Lecture Notes in Logistics

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Efficiency and Logistics

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Efficiency and Logistics

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Preface

Not only is logistics a management function today but a leading discipline in research and science, combining different fields like management, informatics, economics, engineering et al. in evaluating and steering global material, information and finance flows.

As a consequent development logistics research is gaining more and more importance and attention in Germany today which is proved by the fact that the "EffizienzCluster LogistikRuhr" was a winner in the national science leading edge cluster competition run by the German Federal Ministry of Education and Research. Logistics has thus been officially recognized as an important scientific discipline and sphere of innovation beside disciplines as nano-technology, biomedicine or material sciences. Innovations and continuous education and training are crucial for efficient operations of industry and trade in all areas. Efficiency is about the improved ratio of (minimal) input to output. Connecting supply and demand while meeting individual needs and operating economically is the first and foremost target of logistics. Logistics' major task is to produce efficiency with a comprehensive view on social and ecological dimensions with respect to resources consumed.

This first proceedings issue of the EffizienzCluster LogistikRuhr presents a scientific overview about the research program and its first results. Authors from 11 research and training facilities, working in 27 projects with 120 companies in the cluster, submitted papers that were peer-reviewed prior to publication in this book. On behalf of all colleagues in our partner institutions we want to share these first results with researchers in the field worldwide, stimulate the exchange of knowledge across countries and disciplines and promote the ideas of "efficient logistics" to "efficiency by logistics".

August 2012

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Contents

Logistics Research and the Logistics World of 2050

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Abstract. Without doubt the logistics industry as well as logistics research are a central element of worldwide business structures and societal welfare. Therefore increasing interest and funding is directed towards innovative research in logistics – sustaining the broad expectations towards this sector in providing economic cost-effective as well as sustainable transport chains for global value chains. The challenge to provide even more availability with less resources and even less environmental impact will be crucial for industrial nations as well as developing countries – access to markets at reasonable transport prices is a cornerstone for the benefits of globalization. One major research initiative in this area is the EffizienzCluster LogistikRuhr established 2010 in Germany with international network links. This overview connects logistics trends and innovation expectations with the research objectives and structure of this cluster in order to clarify the eminent research agenda in logistics.

Keywords: Logistics trends, logistics research, ExcellenceCluster LogistikRuhr.

1 Introduction

In 2010 the largest logistics research endeavor in Europe to date started in the Ruhr area in Germany with the research initiative EffizienzCluster LogistikRuhr with more than 120 participating research institutions and industry as well as logistics companies [1]. This is a culmination point of different developments during the last two decades: First the increasing *globalization* brought longer and more complex transport and supply chains, especially for Germany as the economy with the highest export value worldwide. Second the market *liberalization* in Europe and Germany in such different areas as telecommunication, surface mail, rail transport and road transport brought an increasing competition as well as capable competitors from small and medium sized companies to the two global players Deutsche Post DHL and DB Schenker in Germany – this sustained the position of the already strong German logistics sector to be a world leader in this industry, supported by excellent ratings as e.g. from the

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 1–6.

World Bank regarding the transport infrastructure and performance in Germany – placed first in 2010 and fourth in 2012 [2].

Interacting with this business practice development also the traditionally strong German *business science* in the fields of production and transport as well as operations research was strengthened; also the interaction of business and science increased in this specific field of logistics and supply chain management, i.e. supported by the two major logistics associations BVL and BME in Germany [3]. Naturally, this development had a stronghold in the Ruhr area as a former industry melting pot, now transformed to a lively service and science area within the by population largest German state of North Rhine-Westphalia [4]. Therefore the EffizienzCluster LogistikRuhr was in a way a given for an innovative research initiative within the German national “Leading Edge Cluster Competition” to secure the leading position of German science and business in important fields for the future (fourteen other clusters addressing science fields such as biomedicine, nanotechnology and information technology). This article describes subsequently the innovations foreseen in logistics until about 2050 and derives from this future perspective the cluster structure and research topics in logistics in order to introduce and connect the following individual research reports from different cluster research projects.

2 Innovation Expectations for Logistics 2050

As shown for example in the new DHL Delivering Tomorrow report, future developments are difficult to anticipate and even more difficult to transfer to operational business research in logistics – though some major developments can be identified e.g. by scenario technique [5].

- Resource shortage and sustainability;
- Urbanization and new importance of urban logistics systems;
- Security concerns and problems within international transport systems;
- Importance of demographic changes and knowledge management concepts;
- Technological innovation as e.g. RFID and GPS implementation as well as the internet of things with new steering mechanisms for logistics systems.

(a) The foreseen resource shortage and *sustainability* requirements will have significant impacts on logistics and supply chains worldwide. For example sharp price increases for oil may be expected as has been happening for other raw materials in the recent past. Therefore sustainable transport systems will have to be developed – e.g. supply chains coping with oil prices up to US$ 1,000 per barrel have to be designed and implemented. This will render some supply chains completely impossible and force others to a complete change of transport modes and distances e.g. in the textile industry.

(b) Supply for the increasing number of mega-cities worldwide as well as the revival of exiting *urban centers* will be an important challenge in the future [6]. Logistics is expected to contribute significantly to this developments e.g. by new city logistics and e-commerce distribution concepts [7] as well as new transportation systems for urban areas (cargo streetcar, cargo bikes, parcel stations or transport-buddy concepts). This can be expected to be combined with innovative value added services for example in the medical and nursery care service industry – with an important link to demographic changes and increasingly older (and wealthy) populations in most countries. Home delivery and out-patient nursery care at home will be important satisfaction and growth factors in urban areas in the future – logistics research will have to establish cost-efficient systems to fulfill these needs.

(c) *Security* requirements in an increasingly unsecure and disturbed world will be a further major task and innovation expectation towards logistics – in most cases solved by increasing technology implementation such as GPS tracking and tracing. But in other cases also "old-fashioned" solutions may be relevant as e.g. the co-operation with armed forces to counteract piracy threats or terrorist actions. But these traditional concepts will be enhanced by high-speed communication networks – on both sides of this silent "war" against trade routes and transport infrastructure worldwide.

(d) Due to very different local *demographic changes* within a still increasing total world population transport requirements will change and differ significantly in different parts of the world: Whereas in Europe traffic volume will decrease at least in the area of personal transportation, for India the required total logistics staff is expected to rise from 7.3 million in 2011 up to 25 million in 2022 [8]. Therefore logistics systems will have to adapt sharply to such changes and implement rigorous qualification and training schemes as especially in developing countries there are significant gaps as e.g. for dangerous goods transportation [9]. The combination of technology and qualification development of personnel will be a key question for logistics research – as not in all areas like i.e. in the case of a new Scania truck steering concept based on GPS technology will be able to replace personal knowledge [10].

(e) The further integration of telematics and *information systems* in operative logistics processes will bring revolutionary changes described among others by the term "internet of things" as many transport objects will become subjects and take over independent information retrieval, analysis and decision capabilities [11]. This will bring new processes as well as qualification requirements as personnel will be less and less integrated in physical material handling and flow tasks but more and more in supervision, steering and exceptional event management tasks [12].

Many of these trend and innovation developments will be highly interdependent as for example the question of technology innovation and knowledge management addressed last. Therefore the described research cluster approach is highly feasible for the described tasks awaiting logistics research – in this sense the EffizienzCluster LogistikRuhr is expected to serve also as a research process blueprint for other research locations and topics within logistics research in the future.

3 Cluster Research Structure

In connection with the described trends and innovation expectations the German research cluster EffizienzCluster LogistikRuhr has defined seven major topics as internal research structure, wherein several research projects with specific objectives and institutional setups have been established. The following table shows the cluster research projects and gives an overview about the research content within the cluster.

Table 1. Cluster topics and research projects within the EffizienzCluster LogistikRuhr

Cluster Topic	Research Projects	Description
Changeable Logistics Systems	- smart Reusable Transport Items (smaRTI) - Hub2Move - Stewart-Gough-Platform - Tracing Intelligent Logistics Objects	Establishing flexibility in strategic and operative transport settings e.g. by intelligent flexible objects, containers or hub buildings
Logistics-as-a-Service	- Service Design Studio - Supply Chain Planning - Supply Chain Execution - Supply Chain Design	Service-oriented software and processes in cloud computing environments support efficient solutions for future supply chains
Urban Logistics Systems	- Dynamics in Navigation - eBase4Mobility - ePOD@Home - Homecare Services - Urban Retail Logistics - Urban Business Navigation	Solutions for new mega cities and other urban centers in efficient and sustainable concepts
Transport Systems Management	- Dynamic Consolidating - Efficiency in Logistics Hubs - Integrated Air Cargo Hub (IACH) - Efficient Building Sites - Multimodal Promotion - Organizational Innovation with Good Governance in Logistics Networks - Safe Networks for Logistics	Intelligent telematics and transport management concepts in order to use existing infrastructure mode effectively
Sustainability / Green Logistics	- Green Logistics Certification - Tray Cycling - Logistics for Urban Mining (TraCy) - Resource-efficient Maintenance Logistics - Sustainable Sourcing Excellence	Resource input and emissions reduction concepts for transport systems
Logistics Competence	- eQuaL 2.0 - e-Qualifizierung für effiziente Logistikprozesse - CSR Management in Logistics - Supply Chain School - Scientific Continuing Education in Logistics	Innovative concepts, institutions and networks for logistics qualification as well as competence-measurement and management
Cluster Innovation Management	- Cluster iMATE - Competitiveness Monitor (CoMo)	Active steering / management of cluster potentials

4 Logistics Personnel in 2050

But as any university and research undertaking the EffizienzCluster LogistikRuhr will not only achieve many outcomes in innovation, publications, products, services and work places in the logistics industry – but also many highly qualified persons, contributing to the already well-educated pool of logistics personnel in Germany [13]. This will – combined with the increase of high-qualification jobs in logistics – lead to a reduction of the existing wage gap between e.g. the average wage in the banking sector and logistics; this spread can be quantified today as about 40% on average world-wide [14]. But it well be reduced and therefore provide the logistics sector also with a further competitive advantage – or a reduction of the up to now existing disadvantage of lower wage levels and therefore lower attractiveness for highly qualified personnel.

This leads to an optimistic outlook into the economic and logistics systems future until 2050, based on research and innovation. For Germany and the global economy logistics systems will be a crucial contribution as also argued by the World Bank and supplemented by the Logistics Performance Index studies since 2007 [15]. In order to keep this performance and wealth contribution by logistics, states as well as companies have to invest further: In infrastructure, research and people.

References

1. EffizienzCluster LogistikRuhr (2012a), `http://www.effizienzcluster.de`
2. World Bank: Logistics Performance Index 2010; 2012, Washington (2010, 2012)
3. BVL (2012), `http://www.bvl.de`, BME (2012), `http://www.bvl.de`
4. Statistisches Bundesamt, Destatis (2012), `http://www.statistik-portal.de/Statistik-Portal/de_jb01_jahrtab1.asp`
5. DHL: Delivering Tomorrow - Logistics 2050, A Scenario Study, Bonn (2012)
6. EffizienzCluster LogistikRuhr (2012b), `http://www.effizienzcluster.de/de/leitthemen_projekte/leitthema.php?lthPid=3`
7. Klumpp, M., Noche, B., Kandel, C., Hohmeier, T.: Dynamic Scheduling for Logistics Service Providers. In: Delfmann, W., Wimmer, T. (eds.) Coordinated Autonomous Systems, Hamburg, pp. 124–144 (2012)
8. Pricewaterhouse Coopers: Transportation & Logistics 2030. Winning the Talent Race, vol. 5 (2012)
9. Celebi, D., Klumpp, M.: Transport of Dangerous Goods in Turkey: An Analysis in the context of EU Integration. In: Pawar, K.S., Rogers, H. (eds.) Rebuilding Supply Chains for a Globalised World, Proceedings of the 16th International Symposium on Logistics (ISL 2011), Berlin, Germany, July 10-13, pp. 703–709 (2011)
10. Grünig, G.: Fahrer bald überflüssig. In: Verkehrsrundschau, pp. 40–44 (15/2012)
11. ten Hompel, M., Kamagaew, A., Stenzel, J.: Cellular Transport Systems in Facility Logistics. In: Delfmann, W., Wimmer, T. (eds.) Coordinated Autonomous Systems, Hamburg, pp. 246–254 (2012)

12. Clausen, U., Schoneboom, J.: Dynamic Navigation of Delivery Fleets – An Approach to Integrate Autonomous Vehicles in Logistic Service Networks. In: Delfmann, W., Wimmer, T. (eds.) Coordinated Autonomous Systems, Hamburg, pp. 350–359 (2012)
13. Hildebrand, W., Roth, A.: Führungskräfte für die Logistik – Akademische Ausbildung in Deutschland. In: Baumgarten, H. (ed.) Das Beste der Logistik. Innovationen, Strategien, Umsetzungen, Berlin, Heidelberg, pp. 69–80 (2008)
14. PricewaterhouseCoopers: Transportation & Logistics 2030. Winning the Talent Race, vol. 5 (2012)
15. World Bank: Logistics Performance Index 2007, Washington (2007)

Integrated Corporate Social Responsibility Management in Logistics Networks (CoReLo)

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Abstract. The project "Integrated Corporate Social Responsibility Management in Logistics Networks" (CoReLo) focuses on smaller and medium-level corporations of logistics service provider industries. The aim of the project is to systematically outline the significance of and interlinkage between a) corporate culture (with corporate values and their embedding in the specific culture of the logistics sector), b) corporate sustainability strategy (with the identification of themes and areas that are especially relevant for a company) and c) systematic stakeholder analysis (in consideration of power, urgency, influence, legitimacy and values and norms of each stakeholder).

Keywords: corporate social responsibility, corporate ethics and culture corporate sustainability, stakeholder analysis, logistics industry.

1 Introduction

In the context of the sustainability debate, logistics, as the connecting link in global value-creation processes, are confronted with the social, ecological and economic demands of corporate social responsibility (CSR) in a particular fashion [1]. On the one hand, logistics processes are increasingly coming to the attention of stakeholders and public criticism on account of their ecological and social repercussions (cf. On the Stakeholder Concept, section 2.3.). On the other hand, the customer oriented logistics industry has to find solutions to the increasing CSR requirements that producing companies are facing, while at the same time price and performance is expected to remain constant.

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 7–18.
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The logistics industry is primarily made up of small and medium-level companies and is typically characterised by highly-interdependent international network structures, which are structured and organised to greater and lesser degrees [2]. CSR strategies therefore demand collaborative structures at the interfaces of economic exchange, as well as goal-oriented management of the initiatives and the engagement of individual logistics service providers [3].

To achieve this, integrative strategies of sustainability management [4] shall be combined with corporate ethics and systems of value management [5]. Analyses have shown that successful implementation of sustainable strategies depends on ethical business climates and the corporate culture [6]. For these reasons, strategic activation of CSR programs should take account not only of network integration [7, 8], but also the integration of stakeholders and the enabling of value-oriented management [9].

It is the goal of the project entitled "Integrated Corporate Social Responsibility Management in Logistics Networks" (CoReLo) to foster these requirements in smaller and medium-level corporations of logistics service provider industries, to analyse the conditions for their implementation, and to introduce the first steps towards implementation in participating partner companies.

Accordingly, the project is divided into three main phases: CSR diagnoses, consisting of inventory and effect analyses; the development of CSR strategies and programs; their implementation with especial emphasis on dialogic network instruments and transfer to other companies in the industry.

This article will show the results of the first phase, in particular the inventory analysis.

2 CSR Inventory Analysis

For inventory analysis of existing CSR engagements in companies, three relevant levels were identified. Each research project partner (KWI, UWH and UDE)[1] was entrusted with one of these three levels. This concerns *firstly* corporate culture with corporate values and their embedding in the sector-specific culture of logistics industries (KWI), *secondly* the sustainability-oriented topics of particular relevance or alarm ("HotSpots", UWH), and *thirdly* the corresponding groups and actors concerned by or contained within these thematic areas in the company, or to formulate these thematic areas as requirements (Stakeholder, UDE). The three levels are shown in figure 1:

[1] KWI: Institute for Advanced Study in the Humanities; UWH: Witten/Herdecke University; UDE: University of Duisburg-Essen.

