illustrated in Figure 7.

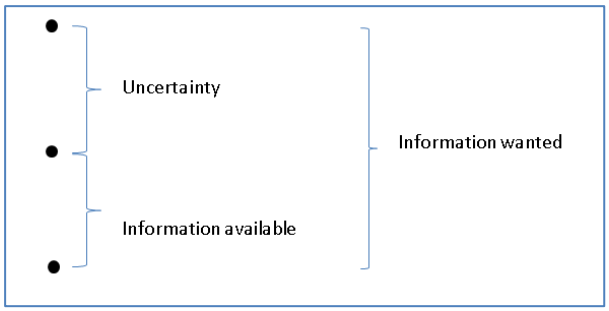

Figure 7: Uncertainty and information wanted to reach a decision.

Hovever, for some decisions like the ones based on negotiations, increasing the amount of information will only help to some extent to support the decision. The inherent equivocality of a negotiation cannot be eliminated by providing more information. The inherent equivocality of a negotiation cannot be eliminated more information. Equivocality is defined

(Daft, Lengel and Trevino, 1987) as the ambiguity inherent in the task caused by conflicting and inconsistent interpretations and expectations and cannot be reduced by getting more information. For example in sourcing, when negotiating the contract with suppliers, the purchaser has to reach a decision. Uncertainties can be reduced by acquiring more information, but the inherent equivocality of negotiations results from a fight of give and take that cannot be eliminated by getting more information. This is illustrated in Figure 8. Popular tools to handle inherent equivocality are risk management and practices based on gaming theory.

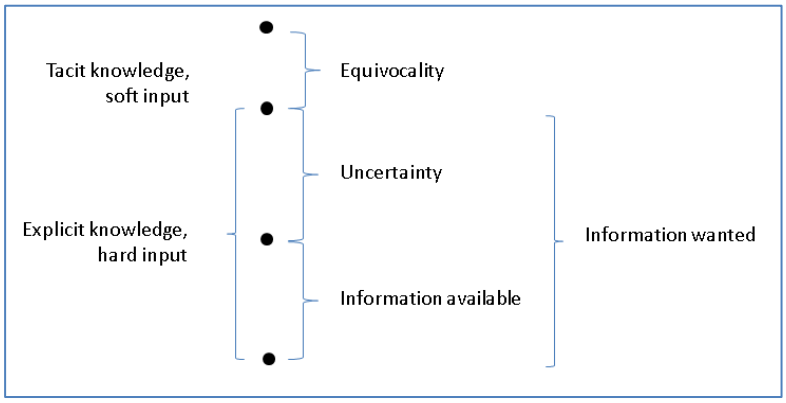

Figure 8: Uncertainty, equivocality and information wanted to make a decision

5 Case Study Design: Purchasing decisions in furniture manufacturing companies

We show how the framework in Figure 5 can be used to explain and analyze the use of information in a purchasing decision making process. The purpose of the case study is to compare the proposed theoretical framework to real decision making process of purchasing managers in practice and to summarize all the factors that have impact on decision making on tactical level of purchasing. Specifically, we hope to find and to clearly identify some of the factors that cause necessity of soft inputs utilization in the decision making process. There is theoretical assumption that these factors might be somehow connected to logistics operations, which happen in time and space in the network of supply chain actors, and therefore higher level of uncertainty and more communication and soft skills are required to solve some decision situations in purchasing.

For the case study, four companies were selected within one industry, the furniture manufacturing industry. The reason to do the case study only within one industry is to find out whether one of the factors influencing decision making is clustering and how clustering effects the decision making process in purchasing.

