Enabling SME Logistic Networks using Lean IT Solutions – A Case Study

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Abstract. Presently, we observe a general tendency for markets to evolve into customer markets. Customer requirements grow in terms of overall higher logistic quality. In consequence, the producers undergo an increasing pressure to stay competitive and to adapt to customer requirements. A promising approach for producers to face this pressure is to cooperate with transport companies within networks.

In this paper, we present the results of a research project in which a small number of autonomous, competing producers from the plant cultivation industries and carriers form a heterarchical network of SMEs. In order to improve the quality of their logistics while decreasing costs, the companies within the network establish a cooperation. This particular cooperation is an adoption of the LLP concept that is known from the domain of large-scale enterprises. We refer to this novel concept as virtual LLP. We determined that the application of a lean IT solution is a crucial factor in establishing a virtual LLP and ultimately enabling a SME logistic network.

The contribution of this paper is the introduction of the novel concept virtual LLP and the report of experiences we gained in the process of establishing this concept using a lean IT solution.

Keywords: SME Networks, Logistics, LLP, Lean IT.

1 Introduction

The paradigm shift in the consideration of logistics has lead to the awareness that logistics is not only an expense factor but also has significant impact as a competitive factor (Bäck 1984). Producing enterprises can gain advantages over their competitors if they deliver overall higher logistic quality. Furthermore, we nowadays observe a general tendency for markets to evolve into customer markets. The cus-
Customer requirements grow in terms of e.g. supply frequency, smaller deliver quantities and overall higher logistic quality. In consequence, the producers undergo an increasing pressure to stay competitive and to adapt to customer requirements. A promising approach for producers to face this pressure is to cooperate with carriers within networks (Nissen/Bothe 2002).

However, establishing a working cooperation between producers and carriers is not a trivial task. The initial design space for building such a cooperation is huge, several theoretical and practical approaches exist and a working solution has to take into account both the goals and requirements of the individual enterprises and the cooperation as a whole. For example, large-scale enterprises today organise their value chain in accordance with the idea of the Supply Chain Management (SCM) concept. In this approach, logistics is organised by a Third Party Logistics Provider (3PL), a Lead Logistics Provider (LLP) or a Fourth Party Logistics Provider (4PL). Another option for organising logistic processes is to adopt the Supply Chain Collaboration (SCC) concept.

Not only large-scale enterprises, but also small and medium sized enterprises (SMEs) can take advantage from participating in logistic networks. Thus, networks can enable participating SMEs to satisfy the growing demands on logistic quality and to reduce logistics costs. These advantages are especially relevant in industrial sectors that exhibit low product differentiation, e.g. in the plant cultivation sector. For example, enterprises could participate in a cooperation network in order to achieve higher deliver frequency and smaller deliver quantities. Moreover, they could aim at reducing costs by e.g. bundling freight while sustaining the same logistic quality.

Besides the anticipated advantages, building, operating and maintaining a logistic network generates overhead. Generally, information technology (IT) solutions are applied to support the logistic processes in an effective and efficient way. However, most standard IT solutions are expensive and heavy to install, operate and maintain. They have substantial demands on the required technological infrastructure and technological competences. Typically, in these areas SMEs have very limited resources. Hence, standard IT solutions are often infeasible for SMEs and even networks of SMEs. In this context, lean IT solutions are required to enable logistic networks of SMEs. These lean IT solutions must be efficient, effective and minimal regarding costs, functionality and required infrastructure and resources. They must exhibit a low barrier for enterprises to use them and eventually to profit from them.

In this paper, we present the results of a research project in which a small number of autonomous, competing producers from the plant cultivation industries and carriers form a heterarchical network of SMEs. In order to improve the quality of their logistics while decreasing costs, the companies within the network establish a cooperation. This particular cooperation is an adoption of the LLP concept that is known from the domain of large-scale enterprises. We refer to this novel concept as virtual LLP. We determined that the application of a lean IT solution is a crucial
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factor in establishing a virtual LLP and ultimately enabling a SME logistic network.

The contribution of this paper is the introduction of the novel concept virtual LLP and the report of experiences we gained in the process of establishing this concept using a lean IT solution.