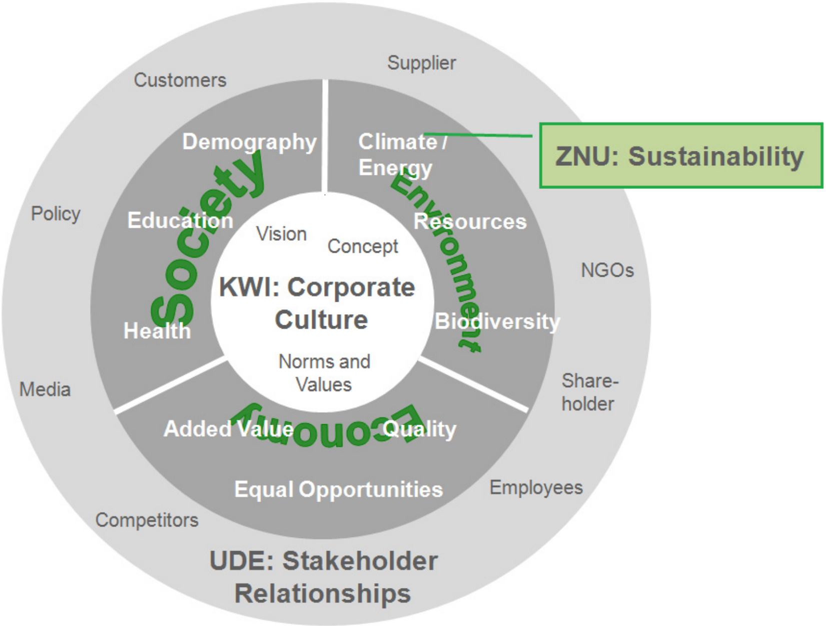

Fig. 1. The three CSR levels (own illustration, on the basis of: ZNU 2011

All three components: corporate culture and values, sustainability themes and stakeholders stand in mutual relation to one another. In figure 1 this relationship is represented in the form of a concentric circle in which the individual elements are arranged.

The first results could be generated on the basis of research, industry analyses, explorative studies, expert discussions and workshops; this includes evidence of the embedding of companies in logistics networks, corporate culture and values, relevant sustainability themes and their stakeholder relationships.

2.1 Corporate Culture and Values - KWI

To get an idea of existing values and cultural patterns in relation to CSR strategies, an indirect path must be taken through norms and practices, existing strategies, and cooperations etc. since as a rule it is difficult to capture values explicitly [10]. One exception is the Ethical Climate Questionnaire (ECQ) developed by Victor and Cullen in 1987 [11]. The questionnaire asks employees for their value-based ethical potential to which they align their activities [12]. Through the ECQ it can be stated, for example, that efficiency criteria play a large role for companies in taking care of existing tasks. On a scale between 1 ("I do not agree at all") and 5 ("I totally agree"), the average value was 3.65. Clearer still was the orientation of company-internal and specific rules and processes; with an average value of 3.86, the strongest agreement was to be found here.

Since, however, only crude evaluations of general value tendencies can be determined with the help of the ECQ, this survey was expanded to include qualitative interviews concerning CSR preferences and measures in order to indirectly comprise the existing CSR culture in companies and industries. For this reason certain overlaps with the other project areas emerged, since stakeholders and sustainability themes were automatically addressed in the discussion of CSR measures. This did not pose any drawback for the project, since through these overlaps the results could partially be validated.

Table 1 shows the scheme of analysis and illuminates how data collected in the interviews were structured according to a research project entitled "Understanding and responding to societal demands on corporate responsibility" (RESPONSE) [13].

Table 1. CSR analysis scheme inventory (own illustration, on the basis of RESPONSE 2006)

Focus of analysis	Examples
CSR requirements	External influences that support, encourage or substantiate CSR engagement
Motivation for CSR	Commitment to CSR and how this is validated, for example by • the "business case", • personal or organisational values, • expectations of the industry
CSR processes	
1. CSR commitment	Commitments and obligations with reference to CSR, for example: • support of high-level management for CSR themes, • the extent to which themes are integrated into strategic corporate decisions and processes
2. CSR structures	Findings concerning the developments of CSR in companies, for example: • whether, where and how CSR is situated • how intensive, for example, the exchange between high-level management and CSR designates is
3. CSR management initiatives	Specific programs, strategies and projects, for example • CSR training programs, employee evaluations according to CSR criteria, • integration of CSR in central business processes • manner and means of communication, like stakeholder dialogue, target agreements, reporting, monitoring, investment, etc.

The results grouped together under the "challenges" rubric clearly show that the short-term, open and informal network type is seen as a challenge. In its loose coupling, it complicates CSR engagement for individual companies, since according to those questioned, sustainable services or products require consistency and reliability. In relation to the motivation of the companies analysed, it can be seen that those questioned, particularly the executives, are very open-minded to sustainability themes. This simultaneously confirmed the consequent efficiency thinking of the ECQ: if sustainability brings the company forward, corresponding measures are also implemented. In this regard one can speak of a blend of external efficiency pressure and intrinsic value stances among executives. Efficiency thinking therefore also plays an important role, since logistics service providers heavily depend on market developments and customer engagement. On account of these external "restrictions", the engagement of the companies analysed can at present be characterised as (re-) active rather than pro-active.

In the context of the company processes already discerned, a very diverse understanding about what CSR actually means can be seen in the "CSR commitment" category. This problem is also recognised by the companies, which is why the wish for the development of a broad, communal understanding of CSR was clearly articulated. "CSR structures" are supported strongly by executives in the companies analysed. The question is how engagement can be integrated more strongly into the organisation. In spite of this internal structural challenge, "CSR management initiatives" can already be seen in the companies. However, these are at present hardly documented, prioritised or evaluated. In addition, there exists the difficulty of developing a particular communication strategy for CSR measures. Here the companies remain reluctant. The reasons for this lie in the fact that authenticity is very important to the companies analysed. They are uneasy about practicing "green washing" and of communicating something that does not reflect the actual activities and practices in the company.

2.2 Relevant Sustainability Issues - ZNU

If the corporate culture and ethical climate analysed by the KWI represents the breeding ground of CSR, it is the goal of the ZNU to identify those themes and areas (sustainability HotSpots) that are especially relevant for a company in the context of its CSR and sustainability strategy. The ZNU phase model will be introduced first in the following and will serve as a foundation for further steps in the analysis of network perspectives in the project. Building on this, the risk-inventory methods were carried out in relation to the "employee", "customer" and "public" stakeholder groups. The HotSpots identified in relation to these will be presented here summarily. The phase model and the results of the risk inventory method will from here onwards be connected with a "Good Practice Databank", in which implementation examples from practice will be collected. In this way, a more informed perspective on sustainability activities in logistics companies will be made available to companies which aid the evaluation of their own status quo and displays possibilities for action.

2.2.1 The ZNU Phase Model

If sustainability is understood as interpersonal and intrapersonal generational justice [14], then a learning process ideally takes place between the diametrical poles of three dimensions or processes respectively: on the spatial level, a process from local to global thinking (x axis), on the temporal level a development from short to long-term perspectives, and on the processual level a movement from issue management through strategic to transformative management (y axis). These three perspectives are integrated into a phase model, invented by Geßner [15] (see fig. 2). The horizontal axis describes the degree to which implemented strategies give answers to sustainability questions primarily in one's own business, or whether discovered solutions are transferred to the outside, as well. The vertical axis should point out whether solution measures have the character of a short-term, individual project, or whether they are integrated systematically on the management level.

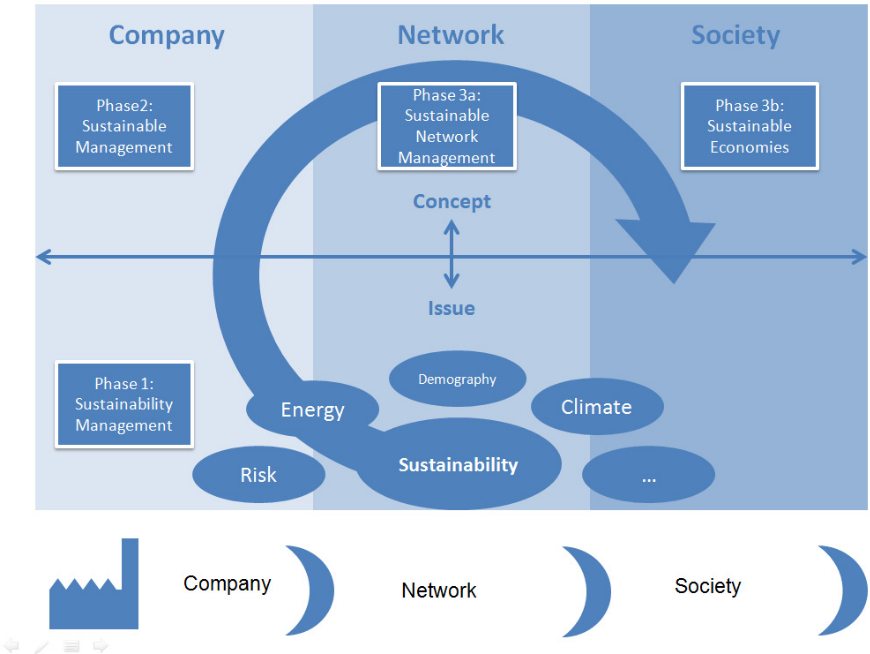

Fig. 2. The phase model by Geßner [15], with an expanded network perspective [16]

In order to make the phase model applicable for logistics, an additional network perspective was integrated. The sustainability issues are now being approached from the environment, over the network to the individual company. In total, four learning phases are passed through: sustainability management, sustainable management, sustainable network management, and sustainable economies (see fig. 2). In this final learning phase, the inside perspective develops towards an outside perspective. The company actively enters into dialogue with multifarious external and internal stakeholder groups. Part of this process is experimentation in the context of theme-related cooperations, for example along the value-creation chain with the goal of developing innovative products, or working on standards or guidelines.

To determine the themes that are most relevant to logistics companies, when they want to integrate sustainability, the risk-inventory method can be applied.

2.2.2 Determination of HotSpots with the Help of the Risk-Inventory Method

The risk-inventory method helps companies to evaluate sustainability action fields on the basis of its business processes with reference to the central stakeholder groups, and to organise relevant themes according to priority. The method also supports the strategic organisation of the CSR engagement. This was first carried out with the stakeholder groups prioritised by the companies, namely employees, customers and the public. For a deeper analysis that covers all risks, a systematic record of other, less-clearly visible stakeholder groups is helpful; the methodology of such a stakeholder analysis is presented in the third section. The risk inventory can then be carried out with these groups correspondingly.

The employee stakeholder group shows that employee bonding and further education is a very relevant sustainability field for logistics companies. This is also reflected in an evaluation of working conditions in the Goods Traffic and Logistics 2011-I of the "Bundesamt für Güterverkehr" which states that "in the goods traffic and logistics industry as a whole, the need for qualified professionals is growing strongly to greater and lesser degrees." [Own translation; 17] Simultaneously, however, fewer and fewer workers move up through demographic transition. Correspondingly, on the one hand logistics strategies must be developed with regard to how employees can be obtained for logistics, and how they can be kept in companies on the other hand. Generally it is true for the companies analysed that the compatibility of family and work must be worked on fundamentally, as care for the elderly and other social benefits have to be right, and healthcare needs to be strengthened.

Another important stakeholder group are the customers, whose main interests as ever are price and quality, even if they increasingly expect the fulfilment of sustainability requirements. For example, ever more customers demand the calculation of a CO_2 footprint. In relation to sustainability themes, the challenge for the companies analysed is posed by prices and delivery times that must remain static while still being able to offer ecologically-optimised services "on top"; for example in the case of traffic relocation from road to rail, it is expected that the service must be at least exactly as beneficial and as quick as the truck variant.

Finally, the public is an important stakeholder group. The relief of the streets or even longer holiday periods (e.g. Sunday transportation ban) are themes which constantly challenge logistics workers. Social engagement is simultaneously expected from them, like for example having an appropriate relationship to living, green and commercial spaces.

2.3 Stakeholders - UDE

As already noted, a systematic stakeholder analysis is necessary for taking into account all relevant stakeholder groups that contain not only public stakeholder groups, but also those who are of indirect relevance for the company, for example.

Accordingly, the UDE has developed a methodological concept that provides a step by step approach and practical guidelines for CSR-managers who desire to generate the relevant information about stakeholders in logistics networks. The figure below gives an overview of the tasks and methods to identify the relevant stakeholders as well as their relevant values and norms.

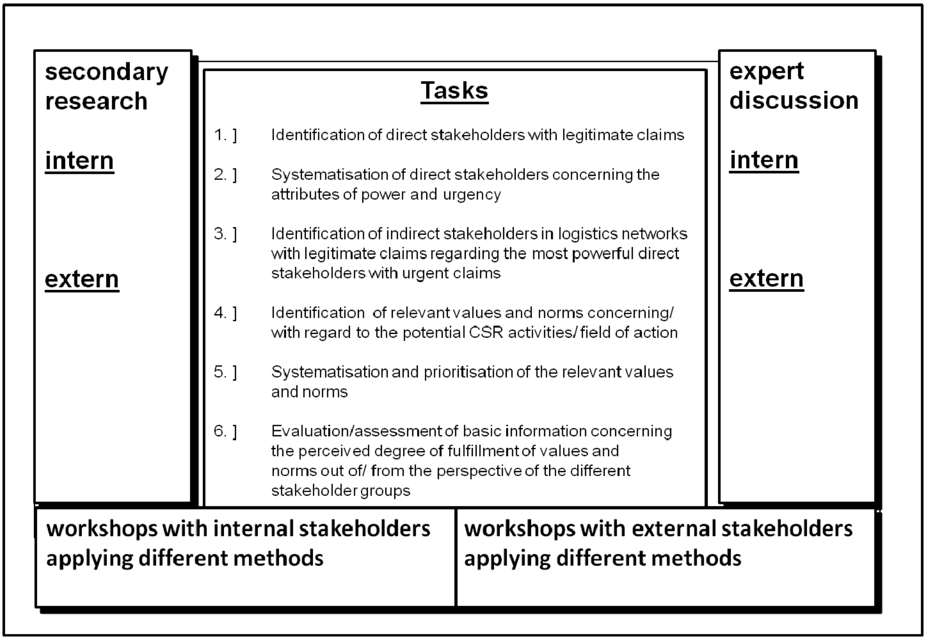

Fig. 3. Methodological concept

Due to restrictions in terms of cost and time it is not possible to consider the whole set of stakeholders. Therefore, the company has to focus on specific target groups of stakeholders. It is widely accepted that companies should only consider stakeholders with legitimate claims. These ones can be a part of contractual agreements, such as work-, cooperation- or purchase contracts [18]. On the other hand, these may arise from morally justified or accepted behavior within a society going beyond compliance with laws and human rights [19]. In the context of CSR legitimate claims encompass only environmental and social aspects. Finally, the relevant CSR-stakeholders are defined as follows: Individuals, communities or organisations with legitimate claims concerning society and environment.

First of all, the relevant CSR-stakeholders who have legitimate social and/ or legitimate ecological claims to the company are identified. Here as well as for the other different tasks of the concept the starting point is secondary research as basis for the further analysis [20]. In the next step, the companies should make use of internal workshops and expert discussions in which different methods have to be applied. For example one supporting tool for the visualisation of the identified relevant CSR-stakeholders is the so-called stakeholder map [21]. It is important to differentiate between the internal and external perspective and within the last furthermore between the economic, the social and ecological system. Internal stakeholders could be e.g. employees, whereby examples for external stakeholders are customers, suppliers and NGOs.

Once the relevant direct CSR-stakeholders have been identified within the logistics network, they must be systematised and prioritised due to limited resources. For these issues, the approach of Mitchell/ Agle/ Wood (1997) (stakeholder typology) is applied. In addition to legitimacy this idea proposes the usage of the attributes of power and urgency. Power describes a form of social influence and is measured in the ability of stakeholders to enforce their interests and to impact the business success of each organisation [22, 23]. Urgency expresses "the degree to which stakeholder claims call for immediate attention" in order not to deprive the own action of the logistics company [24].

In the following analysis the firm should consider all direct stakeholder groups with powerful claims. Moreover, stakeholder groups which only have urgent claims have to be considered in detail as well because these can influence other powerful groups, and thus have an indirect impact on the company's success [25].