The case study involves the following companies and persons to interview:

- Ekornes ASA, 6222 Ikornnes, Norway with Harald Garberg Gule, Procurement Category Manager
- Formfin Møbler AS, 6224 Hundeidvik, Norway. Interview with Geir Kvalvåg, Product manager

- Brunstad AS, 6230 Sykkylven, Norway. Interview with Helge Brunstad and/or Ole Jakob Tronstad
- IMG/Hjellegjerde, 6230 Sykkylven, Norway. Interview with Nils Gunnar Hjellegjerde

In each of the companies, purchasing managers of strategic goods were interviewed. The semi-structured interviews followed a framework depicted in Figure 9. The figure shows the question areas within the management levels model that are used to guide the interviews. This approach to interviewing is considered to be more natural and easier to understand for managers from practice than following of the theoretical framework proposed in Figure 5. By conducting the interviews in this way, we cover all the core elements of the systems view of Decision Making in Figure 5. A detailed guide for these semi-structured interviews are provided as an appendix.

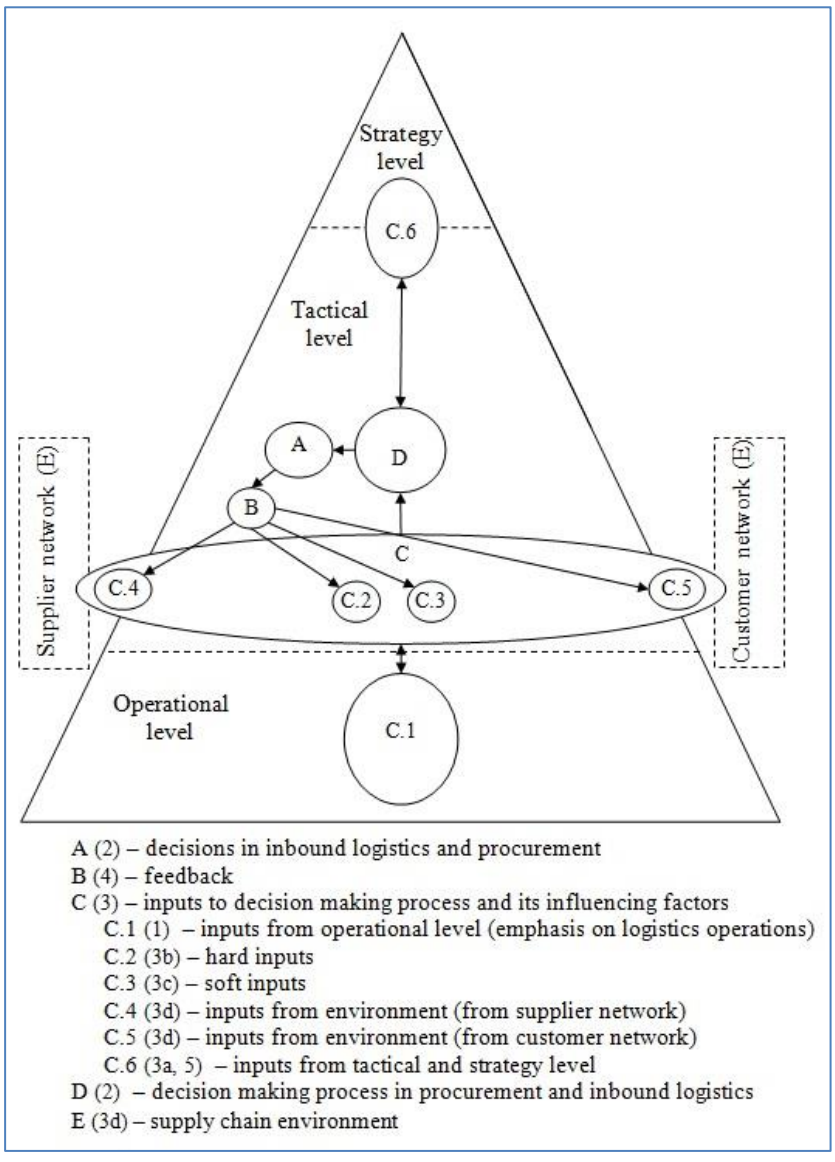

Figure 9. Interviews question areas in the context of Managements Levels Model. Letters A, B, C, D, E relates to systems model phases, letters in brackets reference the part of the interviews dealing with a particular systems model phase.