The remainder of the paper is organised as follows. Section 2 presents the research questions and gives details on the case study and project context. Section 3 details characteristics of the cooperation concept virtual LLP and how it was derived from project requirements. Section 4 presents the requirements, design and implementation of a lean IT solution that acts as the medium of a virtual LLP. Section 5 briefly reviews related work. Finally, Section 6 concludes the paper and outlines future work.

2 Research Questions and Case Study

The goal of the research project that we report on was to improve the competitiveness of a logistic network of SMEs by the adaption of logistic concepts from the domain of large-scale enterprises and by the adoption of IT. We considered a configuration where a small number of autonomous, competing producers and carriers form a heterarchical network of SMEs. This network aims at improving the quality of its logistics and at the same time decreasing costs by exploiting synergetic effects. The primary research question we faced was as follows:

What are adequate concepts to enable a heterarchical network consisting of SMEs to cooperate successfully in order to improve logistic quality and reduce logistic costs and how are they applied?

A focal point of the research project was to study the transferability of logistic concepts from the domain of large-scale enterprises (like 3PL, LLP, 4PL and SCC) into the domain of SMEs in a single case study and ultimately to perform this transfer. For these purposes, the characteristics and peculiarities of SMEs compared to large-scale enterprises have to be taken into consideration.

In this context, the most significant differences relate to size and structure, or more precisely, to the limited amount of available resources and heterogeneity. Typically, SMEs have limited technological infrastructures and technological competences (Tan et al. 2006). Moreover, producing enterprises often have limited logistic competences. The amount of money that SMEs are able and willing to invest in these areas is very little compared to larger enterprises. Furthermore, SMEs can be very different among each other. The number of employees ranges from just a few in very small enterprises to up to 250 employees in medium sized enterprises (European Commission 2003). Hence, the available technological infrastructure,
technological and logistic competences and financial resources can differ considerably between individual SMEs.

A framework requirement that is usually not present in the original domain of large-scale enterprises and that complicates the adoption of a logistic concept is that in our context the enterprises form a heterarchical network. They are autonomous and competing participants.

A crucial aspect of the application of a logistic concept in general and in the domain of SMEs in particular is IT. In our opinion, an IT solution is essential in order to support the logistic processes in an effective and efficient way. It is known that a positive relationship exists between IT application and business performance, see e. g. (Rothgang et al. 2006). Moreover, the employed IT solution has to reflect the characteristics and peculiarities of SMEs.

In the research project *AmmLog*, we exemplarily sought for answers to the research questions stated above by employing the methodical means of action research. The project consortium consisted of four producers from the plant cultivation industries, three transportation companies and the OFFIS institute for information technology. Regarding the product portfolio, the producers both showed overlap and specialisations ranging from ornamental plants to trees. The producers and carriers were all located in the Ammerland region, northern Germany. Producers sold and carriers delivered goods respectively to customers across Germany. Within their respective scope of business, they competed directly to some extent. The OFFIS institute managed the project, conducted the research and designed and implemented the IT solution. The German foundation Stiftung Industrieforschung funded the project for a period of two years.

The project consortium identified the following goals that the intended logistic network should achieve:

1. Optimised freight bundling to face the trend of decreasing shipment sizes.
2. Increased planning reliability for producers and carriers.
3. Increased process quality by establishing common, binding logistic processes.
4. Increased transparency of quality and costs.
5. Increased flexibility to react to customer requirements regarding shipments.
6. Reduced costs and higher process quality by application of IT solutions that support the logistic processes in an effective and efficient way.

In the next Section, we elaborate on the design of the cooperation and introduce the concept virtual LLP. Section 4 presents the requirements, design and implementation of a lean IT solution that acts as the medium of a virtual LLP.
3 Designing the Cooperation

The cooperation concept is a central design decision that had to be taken and that vitally influenced the form of cooperation. We identified different concepts in both theoretical research and practical projects. The identification of the most advantageous cooperation concept has been done based on the requirements of the project members.

3.1 Theoretical Background

As already mentioned, the role of logistic shifted from a simple cost driver to a distinguishing feature in the competition (Bäck 1984). One consequence of this paradigm shift was that logistic moved into a broad research focus. Logistic concepts became objects of research, especially in sectors like automotive and the trade, where the importance of logistics was obvious. Mainly, research was focussed on the situation in large enterprises and their supply chains, which are controlled by these focal enterprises. In consequence, research is dealing with topics motivated from such kind of networks, like the increasing requirements on quality aspects (Choi/Rungtusanatham 1999), the increasing number of partners within a Supply Chain, the increasing use of IT Solutions and the stronger look at the consumer needs. All these aspects lead to an increasing complexity. To handle this complexity collaboration between the networked companies is proposed as a possible solution, e.g. by (Nissen/Bothe 2002).