Furthermore, the stakeholders of a company in turn have (other) their own stakeholders. In this paper the stakeholders of the logistics companies (e.g. a logistics service provider) are named as direct, whereby the stakeholders of the direct ones are summarised as indirect. Direct and indirect stakeholders can often form a network of relationships in which they influence each other as well as their claims [26]. Therefore, it is necessary to identify the indirect stakeholders. For the purpose it is sensible to use the approaches of the network analysis meaning the network generator and the snowball procedure [27]. Again, due to restrictions in terms of cost and time it is not possible to consider all indirect stakeholders. That's why the company should focus on indirect stakeholders with legitimate claims regarding the most powerful direct stakeholders with urgent claims.

Moreover, to gain a competitive advantage by implementing CSR-strategies it is necessary to recognise the values and norms of the relevant stakeholders and to operate in a social and environmental manner to them. As stakeholders may include a wide variety of values and norms they have to be identified and their different importance has to be analysed.

Therefore, the values and norms are evaluated in several discussions which can be supported by the critical incident technique. Usually, this technique is practiced in the service sector with critical situations being understood as key events within a process of interaction between service providers and customers [28, 29, 30]. For the systematisation of the different identified values an approach by Wieland is proposed, differentiating the categories of communication, moral, cooperation and performance values [31].

Based on this generated knowledge the logistics company can go a step further and analyse the relevant Sustainability Hot Spots for all detected stakeholder groups as shown in chapter 2.2. [32].

3 Conclusion

The analysis so far gives evidence about the specific corporate culture and values of the participating companies as well as the embedding of them in logistics networks. Moreover, the relevant sustainability themes are determined and the most relevant stakeholder relationships are identified. Furthermore, a detailed conceptual approach to analyse stakeholder relationships is given at hand.

Thus, the goal of the project to foster "Integrated Corporate Social Responsibility Management in Logistics Networks" (CoReLo) can now be taken one step further, as the conditions for the implementation of integrative CSR-programs are known and the participating partner companies can make an informed decision, which strategies they want to implement.

References

[1] Europäische Kommission: Grünbuch: Europäische Rahmenbedingungen für die soziale Verantwortung der Unternehmen, KOM, 366 endgültig, pp. 4–5 (July 18, 2001), `http://eur-lex.europa.eu/LexUriServ/site/de/com/2001_0366de01.pdf`;
Europäische Kommission: Eine neue EU-Strategie (2011-14) für die soziale Verantwortung der Unternehmen (CSR). Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. KOM, 681 endgültig (October 25, 2011), `http://ec.europa.eu/enterprise/newsroom/cf/_getdocument.cfm?doc_id=7008`

[2] Bretzke, W.-R.: Logistische Netzwerke. 2., wesentl. bearb. u. erw. Auflage, p. 47. Springer, Heidelberg (2010)

[3] Carter, C.R., Jennings, M.M.: Logistics Social Responsibility: An Integrative Framework. Journal of Business Logistics 23(1), 145–180 (2002)

[4] Schaltegger, S., Herzig, C., Kleiber, O., Klinke, T., Müller, J.: Nachhaltigkeitsmanagement in Unternehmen. Von der Idee zur Praxis: Managementansätze zur Umsetzung von Corporate Social Responsibility und Corporate Sustainability, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, econsense – Forum Nachhaltige Entwicklung der Deutschen Wirtschaft e.V. und das Centre for Sustainability Management (CSM) der Leuphana Universität Lüneburg (2007) `http://www.bmu.de/files/pdfs/allgemein/application/pdf/nachhaltigkeitsmanagement_unternehmen.pdf`

[5] Wieland, J., Grüninger, S.: EthikManagementSysteme und ihre Auditierung – Theoretische Einordnung und praktische Erfahrungen. In: Bauch, T., Kleinfeld, A., Steinmann, H. (eds.) Unternehmensethik in der Wirtschaftspraxis, pp. 155–189. Hamp Mering Verlag. München (2000)

[6] Eigenstetter, M., Löhr, A.: Ethikprogramme in Unternehmen. In: FORUM Wirtschaftsethik 16. Jg. Nr. 3/2008, pp. 17—33 (2008)

[7] Crane, A., Matten, D.: Business Ethics, 2nd edn. Oxford (2007)

[8] Werhane, P.H.: Corporate Social Responsibility/Corporate Moral Responsibility. Is There a Difference and the Difference It Makes. In: May, S., Cheney, G., Roper, R. (eds.) The Debate Over Corporate Social Responsibility, pp. 459–474. Oxford (2007)

[9] Rose, I.: Wertemanagement im Unternehmen. Nachhaltige Wertschöpfung und Chancen durch Kooperation. VDM Verlag (2008)

[10] Sackmann, S.: Unternehmenskultur. Erkennen – Entwickeln – Verändern, im Eigenverlag. München (2007)

[11] Victor, B., Cullen, J.B.: A theory and measure of ethical climate in organizations. In: Frederick, W.C., Preston, L. (eds.) Research in Corporate Social Performance and Policy, pp. 51–71. JAI Press Inc., Greenwich (1987)
[12] Cullen, J.B., Victor, B.: The Ethical Climate Questionnaire: An Assessment of its development and validity. Psychological Reports 73, 667–674 (1993)
[13] RESPONSE Final Report Understanding and Responding to Societal Demands on Corporate Responsibility(2006) http://www.insead.edu/v1/ibis/response_project/documents/Response_FinalReport.pdf
[14] Hauff, V. (ed.): Unsere gemeinsame Zukunft. Der Brundtland-Bericht der Weltkommission für Umwelt und Entwicklung. Eggenkamp Verlag, Greven (1987)
[15] Geßner, C.: Unternehmerische Nachhaltigkeitsstrategien. Peter Lang Verlag (2008)
[16] Endres, P.: Nachhaltigkeitsintegration in Logistiknetzwerken, Forschungsarbeit im Rahmen des Verbundprojekts CoReLo (2011)
[17] Bundesamt für Güterverkehr. Marktbeobachtung Güterverkehr. Bericht Herbst 2011, p. 1 (2011), http://www.bag.bund.de/SharedDocs/Downloads/DE/Marktbeobachtung/Herbst_und_Jahresberichte/Marktb_2011_Herbst.pdf?__blob=publicationFile
[18] Habicht, H.: Universität und Image – Entwicklung und Erprobung eines stakeholderorientierten Erhebungsinstrumentariums, p. 23. Gabler, Wiesbaden (2009)
[19] Habicht, H.: Universität und Image – Entwicklung und Erprobung eines stakeholderorientierten Erhebungsinstrumentariums, p. 24. Gabler, Wiesbaden (2009)
[20] Meffert, H., Bruhn, M.: Dienstleistungsmarketing – Grundlagen – Konzepte – Methoden, 4th edn., p. 132. Gabler, Wiesbaden (2003)
[21] Münstermann, M.: Corporate Social Responsibility – Ausgestaltung und Steuerung von CSR-Aktivitäten, p. 89. Gabler, Wiesbaden (2007); referring to Rühli, E.: Gestaltungsmöglichkeiten der Unternehmensführung. Führungsstil, Führungsmodelle, Führungsrichtlinien, Mitwirkung u. Mitbestimmung, p. 14. Haupt, Bern (1992)
[22] Mitchell, R.K., Agle, B.R., Wood, D.J.: Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts. Academy of Management Review 22(4), 865–866, 872 (1997)
[23] Habicht, H.: Universität und Image – Entwicklung und Erprobung eines stakeholderorientierten Erhebungsinstrumentariums, p. 54. Gabler, Wiesbaden (2009)
[24] Mitchell, R.K., Agle, B.R., Wood, D.J.: Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts. Academy of Management Review 22(4), 867, 872–879 (1997)
[25] Mitchell, R.K., Agle, B.R., Wood, D.J.: Toward a Theory of Stakeholder Identification and Salience; Defining the Principle of Who and What Really Counts. Academy of Management Review 22(4), 877 (1997)
[26] Rowley, T.J.: Moving Beyond Dyadic Ties: A Network Theory of Stakeholder Influences. Academy of Management Review 22(4), 890 (1997)
[27] Franke, K., Wald, A.: Möglichkeiten der Triangulation quantitativer und qualitativer Methoden in der Netzwerkanalyse. In: Hollstein, B., Straus, F. (Hrsg.) Qualitative Netzwerkanalyse – Konzepte, Methoden, Anwendung, 1. Auflage, pp. 153–175. VS Verlag für Sozialwissenschaften, Wiesbaden (2006)

[28] Gelbrich, K.: Blueprinting, sequentielle Ereignismethode und Critical Incident Technique. In: Buber, R., Holzmüller, H. (eds.) Qualitative Marktforschung – Konzepte – Methoden – Analysen, 2nd edn., p. 620. Gabler, Wiesbaden (2009)
[29] Meffert, H., Bruhn, M.: Dienstleistungsmarketing – Grundlagen – Konzepte – Methoden, 4th edn., p. 310. Gabler, Wiesbaden (2003)
[30] Bitner, M.J., Booms, B.H., Tetreault, M.S.: The Service Encounter: Diagnosing Favorable and Unfavorable Incidents. Journal of Marketing 54(1) (1990)
[31] Wieland, J.: Wozu Wertmanagement? Ein Leitfaden für die Praxis. In: Handbuch Wertemanagement, 1st edn., p. 24. Murmann, Hamburg (2004)
[32] For further information please have a look at our practical guidelines: Systematische Gewinnung von CSR-Stakeholderinformationen in Logistiknetzwerken (in press)

Good Governance in Global Supply Chains from Eight Perspectives

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Abstract. The development of a reactive branch for “tomorrow´s logistics”, which considers itself to become an active leading authority, demands – especially under the conditions of permanent change – an agreement on Good Governance between those responsible for tasks of the supply chain management. Observations of behavior in business relations across small and medium sized companies indicate that the communication between varying actors about sustainable compliance with different demands is impeded by complex structures of the working reality. In a study based on several years of a participatory observation of significant actors at the interface of industry, forwarder and customs administration in the inland and abroad a model was developed that may assist professionals to gain an active “understanding of the other”. It shall facilitate the joint agreement on similarities and differences of the respective realms in which the participants of global supply networks work with each other while facing partly opposed interests. Using methods of comparative political research, reasons were discovered as to why cooperation under partial competition conditions is successful or not.

Keywords: behavioral pattern, change, competence, governance, innovation, integration, logistics, other, organization, perspectives, responsibility, subjective reality, supply chain, supply network, understanding.

1 Methods

The development of a foundation for the agreement on rules of a Good Governance in global supply networks is impeded by traditional descriptions of logistics which either label relevant sections as subsidiary or distort the reality of important actors in an idealistic way. An example is the common separation of the object of study in inbound, production and outbound logistics which does not provide an adequate base for the construction of a categorical model from which the quantitative data ascertainment is as dependent as the construction of structural questionnaires for qualitative studies.

A schema of that kind was missing at the outset of this study and therefore had to be worked out first on the basis of a long-term, actively participating observation of the work of persons from various areas of responsibilities. For the interpretation of the resulting material, special care was taken to assure that the versions of participants could be reconstructed from the records.

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springerlink.com

The purpose of this study was the exploration of the working environment of actors in global supply networks, focusing the interest to the selection of attitudes and behavioral patterns on the basis of their role in the overall system. [1]

For a thorough interpretation of the material it was of great help to use the example of Todorov´s comparative and interpretative research concept. [2]

2 Situation

For logistics being an important bridging system within economy and society, the involving of value-added concept is certainly a significant advance. Same applies to the methods describing separation of core and support processes for the analysis of potential cost and risk minimization. By observing the work practices of logistics managers in small and medium-sized industrial companies, however, it is noticeable that company strategists easily subject to misinterpretation, when their effort to resolve complexity of global supply network relations has only limited success.

The word "customs (duty)" is quickly added to the category of "administrative infrastructure management" and abandoned as an external factor (in contrast to the seemingly more important core processes) influencing strategies of outsourcing. May it apparently succeed to reduce cost in the outsourcing of customs clearance – the risks of shifting no delegable responsibilities are enormous. This is proved by examples of threat or payment of larger fines for poor export controls [1], back taxes due to improper documentation of preference-proof [2] and sanctions due to the lack of quality certificates [3].

The control of knowledge of rules and regulations on customs and foreign trade is crucial for the success in the design and operational use of global supply networks. It is also applied to the consideration of other processes, such as the use of documentary letters of credit (L/C). Whether in customs clearance or L/C documents presentation, in preparing commercial invoices or monitoring transport time – the logistics manager or shipping expert, being employed by a manufacturing company, holds a key role in "governing" supply chains. This appears from insights into numerous practical examples, verifying that the position of such persons is not limited to operational activities of their company, but has more tactical importance, i.e. their daily decisions have even strategic impact on the cooperation with different actors in changing delivery systems or supply networks.

Given these consequences, it is logical that a team of researchers and traders currently try to find ways to implement standards of good governance in logistics networks. With their analysis of economic practices, they have provided important insights about the potential for innovation.[4] It will be

[1] The authors know of a case in which there is a penalty in the amount of 820,000 € for continued violations of German export regulations for shipments to India – see [3].

[2] In another case, it involved payments of approx. 700,000 € based on documents for exports to Turkey which were refused by a German customs inspector – see [4].

[3] One case concerned penalty notice by the U.S. Customs Authorities on approximately 1.3million U.S. Dollars against the importer of German machinery parts, for which no test reports (“Mill Certificates”) were submitted on the quality of the steel used (Source: Lautenschläger, unpublished report).

[4] See project reports to joint research project OrGoLo – Organizational Innovations with Good Governance in Logistics Networks; http://www.orgolo.wiwi.uni-due.de

explained below, on which areas they see need of good governance and what kind of difficulties are to overcome in the simultaneous intake of different perspectives of supply chain management.

Consequently, some practical implications for organizational innovation will be complemented in three short sections. These will be to begin in which range good governance extends on the cooperation of people and is not limited to the management of affairs. This is followed by explanations on the importance of management of distributed competence in logistics networks, using a special view on joint efforts to increase efficiency. In conclusion, it is stressed that an important part of good governance is to grant trust protection to those who are devoted to supply chain management, if they fill gaps and heal failures of others rather than to emphasize their own powers.

3 Controlling Perspectives – A Guideline for Good Governance

Logistics responsibilities in the "shipper" company of industry and trade is connected with real executive ("governing") power. Therefore, logisticians of this group might be identified as "governors", although such naming is not common – neither in science of industrial management, nor economic practice. Given the consequences of their decisions in relation to a variety of external supply chain participants, it seems reasonable to describe various – often simultaneously occupied – perspectives. From the coincidence of the perspectives in one person, indications can derive on conditions whether being useful or detrimental for practicing good governance.

The use of terms, such as to govern, governors or good (and poor) governance policies serve below in deliberate understanding of political science. This is due to the perception that the art of organizing varying cooperative relationships between each autonomous company in global supply networks has to overcome similar problems as it has to, when organizing manifold relations between states or nations in a world of autonomous countries.

For the latter, it can be recognized that "the worldwide rising importance of globalization lead to the conclusion that governments in the 21 Century would be in a position with only a higher degree of cooperation (global governance) to solve the global problems resulting from interdependence between nations."[5]. Facing the diversity of actors in supply networks, it also seems sensible to resort to innovation concepts of organizational development to involve the cooperation of people. [6]

3.1 Trade (1st Perspective)

Poor governance already starts with an arbitrary choice of delivery terms. [5] The "trade perspective" is marked by the negotiation of two parties between buyer

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[5] Thus, some buyers can easily be mislead to prove a price reduction to their superiors, in which they fail to mention that the figures, being reduced during the negotiation, and noted in the area of "total price" are now based on the EX WORKS delivery condition, which means in consequence that the entire settlement and transportation cost will additionally be charged to their company. This may be more expensive than to accept a higher purchase price at the outset, which – by including the cost of the delivery process – might possibly be made more effective through the seller, on "CIF port of destination" delivery condition, for example.

and seller. The senior decisions are often considered more about pricing (e.g. "Tarn-off") than with the willingness of gaining competency in supply chain management. The resulting process design is then gladly left to logistics experts, who can possibly do nothing else than to select the best of worse alternative solutions.

For example, the logistics manager of a valve manufacturer was forced to operate expensive, unnecessary actions by his clients in Siberia according to the contract, because they persistently refused to participate in the customs clearance. Only after evaluation of depressing experience, the sales expert learned that it is detrimental to his company to agree to the trade term “DDP Siberia” (Delivered Duty Paid) without first ascertaining the active involvement of the customer in the execution of logistics services beyond the Russian border.