The results of the case study will be presented in a later paper.

6 Conclusion

Knowledge is the key for making right decisions when solving semi-structured and unstructured problems or seizing opportunities in complex fields such as logistics. The basis for knowledge is information, but there are much more factors, that contribute to knowledge creation in the managerial decision making process in a company that is a part of a supply chain. Information from DSS (such as BI) is important input to the decision making process. DSS utilize various data from EIS to create and interpret high quality information that could be efficiently used for decision making. Logistics operations are one of the most important data sources in a manufacturing company, in which logistics operations play significant role in customer service. Hence, logistics operations have direct impact on information that inputs to the managerial decision making process. However, logistics operations are carried out in time and in space (not only in the company itself but also in its supply chain environment) and that is one of the reasons why another information and communications aspects influencing decision making process exist. Based on literature review it is possible to claim, that it is still unclear, what the aspects are, why they are important and how they influence decision making process. The problematic of information and communication aspects of logistics operations and their significance for managerial decision making is therefore interesting field for further interdisciplinary academic research, which can contribute to understanding how the knowledge is created in the field of logistics and what components the knowledge contains.

Appendix: Interview guide

General information about the questionnaire

The presented questionnaire is a basis for semi-structured interviews which are part of the research concerning information and communication aspects influencing decision making process on tactical level of Procurement in the furniture industry. The questionnaire is divided into three parts. The purpose of the first part is to get general overview about your company in order to get "the big picture" of Procurement department within the whole company. The second part is concerning with operational level of Procurement, since data and information created on operational level are one of the inputs to decision making on middle (tactical) management level. The third part of the questionnaire contains questions about decision making process on tactical level of Procurement. It is focused on internal and external factors and elements influencing the decision making. Last section put emphasis on soft inputs related to knowledge which is typical for humans and inevitable for making right decision (especially on higher management levels).

Decision making on tactical level of procurement operations

• From all decisions you make at your work,
- what kind of decision has the biggest financial impact on your company?
- what kind of decision takes most of your time to make the decision? (i.e. What kind of decision is the most time-consuming?)
• From all decisions you make at your work typically (every-day routine or more frequently than once a week), which one do you consider to be the most important?

3a. Internal factors and elements influencing decision making process
• Do you have any overall corporate strategy? If you do, does it have impact on your decision making? In what way?
- Does predictive analysis (future predictions of how your industry will change) effect your most important decisions? If it does, which predictions are the most important (see the list below)?

Note: rate importance from 1 to 7 (1 is the least and 7 the most important)
- sources availability predictions,
- political situation stability predictions,
- demography predictions,
- are there any other kind of predictions you consider when making decision? Please specify: ……..
- Do you consider any ethical and environmental issues, when making the most important decisions? If you do, which ones you consider to be the most important?

Note: rate importance from 1 to 7 (1 - not important at all, 7 – very important)
- Do you consider origin of materials used for your manufacturing?
- Do you consider working conditions at your supplier's factories?
- When doing business with your partners, have you ever met with corruption problems?
- Does information about overall financial state of your company effect your most important decisions?

• Do you have any procurement strategy? If you do, does it have impact on your decision making? In what way?
• Which internal performance indicators do you take into account when deciding about the most important issues?

(Note: rate their importance on from 1 to 7, 1 is the least and 7 the most important)
- Return of Assets (net income/total assets),
- Return on Investment ((gain from I- cost of I) / cost of I),
- Total Cost Savings,
- Percent of On-Time Supplier Deliveries,
- Supplier Defect Rate,
- Quality,
- Procurement Cycle Time,
- Contract compliance,
- Customer Satisfaction,
- other (please specify): …….

• When deciding about the most important issues, do you use any kind of Business Intelligence (i.e. Business Analytics) tools to support you decisions?

If you do, what tools do you use:

(Note: rate their importance on from 1 to 7, 1 is the least and 7 the most important)
- dashboards
- scorecards
- alerts
- notifications
- ad hoc querying
- searching
- data mining
- OLAP (online analytical processing, multidimensional database)
- forecasting and planning tools
- "what-if" scenario modelling
- other BI tools (please specify): ……..