If companies cooperate in such a logistic network, it has to be mentioned that it becomes inefficient for each company to run its logistic activities completely on its own. This leads to unnecessary overhead and costs. Furthermore, it is inefficient for each network participant to hold out the needed logistic competences in house. Some approaches to by-pass those inefficiencies base on the outsourcing or pooling of logistic activities. Therefore, different concepts have been developed, namely 3PL, LLP and 4PL. Concepts like SCM and SCC are partially related to this trend, and are taken in consideration here as well. While SCM and SCC focus the organisation of the supply chain, the concepts 3PL, LLP and 4PL provide different concepts how the logistical services can be provided.

Supply Chain Management (SCM) and Supply Chain Collaboration (SCC)

There are different understandings of the concept of SCM, but they can be classified into three categories (Mentzer et al. 2001): SCM as a management philosophy, SCM as an implementation of management philosophies and SCM as a set of management processes. A more classical understanding of this concept is used by Monczka et al.: SCM is a concept “whose primary objective is to integrate and manage the sourcing, flow, and control of materials using a total systems perspective across multiple functions and multiple tiers of suppliers” (Monczka et al. 1998). In comparison to the classical SCM understanding, the SCC concept accentuates that nowadays companies are often part of different supply chains. The coor-
Coordination between different supply chain partners should be achieved by an intensive information exchange, without losing their autonomy. The strategic focus of the cooperation lies in the logistical processes, see (Sahay 2003) and (Simatupang et al. 2004).

**Third Party Logistics Provider (3PL)** A 3PL is a service provider that extends the classical carrier by providing contract logistics. The service provided by the 3PL is first of all the transportation of goods using its own assets, like trucks etc., and only partial the coordination of logistic activities (Baumgarten et al. 2002).

**Lead Logistics Provider (LLP)** The LLP has the role of a coordinator that controls the logistic processes of the entire network. The logistical services are provided by sub contracting companies. The LLP acts only as the organiser of the logistical processes without the need to have own assets. This definition goes in line with (Thomas 1999): “A supply chain integrator that assembles and manages the resources, capabilities, and technology of its own organisation with those of complementary service providers to deliver a comprehensive supply chain solution”.

**Fourth Party Logistics Provider (4PL)** The 4PL concept is closely related to the LLP concept, as one can see in the definition of a 4PL according to (Bauknight 2001): “A 4PL provider is a supply chain integrator that assembles and manages the resources, capabilities, and technology of its own organization with those of complementary service providers to deliver a comprehensive supply chain solution”. If the separation of the concepts LLP and 4PL is meaningful, the interpretation of the definitions has to be different. In fact, this is the case. According to (Klaus 2003) the 4PL has a more strategic and consulting function, while a LLP runs the daily business and is thus located on the operational level.

These three concepts are often discussed as different steps of an evolutionary process in the contract logistic and no pure implementation of the 4PL concept is known so far (Frohn 2006).

### 3.2 Requirements concerning the Cooperation Concept

We identified different requirements towards the conceptual solution deduced from the research questions, the project goals and project characteristics. The requirements concerning the whole project were discussed earlier in Section 2. These are requirements for the project itself and are closely related to the decision for a particular collaboration concept. A major motivation for these requirements is the fact, that the participating companies are SMEs, which often do not have the specific logistic competence within the companies and do not have the abilities to source this knowledge. The specific requirements concerning the form of the cooperation are:

1. Supporting binding and transparent logistic processes of high quality.
2. Initialisation of one central contact partner for the logistic processes.
3. Guarantee that all transportation requests will be carried out by a carrier.
4. Being cost and resource efficient.
5. Supporting the freight bundling.

### 3.3 Selection of an adequate Concept

In the course of the project, we used the SCC concept, as it ensures the autonomy of the participating companies. SCM on the contrary is focussed on enterprise networks with a focal enterprise and centralised control. As the design of collaboration is not given by the SCC concept, this is fixed in further refinement steps. The next step in finding a suitable logistic concept was the decision for a logistic service provider concept (see Figure 1).