3.2 Product (2nd Perspective)

Producers may create good pre-conditions of good governance in logistics networks, if their ambitions to deliver good quality also do include that their goods shall arrive at the users premises in a good condition. This cannot be certified in case of the plant engineer who after the completion of a large-volume apparatus noticed that the truck-loading was not possible without breaking the front of his factory hall, because its door was too small.

This example gives a measure of how important it is to involve logisticians in the "product perspective", as appropriate advice is to be asked early in the design phase. Certain decisions in top management affect like a denial of the use of existing expertise. Reasons may lie in a lack of understanding that – beyond their operational tasks – extra time for advisory efforts must be given to the available logistics experts. Conversely, those, who narrow descriptions of core processes to the effect that valuable supporting processes cannot be actively maintained, must not be surprised by inefficient supply chains.

3.3 Transport (3rd Perspective)

In the "transport perspective", the importance of distinguishing the interests of carriers and forwarding agents is often underestimated. Their price wars with use of "blind" package settlement lead to occlusion of opportunities that may offer an alternative configuration of sample supply chains. This requires however the use of work equipment that facilitate the analysis and reconfiguration of conventional supply chains. Such equipment, however, is often available only for large companies, since it is not affordable for others due to cost.

Small and medium-sized enterprises have modern possibilities of establishing "social networks" in the Internet to work more effectively together on a loose basis in global supply networks. For the formation of communities, however, there is lack of professional organizational framework which could provide more features than the ability for anyone to say anything. A professional collaboration platform, with balanced rules of common handling of sensitive data is a sound technical basis for the practical application of good governance.

3.4 Dispatch / Receive (4th Perspective)

The natural ability to exercise good governance in supply chains are not evenly distributed over the players. A consignee may at any time occur as principal of a logistics service provider – so he owns the role of a "shipper".[6] Here, he can face multiple faults: delayed readiness for dispatch, inadequate packaging, incomplete shipping documents, incorrect assessment of required loading space, lack of knowledge regarding foreign trade practices, etc. For effective elimination of such imperfections, the consignee often carries higher cost than the consignor. He is usually dependant on supporting activities to be effected by the latter.

Conventional optimization in this perspective is mostly geared to the needs of a company. The (start or finish) point of the line where the respective actor is located, determines a different way of dealing with the other partners of the same supply chain. Negative consequences can easily be identified through comparison of behaviors between representatives of each role – sender and recipient – which occur simultaneously within these companies. A common "dispatch/receive perspective" taken by both partners at the ends of a supply chain is best achieved when a goal-oriented communication between consignor and consignee is focused on information about which real conditions were created in order to support an optimal reception of goods. This helps in the best way to eliminate a popular misconception that a target status (whether contract intended or imagined) is supposed to be a true basis for action at the end of a supply chain. Through the practice, this error is often refuted.

3.5 Public Administration (5th Perspective)

From the "public administration perspective", effective logistical action becomes most likely visible, where communication takes place with customs authorities of the exporting country. Near to the place of dispatch, the players feel the importance of a smooth customs clearance for the imminent border crossing. The more the consignment is approaching its destination, the more the likelihood decreases that the new customs clearance in the importing country performs similar smoothly. Then, the responsible importer has frequently had insufficient involvement of the sender.

A good style for the (co-) administration (respectively "government") of the supply chain can be demonstrated by the exporter, for example, offering its customer a Brazilian "smart customs invoice". Such an invoice is characterized by exact wording for e.g. sewing machines which allows correct classification in the Brazilian tariff without further need of time-consuming enquiries. This is the only way to distinguish whether it is a home sewing machine (customs duty 20% of goods

[6] It is not self-evident that the role of the shipper would coincide normally the role of the consignor. Rather, in common phrasing of forwarding agents, a "shipper" is anyone who places the transport order and pays the freight bill. This is well understood by the example of the agreed term of delivery FOB (free on board) in Hamburg. Here, the German exporter (seller) in respect of the subsequent ocean transport is not considered as a shipper, since this role at the moment of on-board placement devolves to its foreign customer (buyer) or to the goods recipient (consignee).

value, or a buttonhole sewing machine (duty free) or any other sewing machine (10%). Consequently, it makes a difference whether the traders have access to advanced internet technologies, which provide the link with a desired foreign customs tariff during the preparation of a customs invoice.

3.6 Infrastructure (6th Perspective)

The "infrastructure perspective" provides insight into the fundamental conditions of daily logistics. Without roads, the truck is useless; just a rail network enables the movement of trains. Ports offer connected structures, where many players come together to merge many supply chains. Here, the physical processes traditionally gain much attention. Investment in modern cranes, optimization of warehousing and consolidation of container traffic are seen as important issues.

In contrast, medium-sized players are so far not offered any infrastructure that is used for the application of good governance in managing their supply chains. For universal communication, conventional media are available to them: postal mail, telephone, fax and email. The information gained by one transfer still has to be processed by the recipient in a way that is shaped by individual methods. However, there are long-proven means and methods existing to avoid manual retyping, copying, converting and sharing data obtained, but to enable anyone in the supply chain – while maintaining confidentiality – to receive those information being needed to complete ones current job. Some of those means like EDIFACT, Internet, https, XML need to be used in social networks with organizational learning techniques, all of them being ingredients of a smart composition to create innovative logistics collaboration communities.

3.7 Credit (7th Perspective)

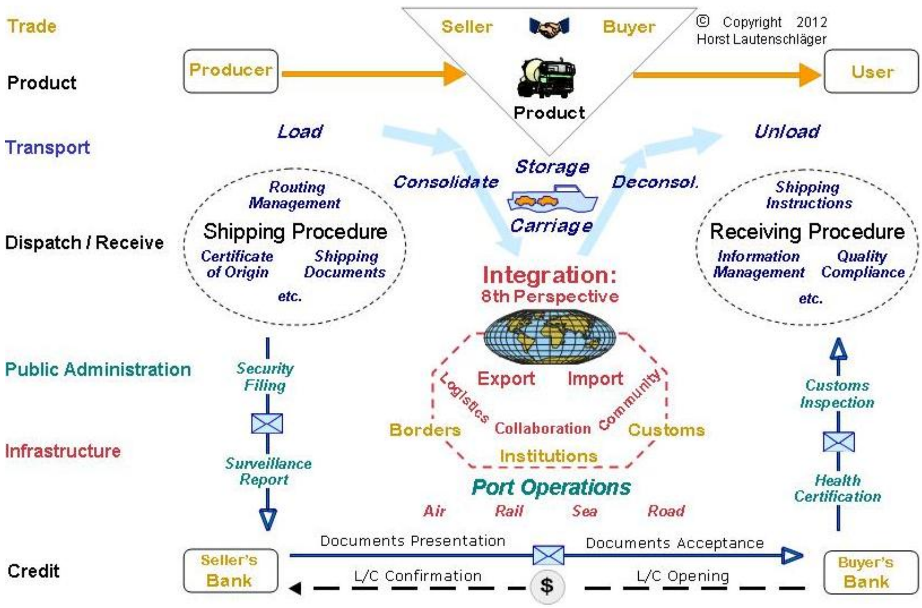
To manage supply chains, it can also mean to provide a central role in securing payment. A German exporter does not necessarily sell his million-dollar machinery to an unknown Indian company, without being guaranteed that the bill is paid after delivery. By using a "Letter of Credit (L/C)", being a well-known banking instrument, an appropriate confidence in the execution of the desired action can be gained: To initiate the payment, certain conditions must be met and documents are to be submitted to a bank within a given time. This requires very careful, well-planned, and precise performance of supply chain management.

In the "credit perspective", certain requirements meet with various demands on the design of a supply chain. The bank document submitter can dominate the work of the logistics planner. Conversely, there is a risk that a logistics partner cancels out the guarantee of payment if he incorrectly issues one single document of L /C relevance. Who governs the supply chain? Strategically responsible and operationally evidence setting actors can effectively complement each other – and simultaneously interfere very easily.

3.8 Integration (8th Perspective)

Approaches to integrating different delivery processes have already been done by large, well-funded logistics service providers, which (as so-called "integrators") have their own transport fleet, traffic aggregation power, and customs expertise and a global network of branches under one brand. Tight organizational structures are associated with their business model. However, there is a need for flexibility in dealing with incessant change of regulations and practices in international trade. The variety of activities interlocking with each other in actor-changing networks will obviously require broader integration approaches.

It is currently known about effective technical feasibility of creating web-based (social) networks for any malleable communities of logistics actors (on a necessary dominance of an individual "shipper" on his own value chains), as well as a set of recommendations of the UN Economic Commission for Europe regarding design of communities is published since years. [7] In the "integration perspective", it is palpable which chances of organizational innovations with good governance in logistics networks are ready to be opened. They create a future-proof basis for mutually supportive, collaborative "governance" of supply chains. With the possibilities of organizational learning, they provide methods to achieve high efficiency through active management of changes that permanently happen in the environmental conditions.



Eight Perspectives of Controlling Supply Nets with Good Governance

4 Good Governance Involves People

Having the insight into the different perspectives，obstacles are visible to which such actors are exposed who are working in narrow limits of a single perspective when they attend to govern logistics networks. On the one hand, the objective of protecting and increasing sustainable efficiency is compromised by poorly being equipped with organizational power. On the other hand, any lack of moderation of distributed competence leads to significant loss of potential success. The analysis of current practice shows that it is useful for supply chain controlling people, if they make use of good governance practices. This involves not only logistics managers or dispatchers, but also their cooperating colleagues across company borders and their superior managers.

Good governance takes the role of governance art in terms of responsibility for people, whose personal support and demand in the "social system logistics" is to operate as carefully as serious management of the accounting issues. This art includes a well-thought use of locally available competence for the common task, whose success is directed to the most all as to the individual involved [8].

The management of social and organizational competence is just as important as the vigilant exchange of data from various professional disciplines and the reuse of stored case knowledge. The latter occurs in the current logistics practice under the primacy of tools and procedures, which is rarely appropriate for decentralized supply of know-how as well as for their specific and effective adaptation to current needs of the participants from community systems.

Daily practice holds different examples, such as the common but unsuitable viewing of dusty file folders – and, more "modern", the word processor based preparation of situation reports on the occasion of failed actions, which rather serves as a justification of the past than for learning effects for a better future. What usually does not happen is an evaluation of numerous existing success factors which appear like being self-evident; their value is often only recognized after a key source of information (a person) is no longer available. To overcome such shortcomings and failures and to achieve sustainable performance of the creative task in governing changing logistics networks, technical and organizational support are required to act in terms of an all day cycle of the collection, analysis and reuse of knowledge (i.e., more than data).

5 Competence Management Provides for Revolving Innovation

For organizational learning [9] in the context of good governance, it is important to observe how broadly distributed competence in the environment of changing supply chains can be re-assessed on the basis of increased knowledge levels. We call this competence management, in which the allocation of responsibilities is a result of the assessment - but not a precondition. Each desired bundling or diversification of competence is accompanied with a distribution of responsibilities, which are covered by insoluble knowledge and capabilities. Only then the actors in a supply network (often being unknown to each other) will be able to bring a consignment to its destination – jointly rather than individually supervised, and not only safe but also efficient.

It is easier to say than to do. This is proved by the report of a German logistics manager, being responsible for the shipping procurement and customs clearance of machinery parts that are constantly needed for the production of an American subsidiary. His purchase-colleague in the United States considered himself in a stronger position ("Who pays for the music, also makes the choice"). However, this was reversed, since he had to discover after a few months that “his” nominated forwarder was systematically "played on the wall" by the German logistics colleague. The latter had the ability to assess controlling processes from multiple perspectives, and used three strengths that distinguished himself from his colleague (and the relevant forwarder): (a) his multiple expertise on the topics of trade, production, transportation, shipping and customs, (b) its declared higher social expertise in dealing with supply chain partners and (c) the tactical advantage of the dispatcher, who may dispose of the items before they are sent on their way – and not just, when they are on the move.

Result of the "power struggle" was that the logistician of the consignor company achieved in the transportation market better price than the purchaser on the other side – so that the recipient company who paid the freight, saved a significant cost. This benefit was worked out by the fact that the logistician – deliberately exceeding his authority – used the opportunities for conversations and correspondence with service providers, which were rejected by the purchaser before. By his request: "Send me messages with never more than five lines," the latter had given evidence that he negligently limited his own organizational competence.

In the described case, the application of good governance art by the logistics manager was effected by the adoption of an overall responsibility for the value chains of the group of companies – in a way like a pioneer, i.e. which was very unusual before. This, however, would have been achieved unsuccessfully without the reported act of disobedience. Nevertheless, the performance occurred was recognized by the CEO and lead to the formation of a new corporate culture. The logistics manager has been appointed as head of a virtual "Change Circle". This was staffed with experts from each of the related companies in Germany, Austria, Brazil and the United States, namely interdisciplinary with expertise in manufacturing, shipping, purchasing and human resources. The working group was given the task of optimizing usual logistics processes between the cooperating factories to changed conditions which were previously known by the actors only from their each individual perspective and limited responsibility.

The reaction to the power game – after the lucky finish, personally described by the logistics manager – proves the ability of the top management to a micro-political analysis of employee’s actions and their transfer into a continuing modernization process. The idea of a competence management as an expression of good governance should be understood also as a method to ensure sustainability of the ongoing effort to make improvements. It creates more than a reaction to power games, namely the development of a revolving innovation game. Innovation games are "basically achievable on three ways: by development of new promising earnings prospects for the actors, by the realization that only the change of existing routines can ensure the viability of the organization and the odds of individual actors or by the use of force and pressure."[10] The first two ways are here given preference.

6 Trust Protection – A Major Component of Good Governance

To govern means more than executing a task catalog subjected to certain rules and compliance needs. Efficient supply chain management requires looking beyond the horizon and seizing opportunities that show up in the ongoing transformation of the challenges of daily work. A vibrant work environment, which is permeated by constant uncertainty, requires the ability and authority to make quick changes of plans resulting from obligatory instructions. If a person is looking for opportunities to meet necessary goals of a value chain by taking responsibilities seriously in spite of adverse circumstances, this person must act in confidence of his action being carried by values and principles of top management.

Persons who strive for their creative tasks in favor of a common goal and thereby reduce or remove significant risks on supply chain success, must sometimes even act beyond given authority. This involves, for example, repairing failures of others, or to bridge gaps between different authorities. As the previous example shows, a real responsible person might widely miss the efficiency target when persisting in its habits and defending a one-eyed view with respect to its authority which might, however, be confused with a non-existent position of power.

With regard to the preservation of trust, it seems important that the supply chain manager enjoys the special and active support from his top management. Trust protection is a major component of good governance. Those who do not receive this, in spite of their courageous, pioneering integration of "foreign" perspectives, are subject to the dangers of erosion (of their power) and failure (of their job). Efficiency of supply chains is too important as to keep persons from promoting it by taking a variety of perspectives. Any lack of trust protection would encourage such experts to reduce their efforts to a minimum extent of their duties. The OrGoLo project takes this into account to develop the vision of sustainable logistics, by involving human beings within the “social system logistics”, "tangible" for the benefit of economy and society.