• What other internal data and information do you use when you make the most important decisions?

(Note: rate their importance on from 1 to 7, 1 is the least and 7 the most important)

• What other factors from internal environment influence you when making the most important decisions on tactical level of procurement?

(Note: rate their importance on from 1 to 7, 1 is the least and 7 the most important)

3b. External factors and elements influencing decision making process

• In what way do your suppliers effect your most important decisions?
- What is the situation in supplier market of primary goods?
- Regarding primary goods, do you prefer to have one big or a number of smaller suppliers?
- What is your position in suppliers market?
- Does the situation in suppliers market allow you to choose among them?
- Is there a possibility to negotiate with your most important suppliers?
- Do you consider risk (see the note below) on supplier side anyhow?

(Note: supplier-side risk is the probability that something unpleasant or unwelcome will happen when doing business with your suppliers)
- Do you have any risk strategy for the case of problems concerning:

- missed or late delivery?
- quality of goods received?
- quantity of goods received?
- loss of a supplier?
- Do you consider risk for any other issues concerning your suppliers? Which ones?
- How do you usually communicate with your most important suppliers?
- electronically
- traditional way (e.g. paper and oral agreements)
- other form of communication (please specify): ……..
- Is your and your suppliers' information system integrated anyhow?
- Do you share any data and information among each other?

If you do, you share data and information about:

- current level of stocks
- short-term production schedules (day to week plans)
- long-term production plans (plans for period longer than a week)
- sales forecasts
- other data and information (please specify): …….
- Do you use EDI (Electronic Data Interchange)?
- Do you use VMI (Vendor Managed Inventory) for any primary or secondary goods?
- Do you use any software application for collaborative planning, forecasting and replenishment?
- In your supply chain, do you have any kind of technology for Supply Chain Intelligence (i.e. Supply Chain Analytics)?

If you do, how does it help you to make better decisions?

• In what way do your customers effect your most important decisions?

- Do you consider customer preferences when making the most important decisions?
- Do quality expectations have significant impact on your most important decisions?
- Does lead time to market have significant impact on your most important decisions?
- Do your customers require a high level of customization?
- Do your customers require the possibility to trace origins of materials which were used to manufacture the final product they buy?

• In what way do third-party providers effect your most important decisions?

- Do you outsource any of logistics activities to 3PLs?

If you do, what activities do you outsource:

- transportation
- material handling
- warehousing
- other kind of activities related to material flows (please specify):

……

- Do you use services of third party information provider to outsource any of information activities in your supply chain?

If you do, which information activities do you outsource:

- providing technological platform,
- filtering data to provide only necessary information between the partners,
- collecting industrial market information and systemize this information into a readable interface,
- managing the collaboration and communication among partners,
- possibilities to track and trace transactions,
- services to manage and synchronize product catalogues and inventory information,
- invoicing services,
- other kind of activities related to information flows (please specify):

…….

• In what way do competitors in your industry effect your most important decisions?

- Do furniture companies in your region collaborate anyhow in order to improve their business performance?
- Does clustering in furniture industry in your region have an impact on your decision making and in-bound logistics operations?
- Do you consider risk of sudden changes in competition in your industry anyhow?

• Which authorities and other factors related to external environment have an impact on your decision making?

- Are there any laws, regulations and taxes that have considerable impact on your most important decisions? If they do, how do you use the information for your decision making?

Which of the laws and regulations increase level of complexity in your decision making the most significantly? (Note: rank the significance from 1 to 7, 1 is the least, 7 the most significant)

- laws and regulations from World Trade Organization
- laws and regulations from International Chamber of Commerce
- other laws and regulations (please specify): ……..
- Are Incoterms significant factor to your decision making?

Note: Incoterms pre-defined commercial terms that are widely used in International comerciall transactions or Procurement processes. A series of three-letter trade terms related to common contractual sales practices, the Incoterms rules are intended primarily to clearly communicate the tasks, costs, and risks associated with the transportation and delivery of goods.