![Possible Organisation Concepts for the Collaboration](image)

As pointed out, a centralised coordination of the transportation services is important for all participating companies, thus making a pure 3PL concept unsuitable for the network. In a 3PL system, coordination of logistic activities would have had to be done by the producers, thus contradicting requirement four. The establishment of a 4PL would have gone beyond the requirements specified, because it would have emphasized a consolidated strategic logistic planning. Apart from going beyond the requirements, this would have also thwarted the collaborative aspect of the network. The LLP concept actually meets all requirements and it was identified as the adequate concept for designing the collaborative network. Of course, alternative concepts to the LLP, like electronic marketplaces or informal collaborations based on common agreements, needed to be evaluated as well.

Electronic marketplaces were identified as being not suitable because they cannot guarantee that each transportation request finds a carrier. Furthermore, freight bundling is not explicitly supported. It is still possible that two different carriers could deliver goods to customers in the same region at the same time. Thus, requirements three and five are not met.

An informal network based on common agreements does not support the timely exchange of data, which is essential for SCC. Moreover, a single contact for the lo-
logistical services cannot be provided. The number of contacts for producers and carriers would stay constant, in the best case. Additionally, an informal network could not enforce, preserve and institutionalise the common agreements. Hence, this concept is contrary to the requirements one, two and four.

Finally, it becomes clear that the LLP concept can satisfy all requirements. For the implementation of a LLP in our network, three options were identified:
1. A virtual LLP, using a lean IT solution.
2. A LLP, coordinating the logistic activities, subcontracting the carriers.
3. An extended LLP that can coordinate logistic activities using its own and subcontracted resources.

The implementations option virtual LLP is an adoption of the LLP concept and is detailed in Section 3.4. All project participants were interested in the implementation of a LLP. However, this would have meant to establish a legal entity that serves as the LLP and has legal obligations like a carrier. After estimating the expected costs, it was decided that this option is too expensive. The resulting costs for each participant were too high, and thus this option would be inefficient and therefore cannot meet requirement four. In consequence, the same is true for the extended LLP option.

The concept of a collaboration using the LLP concept and a lean IT solution satisfied all requirements. The project partners decided to start with this concept. When further companies would join the network, the collaboration should be extended to an association as a legal entity operating as a LLP.

### 3.4 Adoption of the LLP Concept

To use the LLP concept as being defined in Section 3.1, it is necessary to found a company. The LLP contracts with different carriers to source the logistic services. Therefore, de jure, the LLP had to be a legal entity, which implies costs resulting from legal obligations and the need for workforce. Thus, the implied costs increase unacceptably.

The idea to solve this problem is to establish a virtual LLP. The base for the collaboration of the participating companies is a framework of common agreements, e.g. concerning logistic quality and processes. To ensure these agreements and to institutionalise them, an incorporated association was established. By registering to this association, the participants formally accept these agreements. In order to support the operational activities, a lean IT solution should be developed that coordinates and bundles the transportation requests. In short, a virtual LLP can be defined as the following equation:

\[
\text{Virtual LLP} = \text{incorporated Association} + \text{Framework of Agreements} + \text{lean IT solution}
\]
The framework of agreements will be detailed in the next Subsection. The developed lean IT solution will be presented in Section 4. All these components in combination are enabling the collaboration of the companies organised in the association, working with the LLP concept.

3.5 Framework of Agreements
The framework of common agreements is fundamental for the collaboration of the companies. As already indicated, these agreements are binding for all members of the association. At this point, only the organisational agreements will be detailed. In addition, agreements exist concerning the logistic quality.

In order to realise the bundling of shipment orders, there is an agreement between all partners which carrier is in charge for which region. The regions are defined by the postal codes. Actually, the delivery regions are limited to Germany, in order to take the question of duty out of scope.

The carriers committed to carry out all transportations by the producers. This is partially limited, as for each region, delivery and declaration days are defined. The producers committed to use the AmmLog association to place all transportation orders, if possible. This can be limited in special cases as some customers declare a specific carrier for their order.

These agreements offer profits for both carriers and producers. The producers have the guaranty that their transportation orders will be realised by known conditions (regarding costs, quality and delivery days). The carriers can plan their transports more precisely, because it is sure that they get all the transportation orders in their transportation region.