References

1. Berger, P.L., Luckmann, T.: Die gesellschaftliche Konstruktion der Wirklichkeit. Eine Theorie der Wissenssoziologie. Fischer Taschenbuch Verlag (1980); (Original: The Social Construction of Reality)
2. Todorov, T.: Die Eroberung Amerikas: Das Problem des Anderen. Suhrkamp Verlag, Frankfurt am Main (1985)
3. Lautenschläger, H.: Gestaltung globaler Logistiknetze mit dezentralen Kompetenzen, Projektbericht Nr. 4 des Verbundprojekts OrGoLo, Hg. Universität Duisburg-Essen, Institut für Produktion und Industrielles Informationsmanagement, Essen, p. 5 (2011)
4. Lautenschläger, H.: Innovative Instrumente zur Gestaltung globaler Logistiknetze, Projektbericht Nr. 5 des Verbundprojekts OrGoLo, Hg. Universität Duisburg-Essen, Institut für Produktion und Industrielles Informationsmanagement, Essen, p. 9 (2011)
5. Bauer, S., Fues, T., Messner, D., Weinlich, S.: Engagement für Entwicklung und Umwelt. Informationen zur politischen Bildung 310, 38 (2011)
6. Damkowski, W., Precht, C.: Public Management. Neuere Steuerungskonzepte für den öffentlichen Sektor, p. 205. Verlag W. Kohlhammer, Stuttgart (1995)

7. Economic Commission for Europe, UN/CEFACT – Centre for Trade Facilitation and Electronic Business: Recommendation and Guidelines on establishing a Single Window (Recommendation No. 33). United Nations, New York/Geneva (2005)
8. Lautenschläger, H.: e-Logistics: International Net Work of Complementary Competences. Technical Report, 14th Bled Electronic Commerce Conference, Conference Chair: Joze Gricar. University of Maribor, Slovenia, p. 3 (2001)
9. Gairing, F.: Organisationsentwicklung als Lernprozess von Menschen und Systemen, p. 15. Deutscher Studien Verlag, Weinheim (1996)
10. Bogumil, J., Kißler, L.: Verwaltungsmodernisierung als Machtspiel. In: Budäus, D., Conrad, P., Schreyögg, G. (eds.) Managementforschung 8, New Public Management, p. 9. Verlag Walter de Gruyter, Berlin (1998)

The Competitiveness Monitor as an Innovative Foresight Support System for Mobility, Logistics and Beyond

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1 Introduction

A more volatile and uncertain world today puts a premium on companies possessing foresight capabilities [e.g. 1]. As the industry at the center of globalisation, logistics is especially vulnerable, yet its efforts on strategic foresight is lagging behind compared to other industries – not at least due to the large prevalence of small- and medium-sized enterprises (SME). As part of the Leading-edge Cluster Logistics and under the guiding topic of "Activating Cluster Potentials" the joint research project *Competitiveness Monitor (CoMo)*[1] addresses this challenge. The result of the project will be the prototype of a collaborative online platform that combines three innovative supporting tools for futures-oriented decision-making in a foresight support system [cf. 2]. The project first underwent a rigorous multi-method requirement analysis. After project-internal workshops according to the "Volere Requirement Specification Template" we additionally surveyed the 130 cluster partners concerning their expectations and implemented a world-wide real-time Delphi study among approximately 1,000 futurists, thought leaders and foresight experts about the future role of information and communication technology (ICT) for foresight. At the moment the project is progressing according to plan, with two of the prototype applications already in programming.

2 Logistics, Strategy and Futures Orientation

Logistics has come a long way in the past 50 years. Where individual parts of the product flow – such as transport, handling or storing – constituted independent activities, often implemented by a single service provider at the beginning of this

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timeframe, nowadays these steps have evolved into integrated and comprehensively managed supply chains [3]. In fact, the Council of Supply Chain Management Professionals defines logistics management as "*part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements*" [4]. Especially since sourcing, production, and distribution have increasingly become global operations for many companies, reliable and efficient logistics are of strategic importance to many companies or even constitute the basis for corporate strategy [5, 6]. This development comes at a time, in which volatility and uncertainty in the business environment is expected to increase even further than it has already been the case. Globalisation has not only led to more synchronized business cycles and thus more volatility in the world economy [7, 8], but also to an increase in complexity through longer supply chains with more links and larger networks [9-11]. Additionally, the nature of logistics as a global business means that the number of competitors on the market is increasing with every country that joins the global market and with every round of trade-barrier-reduction. Customers can use new media to easily compare prices and services and put thereby pressure on logistics companies to provide better and faster services. Oftentimes, customers demand value creation that goes beyond the timely delivery to the right location [12]. Consequently, logistics companies have to become flexible in their structure and need to be able to quickly adapt their processes to market demands [13]. A further layer of complexity is a added to contemporary logistics by the increasing utilization of technolgy, such as Radio Frequency Identification (RFID) which contributes to the materialisation of even larger, more complex networks of interdependent organisations that synchronize on a global level [10, 11]. As a result, logistics companies additionally have to stay up to date with technological development in order to manage these complex operations or they risk falling behind.

Overall, the increased scope and complexity of logistics also mean that investments in this industry sector have grown. This additionally highlights the discipline's rising importance in relation to other activities. Consequently, logistics management has moved away from a merely operational concern to a top management issue essential for sustainable competitiveness [13]. There are many upcoming challenges (but also opportunities) for the logistics industry [14-17] that companies have to handle besides the traditional tasks of the sector.

Complexity and dynamism in an industry, such as described above, indicate that decision-makers are faced with a high amount of uncertainty [18].Volatility and uncertainty raise the risk logistics managers and their businesses are confronted with. They have to deal with more players in global logistics and have to handle more interfaces and intermodal operations over longer distances combined with more complex administrative processes [19]. Overall, supply chains are constantly becoming more vulnerable.

Analyzing all discussed points, it becomes clear that futures orientation and the management of innovation should become vital processes in logistics. Innovations drive growth and deliver competitive advantages in all industries. Their impact has become especially important in the light of the current fierce competition in the logistics service industry [20]. Consequently, logistics companies not only have to permanently adapt their services and products according to customers' demands and to market conditions [21], but also have to implement process innovations. These may reduce costs, whereas product innovations – i.e. new services – achieve competitive advantages via product differentiation.

Even less developed than innovation management, yet equally important, is the proliferation of corporate foresight in logistics. Possessing capabilities both in innovation management and in futures research possibly provides ample competitive advantage in a knowledge economy [22]. In an ideal world, innovation management and corporate foresight mutually strengthen to each other [23]. Proactively scanning the environment enables companies to develop contingency plans and therefore to react more flexibly to changes. Corporate foresight therefore helps to handle uncertainty and to realise competitive advantages in a turbulent environment [e.g. 1]. Since logistics management is now widely regarded as a strategic issue, long-range planning is directly applicable to impactful logistics decisions [24]. Yet, the forays of logistics divisions into futures research have not been very strong so far. Consequently, many logistics service professionals feel uncomfortable with current traditional forecasting tools, such as trend extrapolation. In fact, many studies have shown the necessity to develop and apply more modern techniques, such as the Delphi or scenario technique, in strategic logistics planning [e.g. 25, 26, 27].

Taking the changes and concerns in the logistics sector into account, the development of the CoMo project aims to promote foresight competence in cluster and beyond. Thereby, logistics companies will be offered an innovative online platform that provides different foresight tools. Each helps to be better prepared for future volatilities and to systematically elaborate on (process) innovations in logistics. This will improve firms' readiness and flexibility towards the future and enable further product and process innovations for the future.

3 Requirement Analysis

CoMo is a joint research project that creates future-oriented knowledge within the cluster. Four diverse partners (a large manufacturing corporation, a supply chain management consultancy, an IT service provider, and a research institution) are directly involved in the CoMo project. This mix ensures high levels of scientific rigor and industry relevance. CoMo is designed as a future-oriented IT platform where science-, business-, and politics-partners of the cluster can co-operate to ensure a sustainable competitive advantage for all stakeholders. From the above discussion about the changed environment of logistics companies, four major challenges for CoMo can be derived:

(1) The various countries, industries and companies linked by logistics networks impede the creation, linkage, and processing of information about future macro- and microeconomic developments in logistics and its environment.
(2) Incentivizing stakeholders to systematically deal with their futures and to foster innovations is crucial for success even if the resource base of companies is limited.

(3) Many logistics providers lack experience in applying foresight processes and thus require a tool that provides educative information on futures studies.
(4) Constant pressure to innovate and remain competitive requires sharing of knowledge and co-operation among cluster stakeholders.

Initially the project team developed an overall framework for the tool, which consists of a collaborative platform integrating three innovative foresight tools. The overarching structure of the tool can be seen in Figure 1. In order to develop a cutting-edge tool that will address the major challenges in logistics, we carried-out a multi-method requirement analysis. From June 2010 the joint project team conducted intense scientific desk research and several participatory workshops. Roughly 1,000 initial requirements for the tool functionality and its interfaces were identified at this stage. Afterwards, the requirement analysis was continued systematically, supported by the 'Volere Requirements Specification Template' [28, 29], which was identified as our preferred process frame. Requirements were sorted along the lines of intended applications (Futures Platform, Trend Database (TDB), Future Workshop, Prediction Markets, or app-inter-linkages), type (functional, non-functional, or constraint) and categorical purpose (e.g. user collaboration). Then, all joint research partners prioritized the requirements by rating the dimensions of (1) *feasibility*, (2) *innovativeness* and (3) *importance* in order to narrow down the high number of specifications. We implemented a stakeholder and use-case analysis in order to address dependencies and underlying assumptions, such as trade-offs between feasibility and innovativeness or the fact that importance is subject to one's own perspective. This evaluation allowed cutting down the number of requirements to a set of relevant and innovative specifications, that will provide the foundation of the tool development.

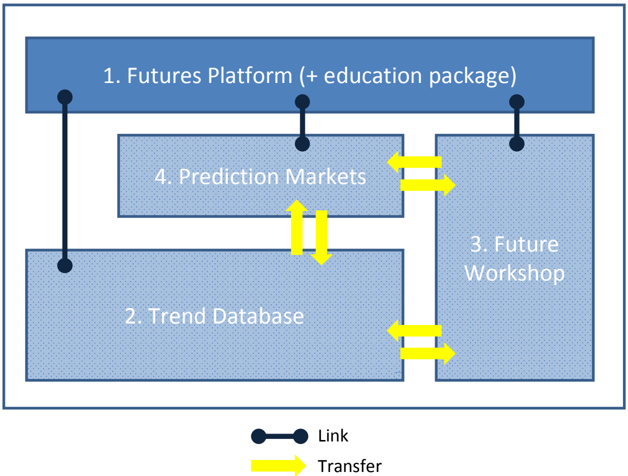

Fig. 1. Conceptual Framework of the Competitiveness Monitor

Additionally to the Volere Requirement Process we also went outside the joint project team to receive further contribution for the requirement analysis. We contacted the 130 cluster partners (overall 178 potential contacts) for interviews about their expectations towards an innovative foresight tool that meets the requirements of the logistics industry. Overall, 21 respondents (a response rate of 11.8%) assessed 13 questions, revealing complementary motivations of companies and research institutions for potential utilization of the tool. Whereas companies expressed their expectations that a tool such as the CoMo would help them to manage their foresight processes and to get insights into market and environment developments, research institution considered the CoMo as a good way to gain attention for their work and knowledge.

The final step of the requirement analysis was the conduction of a Delphi Study among the world's leading foresight experts about expected future developments in ICT-based foresight tools, such as the CoMo. The Delphi method is a proven iterative survey process that aggregates experts' opinions, while encouraging consensus by giving controlled feedback of the other experts' opinions [30, 31]. We used an online, real-time version of the Delphi method, which provides experts with immediate feedback and reduces thereby the time of the survey process [32]. Of the almost 1,000 contacted experts, 177 participated in the Delphi survey. The experts validated the rising importance of foresight in general and ICT-based decision support in foresight in particular. Furthermore they pointed out that the integration of multiple tools into an online application will constitute an effective and cost-efficient path towards value creation by foresight exercises. We found expert panel consensus that future-relevant data should be crowd-generated and that ICT-based foresight tools will contribute to process efficiency in companies thereby improving overall foresight quality.

4 The Competitiveness Monitor

In the following, the features derived from the requirement analysis for all four applications of the CoMo are described. We present major topics as well as minor functionalities that need to be addressed in four fully integrated, connected and harmonized tools in order to make the CoMo a highly-usable, intuitive and integrated prototype for a foresight support system.

4.1 The Futures Platform

The Futures Platform serves as the users' personalized login portal and serves as a single point of entry. Access to the other three tools is provided and information about pre-selected contents from the other tools is displayed. The platform can be individualized by the users according to their interests: they can save trend favourites, display related information or follow the other foresight applications in which they are engaged. This structure will be designed as a flexible, individual decision making environment in order to incentivize the users to actively participate in the CoMo. Furthermore, the platform offers various opportunities for communication among the users. The cooperative nature of the platform will result in high transparency and provide all stakeholders in the cluster with access to future-relevant knowledge. Information asymmetries among cluster partners will be reduced and pace and rate of communication will be raised. A secure code will ensure privacy, so that the application will not jeopardize collaboration inside the cluster.

The platform will also include an educational self-learning package. Here, knowledge about futures research and training for the entire set of CoMo functionalities is offered for self-studies. This will enable every user of the tool to individually navigate his/her way through the CoMo. The modules about futures research ensure that especially newcomers to strategic planning and foresight, e.g. SME, will be able to use the platform in order to build up foresight competencies. This seems especially important when taking the discussion about increasing complexity in global logistics into account.

4.2 Trend Database

The TDB has a pivotal role within the CoMo. Within the TDB, future-oriented knowledge gets generated, further developed, interconnected and stored. The other applications of the CoMo can retrieve data from the TDB but also store new or complement information. In order to reveal the state of art of common TDBs, we analyzed in-depth the architecture and functionalities of eight existing TDB concepts. This analysis provided us a solid fundament at the beginning of our requirement analysis. We revealed several shortcomings of current concepts that we will address in order to develop an innovative TDB concept, which adds value for the cluster partners. Additionally, we searched the Internet and scientific databases for reports, articles and other available documentations about TDB concepts and functionalities that might be relevant for implementation. As result of the TDB analysis, four major challenges appeared: (1) Extend and quality of trend information, (2) cooperation within the TDB-community, (3) linking mechanisms and (4) incentivization of users.

Most TDBs aim to provide trend information and future-oriented knowledge for the entire variety of industries. Thereby, the extensiveness and quality of trend information is quite limited and consequently too unspecific for a single industry. A TDB concept for the leading-edge cluster must therefore in particular be designed to address the relevant topics of the logistics industry adequately and to provide information that creates value for the cluster partners. However, the offered information needs to be clearly structured and smartly presented in order not to lead to an overload of information for the user. While many TDB concepts are based on professionals who collect and edit trend information, the CoMo TDB will follow the emerging trend of wisdom of the crowd [33]. Thereby, users interact with each other and collaboratively generate, edit and assess future-oriented knowledge. It ensures validity and actuality of the provided information and reduces the problems inherent in subjective trend assessment. However, a low interest in a certain trend might lead to fragmentary and out-dated information. Therefore, a combination of user and professional (i.e. expert) participation is most promising in providing best quality of future-oriented knowledge [34].

Cooperation within the TDB-Community is therefore essential to create an extensive and reliable collection of future-relevant knowledge [35]. The involvement of different stakeholder in the process of knowledge creation, sharing and evaluation reduces the environmental uncertainty of each single stakeholder and leads therefore to a win-win situation. This ensures a productive collaboration due to a perceived created value for each cluster partner [36].

Another additional value of the TDB is generated by the intelligent linkage of futures knowledge. The CoMo aims to realise particularly two kinds of linking mechanisms. First, the different trends within the CoMo TDB will be linked in various ways which allows drawing a more holistic and clear picture of the future. The integration of linked wildcards will additionally help decision makers by considering potential changes in the future, which may cause severe consequences for their own business. Second, the TDB will be linked with the other CoMo tools "Prediction Markets" and "Future workshop" ("Zukunftswerkstatt"), and support these tools with information as well as archive their newly generated data.

Finally, a major challenge of the CoMo in general and the TDB in particular lies in the incentivization of the users. They need to be motivated not only to take information from the TDB but also to share their insights in form of providing information, editing information from other users or assessing foresight information. But also the appropriate tagging of information by the cluster partners is an important step in linking data. The quality and extensiveness of tagging determines the degree to which the CoMo can run automated analysis or combine the stored data.

In several creative future workshop sessions of the project team, we identified 160 potential requirements and constraints for the CoMo TDB. Thereby, we strongly focused on the logistics environment and the needs of the cluster partners and tried to adequately address the challenges of the existing concepts. The major goal of the creative workshops was rather to develop new and innovative ideas by "out-of-the-box" thinking than collecting common or obvious functionalities (e.g. "user creates trend"). The assessment of these 160 requirements regarding feasibility, innovativeness and importance allowed us to narrow down the high number of specifications. The most relevant requirements are currently realized in a first prototype. The main topics of the requirements can be categorized as follows.

1. Automated analysis functions
2. Guided analysis functions
3. Indiviualization
4. Input by user
5. Innovative & multimodal output options
6. Standardized trend information
7. Incentivisation
8. Internal & external linking
9. Integration & compatibility

4.3 Future Workshop ("Zukunftswerkstatt")

In the Future Workshop application, CoMo-users can project factors and options from the trend database into their individual futures. User can collaborate in building scenarios, assessing options and deriving plans of action. The idea of Future Workshops goes back to the 1970s and was developed by Robert Jungk, Ruediger Lutz and Norbert R. Muellert [37]. Their original technique comprises four phases: (1) Preparation Phase, (2) Critique phase, (3) Fantasy Phase, (4) Implementation phase. The CoMo will enable the idea for a web-based Future Workshop. However, the requirement analysis showed that it will be more effective to combine the first two phases, so that the CoMo Future Workshop will consist of the generic phases (1) Preparation (2) Analysis and (3) Implementation.