- Which regulation has the highest impact on decision making:
- on operational level of Procurement?
- on tactical level of Procurement?
- Are there any other external risk factors (in addition to supplier-side risk mentioned above) that you consider when making decisions?
- macroeconomic risk (e.g. fluctuations in world economy),
- natural risk (e.g. calamities, disasters)
- social, cultural, demographical or geographical risk,
- political situation and legal risk (e.g. changes in laws, regulations)
- other risk factors (please specify): ……

3c. Soft inputs in decision making process

• Do you use any kind of technology to visualize hard data (see the note below) which you use for your decision making?

(Note: hard data are data provided by computer-based technology)

If you do, what kind of data visualization techniques do you use:

- charts
- graphs
- diagrams
- maps
- other kind of visualization tools (please specify): ……

• How does your decision making look like in case you do not have hard data available?

• In addition to hard data, what soft inputs (see the note below) do you use? (see the list below and in regard to your most important decisions rate the importance of the soft inputs from 1 to 7, 7 is the most important)

(Note: Soft inputs are typical for humans, humans can handle both soft and hard inputs, while machines can handle hard inputs only)

- experience
- intuition (see the note below)

(Note: Intuition is kind of an inner voice of your experience gained during your life that tells you that this might be the right decision)

- context of the situation
- negotiations and gaming (e.g. win-win strategy)
- emotions and feelings
- "common sense"
- "voice from unconsciousness"
- other kind of soft inputs (please specify): …….

• In regard to the most important decisions, how important is knowledge (see the note below) in your decision making? (rate 1 to 7, 7 is the most important)

(Note: Explicit knowledge is higher level of information that is typical for humans and is difficult to be transformed to computerized form," you know something and you can explain it to other people"

Tacit knowledge: you know something but you cannot explain it in words, "you know more than you can explain")

- Approximately how much of the knowledge is explicit and how much implicit? (as a percentage of the whole knowledge, e.g. ca 30% of the knowledge is explicit, 70% is tacit)
- Knowledge can be got from education, routine work and experience. How important for your decision making is knowledge got:

(rate the importance from 1 to 7, 7 is the most important)

- from your education
- What kind of education do you consider to crucial for making your most important decisions?

- from routine (daily) work
- from experience
- How many years are you in your business?

• When you make the most important decisions, who do you communicate with in order make better decision?

- Who are your partners in decision making process concerning the most important decisions?
- colleagues from your department
- colleagues from other departments in your company
- colleagues from partner organizations
- other persons (please specify): …….
.....
- In order to make better decision, do you organize any meetings for group decision making:
- within your department
- within your company
- within your supply chain, including:
- suppliers
- customers
- third-party providers
- other supply chain actors (please specify): …….....
.....

• Please try to estimate how much hard inputs (in the form of data and information from internal and external environment processed by computer technologies) and soft inputs (in the form of your knowledge, intuition, social networking and communication) do you use when you make the most important decisions. (e.g. 30% of hard inputs and 70% soft inputs, in sum it should be 100% - if not, please try to explain what other kind of inputs or factors have an impact on your decision making)

• From hard (computer-based) and soft (human-based) inputs mentioned above, which ones you consider to be the most important in decision situations:

- when decision making takes long period of time (more than a month)?
- when decision making takes shorter period of time (day to week)?
- when you need to make decision immediately (at the moment or in few minutes)?

References

Bertalanffy, K. L., 1968. General System theory: Foundations, Development, Applications.

Eckerson, W.W. and Howson, C., 2005. *Enterprise Business Intelligence: Strategies and Technologies for Deploying BI on an Enterprise Scale*. USA: TDWI.

Daft, R. L. , Lengel, R.H., and Trevino, L.K., 1987. Message Equivocality, Media Selection, and Manager Performance: Implications for Information Systems. pp. 355-366, MIS Quarterly, Vol. 11, No. 3, September.