4 Lean IT Solution
As set forth in the previous Section, the direct application of the LLP concept to a heterarchical network of SMEs was not feasible in the context of our project. The most important reason was that the accumulated costs would have been too high. For instance, not all the companies within the considered network were able and willing to found a new company, which would act as a dedicated LLP.

We argue that in this situation the application of an effective and inexpensive lean IT solution can solve the problem of enabling a logistic network. Only by employing a lean IT solution, the network is able to establish a basic LLP as a first step. We call this LLP a virtual LLP that consists of a formal association of all companies of the network, the framework of agreements of that association and the lean IT solution. This lean IT solution acts as the medium of the virtual LLP that embodies the understandings and resolutions of the formal association as far as possible.
A manifested objective of the network is to incorporate more participants successively over time. Thus, when the network is substantially larger and exceeds a critical size and the effects of economies of scale can be exploited, the LLP can be extended into a “real” LLP that is able to take over further responsibilities.

We define a “lean IT solution” as an IT solution that is minimal in relation to a given limited purpose of application regarding costs, functionality and required infrastructure, resources and competences. Thus, it exhibits a low barrier for enterprises to use it and eventually to profit from it. Furthermore, for a given purpose it provides solely the required functionality while optionally offering extension points. This is opposed to Off-the-shelf IT solutions that typically offer more than the directly required functionality for a given purpose of application while having substantial requirements on the enterprises that employ it in terms of the categories named above.

In the next Subsection, we present the basic requirements that we have identified for the lean IT solution in the context of our project. In Section 4.2, we give details on the design, implementation and challenges of the solution.

### 4.1 Requirements

Table 1 gives an overview of the basic requirements we have identified for the lean IT solution.

<table>
<thead>
<tr>
<th>Type of Requirement</th>
<th>Origin of Requirement</th>
<th>Requirement</th>
</tr>
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<tbody>
<tr>
<td>Non-Functional</td>
<td>Lean</td>
<td>1. Low Investments</td>
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<td></td>
<td></td>
<td>2. Low Barrier</td>
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<td></td>
<td></td>
<td>3. Automation</td>
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<tr>
<td>LLP Specific</td>
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<td>4. Central Platform</td>
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<td></td>
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<td>5. Development Potential</td>
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<td>Project Specific</td>
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<td>6. Third Party Organisation</td>
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<td></td>
<td>7. Scalability</td>
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<tr>
<td>Functional</td>
<td>LLP Specific</td>
<td>8. Embodiment of Framework of Agreements</td>
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<tr>
<td></td>
<td>Project Specific</td>
<td>9. Business Intelligence and Reporting</td>
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</table>

Table 1: Requirements for the lean IT solution

We divided the identified requirements into functional and non-functional requirements. Requirements one to three originate from the need to employ a lean solution. The required investments for building and / or licensing, operating and maintaining the solution must be low. Similarly, the barrier for enterprises to use it and eventually to profit from it must be low. The solution must offer a high degree of
automation therewith no additional personnel is needed to operate the solution and the time that is needed to interact with the solution is kept to a minimum.

Requirements four and five originate from the goal to make the solution act as the medium of a virtual LLP. In order to being able to take over the basic responsibilities of a LLP, the solution must act as the central communication platform and contact for all the companies within the network. It must offer consistent and simple means to communicate with the solution for all participants. Furthermore, the solution must provide potential for additional developments and extensions that are intended to be incorporated as soon as the network reaches the required size to make them feasible. For instance, the intended extensions include support for container management and advanced tracking and tracing features.

Requirements six and seven originate from conditions that are specific to the project. A neutral, independent third party organisation must develop and for a certain time maintain and administrate the solution to ensure a high level of acceptance and to support fostering a relationship of trust among the participants. A third party organisation is essential for these tasks, because the network is hierarchal and consists of autonomous and competing companies. In a conceptual way, for these tasks the network as a whole contracts the third party organisation. As soon as the network and the virtual LLP have reached a stable state and the required amount of acceptance and trust has been established, the formal association of the participating companies takes over the control of the solution. Moreover, for a participating company, the solution must be scalable regarding the trade-off between the performance features of the solution that the company utilises and the efforts that the company invests to use the solution. This kind of scalability is needed because of the heterogeneity encountered among SMEs. For instance, depending on the size and several other characteristics of the company, the applied technological infrastructure can range from telephone and fax, web-based internet applications, standard office applications, Off-the-shelf applications to custom-built solutions for a single company. The solution must enable each participating company to choose its appropriate trade-off.