The Future workshop will apply best practice from a multitude of foresight methods. Elements of scenario planning [see e.g. 38], roadmapping [see e.g. 39], backcasting [40, 41] and Imagineering [42] will be combined for a high practice-oriented value. In the Preparation phase, app users will have the opportunity to select future factors from the TDB to form the basis of the workshop. Additionally, individual factors can be added, so that every workshop can account for the specific situation of the participating users and companies. Afterwards, the users can discuss, prioritize, sort and link the factors, before the second and/or third phase of the workshop is opened by the moderator. Here the group collaboratively assesses the factors and can engage in the above described creative methods for problem evaluation and solution-identification.

Overall, the users are led through a process of problem identification, innovation, and creativity towards problem solving. Spatial boundaries are made irrelevant in this context. Thus, the Future Workshops facilitates foresight in strategic logistics planning. For example, participants can evaluated the robustness of their companies' strategy for the occurrence of three different scenarios hinging on immediate environmental factors such as legislative decisions or price developments. Therefore decision makers are able to combine qualitative and quantitative information as well as creative group processes in order to actively shape their companies' future. A Future Workshops can result – among others – in recommended actions, action plans, priority lists, or roadmaps. Knowledge generated from the workshops, for example assessments of future factors, will feed back into the TDB.

4.4 Prediction Markets

The CoMo Prediction Market Module will provide an innovative foresight method that complements the other tools of the CoMo. Prediction markets originally evolved in psephology. They have been proven to outperform classical opinion polls in accuracy – and consequently have in recent years been transferred into the business world [43]. The Prediction Market Module will enable CoMo users to bet on the outcome of future events in a virtual environment. Future events are similar to stocks, with prices representing for example the likelihood of occurrence. This builds on the theoretical foundation of the wisdom of crowds [33] and the Hayek-Hypothesis about market efficiency [44]. A stock thus represents the aggregated wisdom/knowledge of all market players, while the competition among market participants efficiently aggregates asymmetrically distributed information. Thus, according to their forecasting accuracy, traders can lose or gain credit. This incentivizes participation and accuracy, while it is unimportant whether the credits are virtual (as in the CoMo-case) or real money [45]. To account for possible problems resulting from low liquidity we use a market scoring rule according to Hanson [46].

The CoMo Prediction Markets contribute to the cluster's guiding topic "activation of cluster potentials" by sharing complementary resources and generating future-relevant wisdom/knowledge for all involved companies. Additionally, the innovative nature of the Module will help to incentivize stakeholders in the cluster. The application will further be linked with the TDB and the Future workshop: ideas generated for a workshop sessions can be assessed in an information market, e.g. potential benefits from investment decisions or sales potential sales figures for a product innovation; and information generated in from a particular market will be fed into the TDB, e.g. the probability of a price development or the potential date of a technology innovation.

5 Conclusion

The CoMo is part of the Leading-edge Cluster Logistics, funded by the German Federal Ministry of Education and Research (BMBF). The overall goal of the cluster is to achieve tomorrow's individuality with 75% of today's resources. For this to happen, two developments must take place. All actors must acknowledge that logistics has evolved into a strategic management activity and innovation management must become more prominent. So far, we have developed the framework of a comprehensive foresight support system that will help the cluster to achieve just that. By mid-2013, the prototype will be developed for testing foresight cooperation, stimulating future orientation and encouraging open innovation. The actors are provided with a platform on which they can share complementary resources, especially their visions, thoughts and ideas on expected logistics developments. Therefore, the CoMo will support cluster partners in strategic planning and future-robust decision making. Overall, CoMo is expected to increase the quality of decision-making not only for the Blue chip and mid cap but aldo for the SMEs in the cluster and thereby to contribute to the overarching goal of the cluster.

References

1. Rohrbeck, R.: Corporate Foresight: Towards a Maturity Model for the Future Orientation of a Firm. Springer, Heidelberg (2010)
2. Banuls, V.A., Salmeron, J.L.: Scope and design issues in foresight support systems. International Journal of Foresight and Innovation Policy 7(4), 338–351 (2011)
3. Ballou, R.H.: The evolution and future of logistics and supply chain management. European Business Review 19(4), 248–332 (2007)
4. The Council of Supply Chain Management Professionals: Supply Chain Management and Logistics Management Definitions (2011), `http://cscmp.org/aboutcscmp/definitions.asp` (February 14, 2012)
5. Yeung, A.C.L.: Strategic Supply Management, quality initiatives, and organizational performance. Journal of Operations Management 26(4), 490–502 (2008)
6. Qi, Y., Boyer, K.K., et al.: Supply Chain Strategy, Product Characteristics, and Performance Impact: Evidence from Chinese Manufacturers. Decision Sciences 40(4), 667–695 (2009)
7. Frankel, J.A., Rose, A.K.: The Endogeneity of the Optimum Currency Area Criteria. Economic Journal 108(449), 1009–1025 (1998)
8. Inklaar, R., Jong-A-Pin, R., Haan, J.D.: Trade and Business Cycle Synchronization in OECD Countries: A Re-examination. CESIfo Working Paper No. 1546 (2005)
9. Meixell, M.J., Gargeya, V.B.: Global supply chain design: A literature review and critique. Transportation Research Part E: Logistics and Transportation Review 41(6), 531–550 (2005)

10. Bhatnagar, R., Teo, C.-C.: Role of logistics in enhancing competitive advantage: A value chain framework for global supply chains. International Journal of Physical Distribution & Logistics Management 39, 202–226 (2009)
11. Jain, V., Benyoucef, L.: Managing long supply chain networks: some emerging issues and challenges. Journal of Manufacturing Technology Management, 2008 19(4), 469–496 (2008)
12. Dominic, P.D.D., et al.: The importance of service quality for competitive advantage – with special reference to industrial product. International Journal of Business Information Systems 6(3), 378–397 (2010)
13. Gunasekaran, A., Lai, K.-H., Edwin Cheng, T.C.: Responsive supply chain: A competitive strategy in a networked economy. Omega 36(4), 549–564 (2008)
14. Ruske, K.-D., et al.: Transportation & Logistics 2030 – Emerging Markets – New hubs, new spokes, new industry leaders?, vol. 3. PricewaterhouseCoopers, Duesseldorf (2010b)
15. Ruske, K.-D., et al.: Transportation and Logistics 2030 – Transport infrastructure — Engine or hand brake for global supply chains?, vol. 2. PricewaterhouseCoopers, Duesseldorf (2010a)
16. Ruske, K.-D., et al.: Transportation and Logistics 2030 – How will supply chains evolve in an energy-constrained, low-carbon world?, vol. 1. PricewaterhouseCoopers, Duesseldorf (2009)
17. Beamon, B.M.: Sustainability and the Future of Supply Chain Management. Operations and Supply Chain Management 1(1), 4–18 (2008)
18. Duncan, R.B.: Characteristics of Organizational Environments and Perceived Environmental Uncertainty. Administrative Science Quarterly 17(3), 313–327 (1972)
19. Jung, K.-P., Nowitzky, I.: Das besondere Risikopotential in der Logistik. In: Hector, B. (ed.) Risikomanagement in der Logistik, Deutscher Verkehrs-Verlag, Hamburg (2006)
20. Chapman, R.L., Soosay, C., Kandampully, J.: Innovation in logistic services and the new business model: A conceptual framework. International Journal of Physical Distribution & Logistics Management 33(7), 630–650 (2003)
21. Yazdanparast, A., Manuj, I., Swartz, S.M.: Co-creating logistics value: a service-dominant logic perspective. The International Journal of Logistics Management 21(3), 375–403 (2010)
22. Hines, A.: A practitioner's view of the future of futures studies. Futures 34, 337–347 (2002)
23. von der Gracht, H.A., Vennemann, R., Darkow, I.-L.: Corporate Foresight and Innovation Management: A Portfolio-Approach in Evaluating Organizational Development. Futures - The Journal of Policy, Planning and Futures Studies 42(4), 380–393 (2010)
24. Singh, M.: A Review of the Leading Opinions on the Future of Supply Chains, Supply Chain 2020 Project Working Paper (2004)
25. Sodhi, M.S.: How to do strategic supply-chain planning. MIT Sloan Management Review 45, 69–75 (2003)
26. Deep, A., Dani, S.: Scenario Planning in Supply Chain Risk Management. In: The 10th International Research Seminar on Supply Chain Risk Management, Logistics and Supply Chain Futures Research Unit. Loughborough University, Loughborough (2010)
27. Klement, K.: Entstehung von Innovationsideen im eigenen Unternehmen aus der Perspektive eines Logistikdienstleisters. In: Pfohl, H.-C. (ed.) Innovationsmanagement in der Logistik. Gestaltungsansätze und praktische Umsetzung, pp. 210–226. Deutscher Verkehrs-Verlag, Hamburg (2007)
28. Robertson, S., Robertson, J.: Volere Requirements Specification Template. Atlantic Systems Guild Limited (2010)

29. Robertson, S., Robertson, J.: Mastering the Requirements Process, 2nd edn. Addison-Wesley Professional, Amsterdam (2006)
30. Rowe, G., Wright, G.: Expert Opinions in Forecasting: The Role of the Delphi Technique. In: Armstrong, J.S. (ed.) Principles of Forecasting: A Handbook for Researchers and Practitioners, pp. 125–144. Kluwer Academic Publishers, Boston (2001)
31. Linstone, H.A., Turoff, M.: Delphi: A brief look backward and forward. Technological Forecasting and Social Change 78(9), 1712–1719 (2011)
32. Gnatzy, T., et al.: Validating an innovative real-time Delphi approach - A methodological comparison between real-time and conventional Delphi studies. Technological Forecasting and Social Change 78(9), 1681–1694 (2011)
33. Surowiecki, J.: The Wisdom of Crowds: Why the Many Are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies, and Nations. Doubleday, New York (2004)
34. Cuhls, K.: From Forecasting to Foresight Processes–New Participative Foresight Activities in Germany. Journal of Forecasting 22(2-3), 93–111 (2003)
35. Cuhls, K.: Participative foresight–how to involve stakeholders in the modelling process. In: Future Directions of Innovation Policy in Europe, Proceedings of the Innovation Policy Workshop. European Commission, Brussels (2002)
36. Kane, G.C., Fichman, R.G.: The shoemaker's children: Using wikis for information systems teaching, research, and publication. MIS Quarterly 33(1), 1–17 (2009)
37. Jungk, R., Muellert, N.: Future workshops: How to Create Desirable Futures. Institute for Social Inventions, London (1988)
38. von der Gracht, H.A., Darkow, I.-L.: Scenarios for the logistics services industry: A Delphi-based analysis for 2025. International Journal of Production Economics 127, 46–59 (2010)
39. De Laat, B.: Conditions for effectiveness of roadmapping: A cross-sectional analysis of 80 different roadmapping exercises. In: Proceedings of the EU-US Scientific Seminar: New Technology Foresight, Forecasting & Assessment Methods, European Commission DG JRC-IPTS, Seville (2004)
40. Quist, J., Vergragt, P.: Past and future of backcasting: The shift to stakeholder participation and a proposal for a methodological framework. Futures 38(9), 1027–1045 (2006)
41. Höjer, M., Gullberg, A., Pettersson, R.: Backcasting images of the future city—Time and space for sustainable development in Stockholm. Technological Forecasting and Social Change 78(5), 819–834 (2011)
42. Nijs, D.E.L.W.: Imagineering: Towards a design approach to transform the enterprise logic. White paper in the context of the PhD-study under supervision of Prof. dr. ir. J.M.L. van Engelen, University of Groningen, Faculty Economy and Business Administration, Innovation Management and Strategy, Groningen, The Netherlands (2009)
43. Ho, T.-H., Chen, K.-Y.: New Product Blockbusters: The Magic and Science of Prediction Markets. California Management Review 50(1), 144–158 (2007)
44. Hayek, F.A.: The Use of Knowledge in Society. American Economic Review 35(4), 519 (1945)
45. Servan-Schreiber, E., et al.: Prediction Markets: Does Money Matter? Electronic Markets 14(3), 243–251 (2004)
46. Hanson, R.: Combinatory information market design. Information Systems Frontiers 5(1), 107–119 (2003)

Valuation of Hybrid Identification Processes as an Enabler for the Internet of Things

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Abstract. Today's research projects focus on hybrid identification processes and technologies. That means, that more than one single technology, eg. RFID (radio frequency identification), is needed over the whole supply chain. Projects like smaRTI (smart resusable transport items) come up to the requirements of the different process-steps with hybrid identification processes. The aim is to achieve the vision of the Internet of Things. In this paper the definition of the Internet of Things is clustered into different criteria. A valuation process measures the identification processes of two sample projects in matters of the Internet of Things criteria. The valuation shows the links between the main evaluation factors and their influence on hybrid identification processes.

Keywords: reusable transport items, hybrid AutoID, Internet of Things, smaRTI, DyCoNet, valuation, RFID, RTLS.

1 Introduction

As globalization accelerates worldwide trading, rising dynamic markets and customer requirements display great challenges for coordination and layout of value networks. Competitive factors such as costs, reliability and security are being complemented by efficiency, flexibility and transparency. In order to be able to stand up to these challenges, resources, technologies and IT have to work together flawlessly. Attaining the vision of the Internet of Things, in terms of the aggregated definition of ten Hompel, Mattern and Fleisch, requires the combination of functions. One key issue in this direction are load carriers, the most important resource of logistics. Enabling these load carriers, such as pallets or containers, to be part of the Internet of Things is one major goal of the EffizienzCluster project smaRTI (smart reusable transport items) and DyCoNet (Dynamic Container Network), a project which is part of the 'Autonomic' programme.

These two projects use load carriers among transportation [1]. Since load carriers are widely used and highly standardized in many ways, equipping this resource with intelligence would result in new possibilities of tackling today's logistic challenges.

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 43–53.

RFID still has a key role to play in this context. Numerous pilot projects during the past couple of years have shown that using RFID is possible theoretically throughout the entire supply chain but only feasible to a certain extent in practice which is why this area provides great opportunities for further development. The mentioned projects of Fraunhofer IML address this subject. These exceed the regular use of RFID though and envision the future in hybrid AIDC-processes (automatic identification and data capturing) and the Internet of Things. Here, logistic networks do not only consist of a single identification technology, instead a bundle of functionalities of various technologies serves as a solid basis for a logistic environment inside, which logistic units independently send status information and react autonomously to changes in process operations [2]. This paper describes a valuation process for processes, how they fit to the vision of Internet of Things. The processes of the two mentioned projects are used as an example for the valuation.

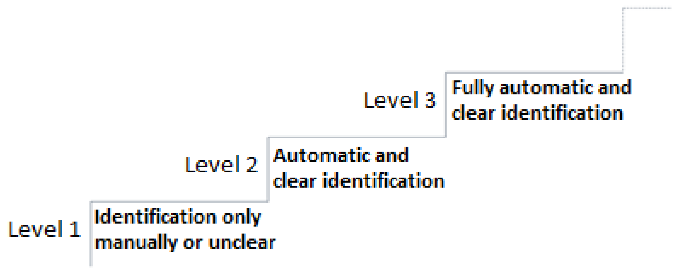
2 Valuation Process

Every process in the fields of logistics and/or automatic identification can be analyzed for how strongly it supports the main ideas of the Internet of Things. There are six main criteria a process can meet up to different extents: identification, localization, autonomy, local communication, global communication and energy supply. For each of these criteria a score from one to three can be given, one being the lowest, three the highest in meeting the criteria. Since it only makes sense to analyze a process that obviously follows the basic ideas of the Internet of Things, a score of zero, meaning a complete lack of a criterion becomes obsolete. The criteria itself are selected by the analysing the definition of the Internet of Things. The valuation was done by the project members of Fraunhofer IML together with the authors of this paper.