Farahani, R. Z., Rezapour, S., and Kardar, L., 2011. *Logistics Operations and Management: Concepts and Models*. USA: Elsevier.

Galbraith, J. R., 1973. Designing Complex Organizations, Reading, MA: Addison Wesley Publishing Co..

Galbraith, J. R., 1974. Organization Design: An Information Processing View, Interfaces, 4, pp. 28-36.

Gharajedaghi, J., 2006. *Systems Thinking: Managing Chaos and Complexity, 2th ed*. USA: Elesevier.

Giunipero, L., Dawley, D. and Anthony, W.P., 1999. *The Impact of Tacit Knowledge on Purchasing Decisions.* Journal of Supply Chain Management, Vol. 35, No. 1, pp. 42-49

Haines, S. G.*, 1998. Systems Thinking & Learning*. Amherst, Mass. HRD Press.

Haines, S. G., 2010. Systems thinking research rediscovered: Ludwig von Bertalanffy and the society for general systems research's relevance in the 21st century, Proceedings of the 54th Annual Meeting of the International Society for the Systems Sciences ISSS, Waterloo, Canada

Haydock, P. M., 2003. *Supply Chain Intelligence.* ASCET, Vol. 5, pp. 15-21.

Helgheim, B. I., Jæger, B. and Saeed, N., 2010. *Technological Intermediaries as a Third Party Service Providers in Global Supply Chains.* Molde University College, Working paper

Hittmár, Š., 2006. *Manažment*. Žilina: EDIS, ISBN 80-8070-558-5.

Klapita, V., 2001. *Logistické technológie a činnosti*. Logistický monitor, ISSN 1336-5851.

Král, J., 2001. *Podniková logistika - Riadenie dodávateľského reťazca*. Žilina: EDIS. ISBN 80-7100-864-8.

Lambert, D. M. and Stock, J. R., 1993. *Strategic Logistics Management*, *3th ed.,* Homewood, Ill. : Irwin, ISBN: 0-256-08838-1.

Laudon, K. C. and Laudon, J. P., 2002. *Management Information Systems: Managing the Digital Firm*, *7. ed.* USA: Prentice Hall.

Li, L., 2007. *Supply Chain Management: Concepts, Techniques and Practices: Enhancing Value Through Collaboration*. World Scientific Publishing.

Mangan, J., Lalwani, C. and Butcher, T., 2008. *Global Logistics and Supply Chain Management*, West Sussex: Wiley.

Porter, M. E., 1985. *Competitive advantage : creating and sustaining superior performance*, New York : Free Press.

Slack, N., Chambers, S. and Johnston R., 2010. *Operations management, 6th ed*. London: FT Prentice Hall.

Solem, O., 2003. *Epistemology and Logistics: A Critical Overview.* Systemic Practice and Action Research, Vol. 16, No. 6, December.

Stefanovic, N. et al., 2007. *Supply Chain Intelligence*. In: Innovative Production Machines and Systems Conference (IPROMS), http://conference.iproms.org/ [Virtual Conference].

Supply Chain Council, 2012. *Supply Chain Operations Reference Model Overview Version 10*. Online [24.6.2012]: http://supply-chain.org/f/SCOR-Overview-Web.pdf

Tilanus, B., 1997. Information Systems in Logistics and Transportation. Antology. Elsevier Science Ltd., UK.

Tingling, P. et al., 2011 *Enterprise Systems Focused Collection: Changing Channels: The Impact of Web 2.0 on Supply Chain Management.* Production and Inventory Management Journal, Vol. 27, No. 2, pp. 31-44.

Turban, E. and Volonino, L., 2006. *Information Technology for Management, 5th ed*. USA: Wiley.

Willems, S. P., 2008. *Real-World Multi-Echelon Supply Chains Used for Inventory Optimization*. In M&SOM, Vol. 10, No. 1, Winter, pp. 19-23, INFORMS.

Zeleny, M., 2005. *Human Systems Management: Intergrating Knowledge, Management and Systems*. World scientific: Singapore.

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