Requirements eight and nine are concerned with functionality. First, the solution must embody the framework of agreements that the formal association of the participating companies has established. This framework comprises the understandings and resolutions of the formal association. As an effect, the solution must map, codify and enforce the common logistic processes that were agreed upon as far as feasible. Furthermore, the solution must offer functionality that supports business intelligence and reporting activities. The companies that participated in the project gave this requirement a high priority. This is comprehensible, since previously none of the companies but one employed IT solutions that supported them in these activities.
4.2 Design, Implementation and Challenges
In the following subsections, we give details on the design and implementation of the lean IT solution we have developed and the challenges we have encountered in the process.

4.2.1 Reuse of existing Solutions
After identifying the key system requirements, we needed to evaluate whether an off-the-shelf system was available and feasible. We categorized the required system as an intermediate between a full-blown SCM-system, a freight exchange, and an EDI platform. We then evaluated AX4 (Axit 2007), a commercial product that can also be categorized as such an intermediate and the only one being available on the German market, and the closed group functionality of the TimoCom freight exchange (Axit 2007) (TimoCom 2007). The evaluation provided the answers to the make or buy question. Both solutions did not fulfil the requirements to the needed extend. Although AX4 offered features to cover the functional requirements, it did not cover the major non-functional ones. Namely, the support for a heterarchical network of SMEs is demanding low technical and financial barriers and a strong focus on the defined process model. TimoCom furthermore lacked the support of functional requirements in respect to the support of our process model. In terms of a lean solution, AX4 moreover failed, because it over fulfilled the functional requirements to a great extend, whilst introducing a higher level of complexity to meet the requirements.

4.2.2 Design Rationale
In this Subsection, we briefly discuss the rationale behind the design decisions regarding the external interfaces of the solution. Companies use these external interfaces to communicate with the solution.

(Kärkkäinen/Ala-Risku 2003) give an overview of four different technological solution approaches for incorporating SMEs in business networks. The first approach uses centralised databases to facilitate the exchange of data between cooperating enterprises. Business-to-business (B2B) application integration denotes the direct integration of company specific information systems. Message transactions, i.e. electronic data interchange (EDI), stands for batch oriented information exchange utilising standard message formats, which is usually organised in point-to-point connections between companies. Finally, portals are web-based internet applications that integrate information from various different systems in a single place and require manual interaction.

In the design of the lean IT solution, it turned out that in order to meet requirements four (“Central Platform”) and nine (“Scalability”) the solution must incorporate aspects from all four solution approaches. Since the solution must act as the
medium of a virtual LLP and this LLP holds internal information of competing companies, it must store all the information that cooperating companies exchange among each other in a centralised database in a secure manner. We determined that a portal offers an interface to the solution that exhibits the lowest cost and lowest barrier for an enterprise to use the solution. Through a portal, the enterprises can inspect, enter and modify information in real-time. They do not have to install specific software on the client side in order to use the solution. A severe drawback is that a portal requires manual interaction and thus limits chances for automation. Apparently, requirements one (“Low Investments”) and two (“Low Barrier”) compete with requirement three (“Automation”). In order to offer an interface that offers a high degree of automation on the one hand and exhibits reasonable low investments and a low barrier on the other hand, we designed a second interface to the solution that is based on message transactions (i.e. EDI messages that are transported via email). A drawback of this approach is that it does not operate in real-time. As a third option, we designed an interface that is based on B2B process integration-oriented application integration that offers the highest degree of integration between a cooperating company and the solution, a high degree of automation and real-time operation. The opportunity to leverage deep process integration is made available by offering B2B web services.

In summary, the solution must provide scalability by offering access on multiple channels. These channels differ in the amount of required investments, the barrier that has to be overcome, the degree of automation and whether real-time operation is supported or not.