2.1 Valuation Criteria

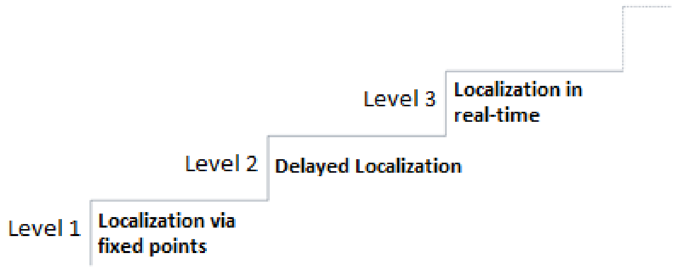
2.1.1 Identification

In the Internet of Things objects are able to exchange information and tasks. They communicate either directly or indirectly, for example via an IT-system. In both cases the clear identification, possibly by recognizing distinct identification numbers, is required of all logistic objects. This is the only way objects can be connected to information and tasks and data can travel from sender to receiver [3]. A clear identification does not render an object “intelligent”, but looked at from a functional view, it is a basic requirement for the Internet of Things, which is why it is mentioned as the first criteria here. Technologies used for identification nowadays or in the future are optical marking, such as OCR or barcodes and electronic marking, such as RFID.



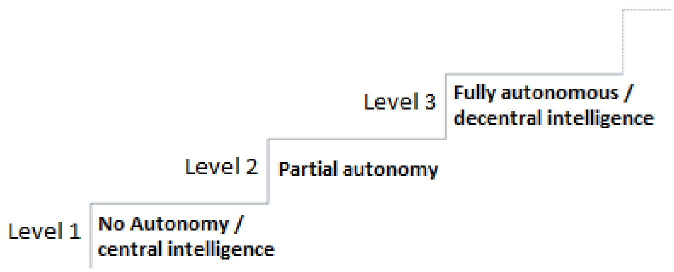
2.1.2 Localization

Smart objects flexibly adjust their behavior according to the environment that surrounds them. Especially when looking at movable objects, such as load carriers, the features of their environment depends on operating site and proximity to other objects. This is why localizing an object is an important criteria for applications in the Internet of Things [4]. The current position is saved as data [5] or constantly known by the object itself as well as other objects [6].



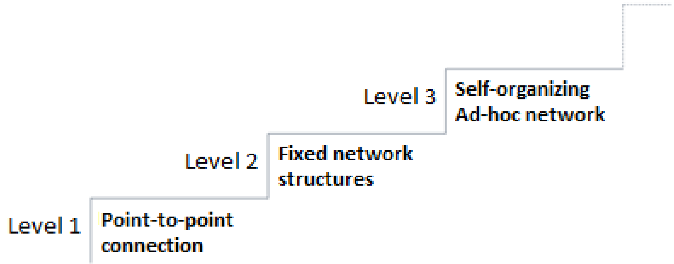
2.1.3 Autonomy/Location of Intelligence

The vision of the Internet of Things poses a change of paradigms for logistics, which carries us away from hierarchic means of control, leading to autonomously acting object structures that communicate with each other [7] and are target-oriented in their actions [8]. Due to this decentralized intelligence, smart objects can make decisions on their own, without the need of a higher planning instance. The transportation process can thus adjust itself in changing situations.



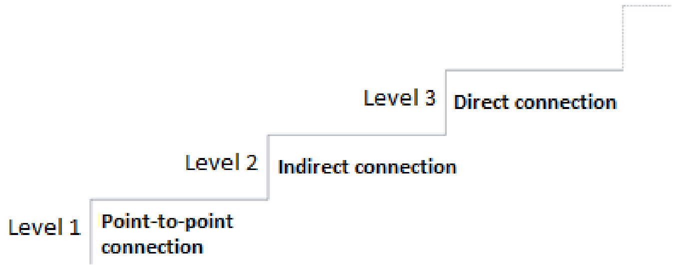
2.1.4 Local Network/Communication

Smart objects should be capable of connecting themselves to other objects of the same kind or even resources of different kinds within a local network in order to exchange data, enable intelligent coordination and make use of offered services [9]. This means for example settling for a loading sequence or demanding for transporters. Furthermore an object should be able to communicate with a human at all times [10], for example via Smartphone or a user interface [11]. Also the IT-system should know about the status of every single object at all times [10].



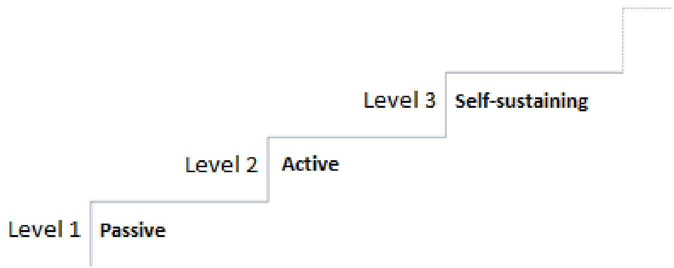
2.1.5 Connection to the Internet/Global Communication

One step further than local networking is the connection of an object to the internet, enabling global communication. This way physical objects should be accessible at all times, giving users the opportunity to supply it with data or services or access information, for example about its current location.



2.1.6 Energy Supply

In order for a smart object to be mobile and independent of nets, it has to be able to cover its energy requirements autonomously and cannot be dependent on a stationary power supply. Today there are still many passive RFID-technologies in use which do not need their own source of energy but whose communication range and functionality is strictly limited. Batteries and accumulators do provide a solution for this but are often unpractical due to their weight and seize and the fact that they will need to be exchanged at some point. Since development in battery technology is only moving slowly, future power supply will be found in the specific object's environment [12].



3 Research Projects of Fraunhofer IML in Context with Hybrid AIDC Processes

3.1 smaRTI (Smart Reusable Transport Items)

This project was launched on July 1st of 2010 as a major project in the EffizienzCluster and is still within its run-time of 42 months. Eight partners of different branches work together to revolutionize intelligent load carriers, granting authority for setting guidelines in the top cluster.

3.1.1 Motivation

Since load carriers represent the most important resource in logistics (the entire economic power of logistics is based on the use of pallets, boxes and containers) and they bring with them current assets of billions of Euros in Germany, combining them with radio frequency based technologies and the concept of the Internet of Things, as well as with modern material flow techniques will result in unprecedently flexible and service-oriented logistic systems.

By integrating additional information and intelligence on the object, a new philosophy of logistic organization occurs, that will have radically innovative effects on everyone who benefits from logistic services. The intelligent material flow, in which objects navigate themselves autonomously through a global logistic network by communicating and interacting with each other as well as with their surroundings, creates a new quality of logistic services and a variety of products, all of which are being accelerated by the smaRTI project.

3.1.2 Vision and Goals

To reach its goal, new developments of identification- and locationing-technologies are being combined with the logistics standard of radio frequency identification (Gen2) in order to enable worldwide usability. Thanks to this connection multi-functional services can be accessed by humans via e.g. mobile phone making them usable for the humans within the system. There are three main project goals that the partners strive for together:

Intelligent air cargo pallets, that are in use at 400 locations all over the planet and constantly provide information about their location, load and environment.

Intelligent transport boxes for the entire German letter mail network. For mail logistics these will not only be identifiable via radio frequency but also via common mobile phones within post offices, serving logistic tasks within mail centers.

Intelligent pallets with radio frequency- and IT-infrastructure which will organize material flow throughout the entire supply chain [13].

These three approaches will be valuated with the described criteria. This should show, that although the use cases are completely diverse, the criteria of the internet of things are matched.

3.1.3 Valuation

This is the result of applying our valuation process on the smaRTI project. The two applications Mail and FMCG (fast moving consumer goods) scored a degree of fulfillment of 60% regarding the current development status as you can see in table 1. Further steps of development would definitely reach even higher scores. In this case the results arose as follows: In both variants load carriers are equipped with RFID-technology, allowing fully automatic identification, giving the project the highest score possible on this criterion.

Localization can be done intra-corporately due to the use of a RTLS-System but for a higher score here, it would necessary to localize load carriers globally and in real-time. On the other criteria, both versions of the project only reached level one. Due to the different weighting of the criteria, an overall score of 60% is reached, meaning that the projects are well on their way to support the vision of the Internet of Things. They already fulfill the most important requirements in the fields of identification and localization, which form the basis for further developments. By combining hybrid Auto-ID technologies (identification and localization) a step towards the Internet of Things has been taken.

Table 1. Valuation of smaRTI

Weighted Scoring Model	Weighting	Levels	smaRTI (FMCG)	Score	smaRTI (Mail)	Score
Identification	6	3	3	18	3	18
Localization	5	3	2	10	2	10
Autonomy	4	3	1	4	1	4
Local Network	2	3	1	2	1	2
Global Network	3	3	1	3	1	3
Energy Supply	1	3	1	1	1	1
Sum				38		38
Degree of fulfillment				60%		60%

3.2 DyCoNet (Dynamic Container Network)

DyCoNet is one of thirteen research projects supported by the German Ministry for Economy and Technology (BMWi) within its framework programme “AUTONOMIK”. This is BMWi’s current focus in research-supporting regarding the beacon project “Internet of Things”. [14] The project is led by Lufthansa Cargo AG. Cooperating companies are Jettainer (ULD management), InnoTec (Hardware

Development), EnOcean (Energy Harvesting and Sensors), PalNet (ULD production) and Fraunhofer IML (Technology management) [15].

3.2.1 Motivation

The project's aim is to prepare air cargo logistics for future challenges in organization as well as in technological aspects of the market. Logistic processes are accelerating nowadays and enormous amounts of data and different data types have to be handled. Not only does identification of cargo become more and more important but also sensory information on the environment, such as temperature and vibration. This is why logistics have to undergo further development in this area.

Logistic data has to be available beyond company borders and material flow needs to work autonomously. Up to now, technologies such as RFID have been used for this but these are limited in functionality due to their dependence on the presence of middleware and readers. This is the reason for DyCoNet seeing the future of logistics in decentralized autonomous organization of logistic objects in order to grant the necessary flexibility and independence of static structures. To accomplish this, DyCoNet complements RFID with other technologies.

3.2.2 Vision and Goals

DyCoNet's final outcome is supposed to be an intelligent air cargo container. These containers will work without the presence of a company's infrastructure, using decentralized and self-sustaining power supply. In addition to this, the containers will be able to communicate and interact via a global network. Apart from an imbedded radio frequency node, the following technologies will form the technological basis for this project: RFID, GSM/UMTS, GPS and NFC.

Integrated software is supposed to transform the obtained data on the environment into the abstract context of business tasks, empowering the containers with the ability to actively execute meaningful operations, like making demands for resources, such as means of ground- or air transportation. In the course of autarkic power supply through Energy Harvesting, the intelligent air cargo containers will be equipped with miniaturized, regenerative energy sources. DyCoNet's vision consists of an autonomously self-organizing network of intelligent air cargo containers that coordinate, execute and supervise every process step by themselves independently through three basic tasks: sensing, thinking, and acting.

Sense: This function is used for situation recognition via GPS, GSM, sensors and networking, to obtain data, such as current position, designated destination, close resources, current status, and connect to other load carriers for exchange of information.

Think: This function is used for analysis, Valuation and decision making. This includes optimizing transport routes, choosing resources and connecting to the surroundings for joint negotiation over decisions.

Act: This function triggers actions, organizes through initiation of transporters and other network clients, causes documents to be issued and sends status reports to the overall system.

3.2.3 Valuation

Since the project is divided into five consecutive steps, the valuation will tackle each step independently. The results are shown in table 2.

Step 1: The container is equipped with GPS and GSM. In this step a battery takes care of power supply. The container can now locate itself on a global map, permitting tracking of the container. Identification is done by using a unique IP address for each container. This step already scores a 78% fulfillment degree, due to the clear identification, possible localization and connection to the internet.

Step 2: The container is equipped with GPS, GSM and a solar collector. This makes the use of batteries obsolete and empowers the container to self-sustainably supply itself with energy. Fulfillment degree is raised by three percentage points compared to that of the previous step. The relatively small raise in score, although the container is now energy-self-sufficient, is justified by the low weighting of energy autarchy. These first two steps were already reached and implemented by September 2011.

Step 3: The container is equipped with GPS, GSM, a solar collector and sensors, the latter of which enables the container to monitor its own status. The sensors gather data on temperature, vibrations and impacts. The door frame of the container is also equipped with an alarm sensor to determine if the container is open or closed. This step reaches an 87% score on fulfillment degree, since the container can now acknowledge its surroundings.

Step 4: The container is equipped with GPS, GSM, a solar collector, sensors and RFID. Having an RFID sensor installed on its door frame the container can now recognize whenever RFID-tagged goods are being loaded into or taken out of it. This gives the container the ability to identify its load and save this information centrally as well as de-centrally. There is also the possibility to let the container know in advance what it is supposed to be loaded with, which eradicates any cases of misloading. Although the container now automatically knows its load, this does not add to its autonomy but the use of RFID in this case works rather as an additional sensor, supplying the container with more information about its environment. This is why the fulfillment degree is the same as in Step 3 with a score of 87%.

Step 5: The container is equipped with GPS, GSM, a solar collector, sensors, RFID and a Men-Machine-Interface (MMI) and it is also integrated into a wireless radio frequency sensor network. The MMI, for example in form of a display, allows an employee to access information directly at the container. The display should show information such as the current load and current ownership. The wireless network connects intelligent air cargo containers with each other as well as with other resources and the internet, giving them the opportunity to execute transportation tasks on their own. In this state of development, the container fleet is able to work on low energy consumption and join themselves together to a local ad-hoc network, exchanging information and organizing themselves de-centrally and autonomously. This network is now able to coordinate a loading sequence, demand for repairs or transportation by a driverless transportation system, all by itself.

All information is saved de-centrally and is made available for the entire network thus creating cross-process transparency and unprecedented information quality. This last step depicts a complete implementation of the Internet of Things. All containers are intelligent for themselves, can be fully automatically identified and located in real-time. These features together with the network among the containers and the connection to the internet raise the last step of development up to a 100% score in fulfilling the requirements for the vision of the Internet of Things.

Table 2. Valuation of DyCoNet

Weighted Scoring Model	Weighting	Levels	DyCoNet Step 1	Score	DyCoNet Step 2	Score	DyCoNet Step 3	Score
Identification	6	3	3	18	3	18	3	18
Localization	5	3	3	15	3	15	3	15
Autonomy	4	3	1	4	1	4	2	8
Local Network	2	3	1	2	1	2	1	2
Global Network	3	3	3	9	3	9	3	9
Energy Supply	1	3	1	1	3	3	3	3
Sum				49		51		55
Degree of fulfillment				78%		81%		87%

Weighted Scoring Model	Weighting	Levels	DyCoNet Step 4	Score	DyCoNet Step 5	Score
Identification	6	3	3	18	3	18
Localization	5	3	3	15	3	15
Autonomy	4	3	2	8	3	12
Local Network	2	3	1	2	3	6
Global Network	3	3	3	9	3	9
Energy Supply	1	3	3	3	3	3
Sum				55		63
Degree of fulfillment				87%		100%

4 Conclusions

With regards to the two research projects, it becomes obvious that hybrid AIDC processes and technologies will play a vital role in the act of realizing the Internet of Things. Attaining the vision of the Internet of Things, in terms of the aggregated definition of ten Hompel, Mattern and Fleisch, requires the combination of functions. Both analyzed projects focus on hybrid technologies to fulfill process requirements among the whole supply chain. That is because one single technology never fits to a complete supply chain. In case of smaRTI the supply chain uses up to five different types of identification technologies. From a simple Barcode-Scan-Device up to ‘Mojix’ as an RFID based RTLS. Within the EffizienzCluster, one major goal is cooperation. In smaRTI, the cooperation is empowered in a technical way. The hybrid processes enable all partners to participate and benefit in an easy way.

The defined functions, the weighting and the collaboration between the single functions is the basis for our valuation process. The analysis of the two projects smaRTI and DyCoNet proves, that the Internet of Things is built up by process innovations which require a high variety of different technologies. By combining them, whole supply chains can be implemented after the Internet of Things principles. The described valuation is focused on projects that work on intelligent load carriers which are circulating in closed loops, which means that only a comparison between projects with a contiguous working field is valid. As part of the EffizienzCluster, smaRTI will provide it´s technical concept to other projects. The first one is Urban Retail logistics (URL) which has committed itself to use smaRTI´s principles in the use of returnable assets. In an ongoing process the Internet of Things projects like smaRTI and DyCoNet try to set standards in connecting logistic assets.