4.2.3 Architecture Overview

Figure 2 gives an overview of the architecture of the lean IT solution that we have developed. The information system AmmLog System (ALS) constitutes the core of the solution. The ALS acts as a central communication platform and contact for all the companies within the network, more precisely the participating producers and carriers. Producers communicate with the ALS through one or more of the provided channels, namely web front end, email and Web services. The web front-end channel requires manual interaction, whereas the email channel offers manual interaction as an option. Software operated by the producer can communicate with the ALS through the email and Web services channels to achieve the deepest process integration and the highest degree of automation. Carriers communicate with the ALS in the same way as producers. However, regarding the offered functionality and access rights, the ALS distinguishes between producers and carriers.
The ALS sends and receives information through channels. Even though there are different channels that information passes through, all the critical business information is encoded as EDI messages that pass through an internal, real-time EDI interface. Thus, internally, information from all the channels is processed in a uniform manner. The ALS contains software components for e.g. selecting a carrier for a given shipment order, bundling freight, calculating freight charges and supporting business intelligence and reporting. Furthermore, the system offers points for future extensions. Information is stored in a centralised database. From a software engineering perspective, the ALS is divided into four tiers in order to assure a clear separation of concerns: client tier (internet browser, email client or producer/carrier software), presentation tier (web front end), business logic tier (core ALS) and data storage tier.

4.2.4 Process Model
As part of the framework of agreements (see Section 3.5), the association defined a process model. This process model captures the common logistic processes as understood and agreed on by the association in a standardised manner. A central constituent of this process model is the definition of the life cycle of a shipment order that is issued by a producer. Figure 3 gives an overview of the life cycle of a shipment order. A shipment order that is entered into the ALS has exactly one state at any point in time. Producers, carriers and the ALS itself can trigger transitions from one state into another state. In the following, we briefly describe the life cycle of a shipment order.

Producers create shipment orders and are to announce these orders to the ALS as early as possible. At that time, the details of an order can be vague and estimated. Based on the postal code of the delivery region, the ALS selects the proper
carrier. The carrier can approve the pending order or delegates it to another carrier. In case of delegation, the originally assigned carrier is obliged to accept the order unless another carrier accepts the order instead. As soon as the producer owns detailed information regarding the order, he confirms the order to the ALS (this is possible without announcing the order first). Again, the carrier must confirm the order or delegate it to another carrier. After a carrier has approved a confirmed order, he commences the transport of the shipment. While in transit, the carrier can notify the ALS and the producer of events like delays and the damaging of goods. After the carrier has delivered the shipment, the carrier can inform the ALS and producer if an interchange of shipping containers took place fully, partially or not at all.

![Figure 3: Process Model](image-url)

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4.2.5 Reuse of Standards

Within the scope of our project, the most important area in which standards should be considered and applied is B2B communication. We subdivide B2B communication into physical data transport (here, implemented with standard internet technologies), communication protocol (of minor relevance) and the most significant aspect: data exchange format.

A priori, we classified several standards as not suitable that are specific to particular industrial sector, like ODETTE and RosettaNet. In addition, several standards exist that are more general, like EDIFACT and ebXML. However, in accordance with (Kärkkäinen/Ala-Risku 2003), we discovered that these standards are so broad that utilising them demands considerable amounts of integration work. Even GBF (GBF 2007), a subset of EDIFACT that is specific to the plant cultivation industries, is too broad and does not support the specific processes and information that our context requires. As a conclusion, we determined that a “lean” custom-made data exchange format is inevitable that supports exactly the required processes and carries exactly the required information. At least, this format is based on common standards at a lower level, namely XML and XML schema.

4.2.6 Reuse of Technologies

In order to keep the development of the solution as cost efficient as possible, a variety of modern, proven, efficient and scalable technologies could be leveraged that are free of charge. These applied technologies include Linux, Eclipse IDE, JBoss Application Server, Tomcat, JEE/JSP/EJB, Struts, MySQL, Cocoon, Eclipse BIRT, XML/XSD and others. We concluded that an effective and efficient business information system can be built using technology that is available completely free of charge.

5 Related Work

Most of the existing research about SME networks is focussed on the empirical research about the usage of information technology in SMEs, see e.g. (Connor/Woodburn 1999), (Tan et al. 2006) or (Rothgang et al. 2006). This research tries to measure the actual state of IT usage and outlines future development. Our work, as a case study establishing a network of SMEs, cannot offer such results, but is actually using results of this work, identifying portals as a promising technologies for the usage in SMEs, for instance.

The formation of a SME network is addressed in other projects as well, but with different scopes. The project InLogNet (InLogNet 2007) is developing tools and methods for inter enterprise business process modelling, evaluation and reengineering, especially for the needs of SMEs. The project ForLog (ForLog 2007) is establishing a logistic network for the automotive sector. In the Collaborative Re-
search Centre 457 (SFB457 2007), the formation of ad hoc networks of SMEs, following the vision of virtual enterprises. Competence cells, from a trusted pool, establish a network to react on actual demands. As the established network in our project, forms a virtual organisation as well, similarities exist of course. The cooperation of competing companies is possible in such a virtual organisation, but it remains a special case and is not explicitly considered. In the AmmLog network, this cooperation of competing companies is the standard.

The potentials of concepts like lean IT for networked SMEs are focused in (Stör et al. 2003) and (Kärkkäinen/Ala-Risku 2003), for example. (Stör et al. 2003) present an IT infrastructure enabling SMEs to exchange information with ERP systems of other companies via the internet. Therefore, SMEs without a complex IT infrastructure can be integrated in a supply chain controlled by larger companies. Obviously the here focussed supply chain is different. None of the participating companies in our network can enforce such information integration, and none of them has the necessary IT system, that can work as a centralised supply chain planning tool.

In (Kärkkäinen/Ala-Risku 2003) a good overview about different existing transparency solutions can be found. Transparency solutions are defined as software systems that allow the information exchange between different companies. These solutions are evaluated according to the needs of SMEs. They find that approaches like centralised databases, B2B integration solutions or message transactions, for instance based on EDI, are not suitable for the needs of SMEs. They present an agent-based information exchange approach. Software agents are used to ease the information transfer between independent companies. Thus, the information flow should be enabled according to the actual material flow. Respecting the actual low degree of usage of information technology in SMEs, see (Connor/Woodburn 1999) and (Tan et al. 2006) and the conservative structure in those companies, it remains doubtable if an agent-based approach is going to be established in SME networks widely. Thus, we focussed on the usage of already well-established technologies.

6 Conclusions

In this article, we presented the results of the AmmLog project. In this project, we established a network of autonomous SMEs to increase logistic quality and decrease costs. Vital to achieve these goals was bundling freight within the network. The network was formed by producing companies in the plant cultivation sector and carriers. The main idea of the network formation was the transfer of logistic concepts known from the domain of large-scale enterprises to the needs of autonomous networked SMEs. The context in which the logistic concept was applied introduced challenging requirements in terms of costs, a centralised contact for logistic processes and defined logistic quality.
The LLP concept has been identified to serve the requirements in an efficient way, which was a central part of our research question. However, we determined that the LLP concept has to be adopted to implement a practical solution that suits the network at the current stage. This adoption is necessary to reduce the costs of the implementation of a legal entity serving as the LLP. Therefore, we introduced the virtual LLP, which we defined in short as:

Virtual LLP = incorporated Association + Framework of Agreements + lean IT solution

The virtual LLP concept has been implemented. Agreements have been negotiated among the partners. For the operational business a lean IT solution has been developed. For the operation of the IT system and the ensuring of the framework of agreements an association has been founded. All collaborating partners have registered to the association, and thus ratified the framework of agreements.

To ensure the transfer of central concepts developed in this project, aspects specific to the industrial sector have been avoided. This is true for significant parts of the lean IT solution as well. The process model (see Section 4.2.4) is not specific to a particular industrial sector.

It was intended to develop a lean IT solution. A central characteristic of such a solution is that it is inexpensive. However, it has to be mentioned that the development of the here presented solutions would probably not affordable for the participating companies. However, as the developed solution offers potential for transfer, the development costs may by further distributed among the users.

In our project, the virtual LLP could be established. If the expected effects, especially in terms of cost reduction, can be realised cannot be answered at the time. The AmmLog System is going into operational work at the end of July 2007. From this point, an accompanying research is necessary to investigate if the collaboration works as designed and the intended effects in terms of costs and logistic quality can be realised. An important task of the AmmLog association is to promote the idea of bundling freight and reducing costs by collaboration and utilising appropriate lean IT solutions. Further companies should register to the association, to allow the extension of the AmmLog association towards a LLP solution that can work as a legal entity. This becomes only reasonable if the resulting costs can be distributed on a larger network.

Bibliography