References

1. Internet der Dinge: smaRTI – smart reusable transport items, http://www.smart-rti.de (checked on: September 29, 2011)
2. Darkow, I.-L., Decker, J.: Logistik – Treiber und Nutzer neuer Entwicklungen und Trends. In: Engelhardt-Nowitzki, C., Lackner, E. (Hrsg.) Chargenverfolgung - Möglichkeiten, Grenzen und Anwendungsgebiete. Deutscher Universitäts-Verlag, Wiesbaden (2006)
3. Pflaum, A., Hupp, J.: Sensornetzwerke und Lokalisierungsverfahren als Schhlüsseltechnologie für die intelligente logistische Umwelt von morgen. In: Bullinger, H.-J., ten Hompel, M. (Hrsg.) Internet der Dinge, pp. S.107–S.118. Springer, Heidelberg (2008) ISBN 978-3-540-36729-1
4. Fleisch, E., Mattern, F.: Das Internet der Dinge. Springer, Heidelberg (2005) ISBN-10 3-540-24003-9
5. Pflaum, A., Hupp, J.: Sensornetzwerke und Lokalisierungsverfahren als Schhlüsseltechnologie für die intelligente logistische Umwelt von morgen. In: Bullinger, H.-J., ten Hompel, M. (Hrsg.) Internet der Dinge. pp. S.107–S.118 Springer, Heidelberg (2008) ISBN 978-3-540-36729-1,
6. Fleisch, E., Thiesse, F.: Internet der Dinge. In: Kurbel, K., Becker, J., Gronau, N., Sinz, E., Suhl, L. (Hrsg.) Enzyklopädie der Wirtschaftsinformatik – Online-Lexikon (checked on: September 29, 2011), http://www.enzyklopaedie-der-wirtschaftsinformatik.de/
7. Schenk, M., Richter, K.: Telematik und RFID – Elektronische Beobachter gestalten die gesicherte Warenkette. In: Bullinger, H.-J., ten Hompel, M. (eds.) Internet der Dinge, p. S.79. Springer, Heidelberg (2008) ISBN 978-3-540-36729-1
8. Pflaum, A., Hupp, J.: Sensornetzwerke und Lokalisierungsverfahren als Schhlüsseltechnologie für die intelligente logistische Umwelt von morgen. In: Bullinger, H.-J., ten Hompel, M. (Hrsg.) Internet der Dinge, pp. S.107–S.118. Springer, Heidelberg (2008) ISBN 978-3-540-36729-1
9. Fleisch, E., Thiesse, F.: Internet der Dinge. In: Kurbel, K., Becker, J., Gronau, N., Sinz, E., Suhl, L. (Hrsg.) Enzyklopädie der Wirtschaftsinformatik – Online-Lexikon (checked on: September 29, 2011), http://www.enzyklopaedie-der-wirtschaftsinformatik.de/
10. Pflaum, A., Hupp, J.: Sensornetzwerke und Lokalisierungsverfahren als Schhlüsseltechnologie für die intelligente logistische Umwelt von morgen. In: Bullinger, H.-J., ten Hompel, M. (Hrsg.) Internet der Dinge, pp. S.107–S.118. Springer, Heidelberg (2008) ISBN 978-3-540-36729-1
11. Fleisch, E., Thiesse, F.: Internet der Dinge. In: Kurbel, K., Becker, J., Gronau, N., Sinz, E., Suhl, L. (Hrsg.) Enzyklopädie der Wirtschaftsinformatik – Online-Lexikon (checked on: September 29, 2011), http://www.enzyklopaedie-der-wirtschaftsinformatik.de/

12. Mattern, F., Flörkemeier, C.: Vom Internet der Computer zum Internet der Dinge, p. S.8 (checked on: October 01, 2011), `http://www.vs.inf.ethz.ch/publ/papers/Internet-der-Dinge.pdf`
13. `http://www.smart-rti.de/p/projekt.html`
14. Bundesministerium für Wirtschaft und Technologie (Hrsg.): AUTONOMIK – Auf einen Blick (checked on: September 30, 2011), `http://www.autonomik.de/de/index.php`
15. Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V (Hrsg.): Forschungsprojekt DyCoNet (checked on: September 30, 2011), `http://www.dyconet.de/`

Efficiency in Logistics Facilities

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Abstract. Resulting from an increase of shipment quantities many logistics facilities (e.g., terminals, distribution centers, or production sites) reach their performance limit and thus become bottlenecks in supply chains. This is endangering defined cost and service goals and therefore the aim of the project "Efficiency in Logistics Facilities"[1] is to develop a suitable modular software tool for the control of large logistics facilities. The developed technologies will increase the amount of available information at logistics facilities including shipment data and properties (e.g., volume, form, and handling requirements) in relation to resources and their current status.

Keywords: Logistics facilities, efficiency, mathematical optimization, simulation, logistics management.

1 Problem Description

Logistics facilities are interpreted as transshipment terminals, distribution or production sites. The focus of research are all transportation and handling processes taking place on this site, at the loading ramp as well as the inside of transshipment halls and logistics buildings. Relevant objects (e.g., shipments or vehicles), processes (e.g., unloading, placing, loading, or picking), resources (e.g., unloading points, forklifts, personnel, or internal and external functional areas), and resource characteristics (e.g., volume, form, arrival plans, or technical criteria) are insufficiently modeled to increase overall efficiency in logistics facilities. Often necessary information is missing so that resources cannot be coordinated, planned, and steered optimally. For example, if the current status of a resource (e.g., filling degree, orders on forklift trucks, and allocation of unloading points) is not accurately described it leads to the fact that scientific methods like mathematical optimization, material-flow simulation, or effective key performance indicator systems cannot reach a sufficient penetration in logistics facilities.

[1] The presented results are parts of the work of the research project "Efficiency in logistics facilities" within the research project "EffienzCluster LogistikRuhr" funded by the German Federal Ministry for Science and Education (BMBF) which takes place in cooperation with the companies DB Mobility Logistics AG, ESG Elektroniksystem- und Logistik GmbH, Kühne + Nagel AG & Co. KG, Logwin Solutions Deutschland GmbH, AMETRAS nobab GmbH and Technische Universität Dortmund.

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To integrate such decision mechanisms the project partners develop a prototypical software application named *"EcoSiteManager – ESM"*. In order to strengthen the competitiveness the efficiency of logistics facilities (i.e., quantity, speed, and quality by the same amount of resources) has to be increased as well as to adapt the facility layout. All these objectives lead to the goals of the *"EffizienzCluster LogistikRuhr"* for more ecologically organized logistics as well as robust and safe urban supply. An efficient operation of existing logistics facilities is also essential for the development of metropolitan regions such as the Rhine-Ruhr.

2 Solution Approach

The application ESM will improve information gaps and support experts to plan and control logistics facilities due to the usage of integrated scientifically and methodically intelligent decision mechanisms. To realise this, methods are developed which enable the parallel optimisation of interlocked logistical areas in real time as well as to integrate human intelligence into the solution process. Technical innovations exist in form of user interfaces which enables direct analysis of failure modes as well as effects of intervention of human experts in the solution process. All this will be realized with solution approaches developed in the following five sub-projects.

2.1 A User-Guided Planning Tool for the Management of Resources on Large Factory Sites

In order to model automatic decision mechanisms, continuous and consistent information is necessary. Therefore, a superordinate control monitor is build which measures and evaluates the efficiency and effectiveness of taken actions. The corresponding data is essentially important for evaluation and control mechanisms, which ensure that each moved commodity has suitable resources available.

Therefore, each project partner takes into account for its own area of operations and develops in close interchange with the Institute of Transport Logistics independent solutions which reflect the different aspects of a logistics facility in the ESM, implemented by the ESG Elektroniksystem- und Logistik GmbH. For example, improving processes in inbound control or intelligent area allocation in facilities one subproject deals with two central questions: How can areas and resources be utilized optimally? Is it possible to combine two owned transportation networks to cut down costs and used resources?

In order to solve such questions, the material flow in the logistics facilities will be simulated for different scenarios to achieve a detailed overview of incoming and outgoing flows of goods inside the facility. The application of these methods enables the software tools to deliver information how operational sequences in a logistics facility can be designed more intelligent and operations can be controlled more efficiently. To cover a wide range of challenges of several kinds of logistic nodes the "EcoSiteManager" will be assembled of three individual modules named, "unitCV", "HugO", and "X-Ray". For all practical purposes the ESM assigns the right shipment to the right resource at the right time, referring to stored data of the unitCV. The unitCV obtains information of the objects and the current state of resources. Thus, resources can act more efficiently supported by human guided optimization methods and controlled by the X-Ray module. This modular concept improves knowledge based in logistics facilities, supports the dispatcher with decision support tools which will be displayed at three control levels (Miodrag, Z, 2011).

2.2 A User-Guided Planning Tool to Bundle Rail Products Using Decentralized Delivery Points

Wagonload traffic is a mode of railway freight traffic. Infrastructural information about the considered railway network and a set of origin-destination-requests (OD-requests) for all relations are given. Most of these OD-requests consist of a small number of wagons, which do not justify direct transport. It is necessary to bundle relations to blocks in order to run the system economically. Therefore, the problem is often referred to as the Blocking Problem in literature. There are reclassification and shunting yards all over the network, where it is possible to separate blocks arriving on trains and compose wagons to new blocks. The aim is the optimization of wagon-flows by minimization of the system-wide costs for a tactical time horizon.

Transportation problems such as the considered wagon flow bundling problem can be modeled as a so called Integer Linear Programs (ILP). The model has two sets of decisions variables. The first one contains variables controlling the route of each relation, the other one reflects the number of blocks on each network arc which is implicitly determined by the routing variables. Since the system-wide costs are minimized, our objective function is the sum of train costs and classification costs for each wagon depending on the number of times it is reclassified. The following constraints have to be incorporated due to technical and legal reasons, respectively: First of all, each request must be fulfilled. Due to infrastructural limitations, trains in Germany may not be longer than a given limit. The weight of each train is limited, too. This implies restrictions on the length and weight of each block, of course. The reclassification yards have capacity limits, too, given as the maximal number of trains, which can be classified per time interval. Due to travel time restrictions, there is a limit on the number of reclassifications for each wagon. At last, all wagons of a relation shall take a common route through the network. Although this is a severe complexification from the mathematical point of view, this constraint is added to the model.

The model takes into account the most important aspects specified by our project partners at DB Mobility Logistics. Unfortunately, real problem instances are too complex to be solved to optimality by modern commercial solvers (Voll, R., 2011). Hence, it is necessary to develop new solution algorithms exploiting structural knowledge about the problem. A special mathematical technique called ‘Column Generation’ (Desrosiers, J., 2005) is used to decompose the whole problem into smaller sub-problems for each relation. It is possible to identify a small number of “good” paths for each relation, which can be combined to a solution which is feasible for the whole system. The specialized algorithms are just being implemented and tested.

The wagon-flow routing problem looks at a logistical network from a very global point of view. Nevertheless, there is a two-way cooperation with the control systems of the logistics facilities constituting the network nodes. Due to the tactical planning horizon of the problem, it depends on statistical data about volume and number of wagons that have to be transported in the next planning periods. This information must be estimated node-by-node and is therefore a task of planning software for a logistics facility. The algorithms developed in this sub-project give recommendations how each wagon in the railway network should be routed and where certain blocks are separated. This knowledge can be used by the ESM to compute optimal loading schemes for the trains built up in the facility. Hence, it is possible to send out trains into the system which are already presorted in order to support efficient usage of railway network resources.

2.3 Intelligent Control in Area Utilization and Supply Networks

The transport network with the corresponding terminals studied in this project is part of the Logwin Solutions Deutschland GmbH. The two most important divisions are traditionally "media" and "fashion". The media network specializes in transport and distribution of printed material while the fashion network conducts transport services for the clothing industry. Thus, these both networks differ concerning their standards. Daily deliveries in exactly predetermined time slots require short response times of the media network. The fashion network has to be flexible to handle especially seasonal fluctuations. This sub-project plans to bring together the media and the fashion network of Logwin Solutions. The intention is to improve the networks' efficiency by reaching higher capacity utilization especially in the logistic nodes.

A transshipment terminal for fashion, which is a node for national and international transports within the transportation network of the logistics service provider (less-than-truckload), is operated as follows. In the afternoon, locally collected transport batches and imports get unloaded and sorted for the following long-distance transport to the other depots within the network. In the night, the long-distance transports from those depots arrive at the considered terminal and get sorted for local deliveries. Different resources are involved in the transshipment processes which have to be employed and controlled. Depending on whether the pieces of clothing are transported hanging or lying, the handling effort and the technology necessary differ. Lying goods can be transported in boxes on pallets. Hanging goods in contrast need special transport equipment. Due to the cost-intensity the trend goes away from hanging goods to transporting clothing lying. Thus more piece goods have to be handled and transport equipment cannot be utilized properly.

The challenge arises to combine the existing transport networks strategically and operationally, in order to optimize the incoming transport planning. After analysis of the existing transport networks, specificities and synergies in transportation are developed in discussions with local experts. On the basis of node and transport data, collected for reference periods, adapted algorithms for a combined network and route planning are implemented and evaluated with jointly developed key indicators. For this purpose, various scenarios with different node functions, capacities, and positions are created. The resulting traffic on each node serves as the system load for the simulation of the terminals.

The components of a transshipment terminal interact in complex dependencies over time. Therefore, the method of discrete event simulation is suited to analyze the processes within such a terminal. The simulation tool TransSim Node, which especially meets the requirements of strategic and operational tasks in logistics terminals, has been developed by the Institute of Transport Logistics in cooperation with

Incontrol Enterprise Dynamics. The tool permits a detailed reproduction of internal and external material and information flows in logistic nodes of road haulage. Thereby TransSim Node helps to optimize strategies and operations in forwarding agencies to increase their performance.

The first step to analyze a terminal is mapping the as-is situation of the real system, focusing the processes, resources and layouts. In a second step alternative scenarios regarding, for example, different strategies for resource control, can be modeled and compared. The processes are split into information flow, flow of material, and flow of resources in the yard. Operations start with the arrival of a driver at the yard and cover all actions and different process steps up to the outgoing of consignments off the terminal. Another important input for the simulation is the layout of the terminal which directly influences the operating costs due to a low level of automated handling. To support fast modeling an additional toolbox has been developed (Clausen, U. et al. 2011). With the help of established software tools it enables the transfer of all essential layout information into the simulation software. Thus, all requirements are given to set up different scenarios. As a next step those scenarios have to be defined in detail, the results have to be analyzed, and deductions for the real system have to be made.

2.4 Optimal Resource Control in Multi-user Distribution Centers

Contract logistics describes the offering of several logistics functions (e.g., transport, handling or warehousing) that are bundled in a service package with high complexity. By delegating different jobs to Third Party Logistics Providers (3PL), the customer can shift the risk of investment for logistics facilities, the facility's infrastructure, and human resources to the 3PL. He can thereby reduce his investments and transform overhead costs to variable costs. (Deepen, J., 2007; Selviaridis, K., 2008).

In contract logistics it is necessary to distinguish between single- and multi-user Third Party Logistics Providers (3PL). While the former concentrate on tasks for a single client per location, the latter use the same facility to fulfill several contracts. That means that a 3PL is operating in one facility, handling different products of several clients. This way, the 3PL can realize synergies at a maximum rate by using shared resources like racks, conveyor techniques, and human resources. This subproject concentrates on service providers who operate multi-user distribution centers. In particular, the focus lies on activities on operational staff scheduling via mathematical optimization and the development of a planning tool to identify best fitting new customers and products. The main goals and challenges of the two planning problems will be illustrated in the following.

An efficient operational staff schedule in multi-user distribution centers ensures that all customer orders can be processed flawlessly and on time with minimal idle times of the working staff members. The biggest challenges for this arise from the very client-specific requirements and a high percentage of uncertain orders. Each order by a client requires specific qualifications on the staff member which has to process this order. In addition, we have to distinguish between own employees which are highly qualified and have particular knowledge for certain clients and subcontract workers which usually are less qualified but more flexible in terms of time schedules. Besides these two groups of staff and the associated working time rules that have to be respected, a multi-user 3PL has to rise to the challenge that – depending on each individual client – only a small percentage of all final orders are known long before the delivery date. Many orders are actually submitted with a temporary status and can change up to several hours before departure. Against this background, the aim is to develop mathematical optimization models and algorithms that consider all relevant requirements that concern the described staff scheduling problem itself and the above mentioned stochastically aspects due to the incomplete and changing knowledge of orders. Therefore, in cooperation with the Kühne + Nagel AG & Co. KG, mathematical scheduling approaches are improved and implemented (e.g., set partitioning, column generation, lagrangian relaxation, and problem specific heuristics) as well as stochastic analysis and forecasting methods. (Caprara, A. et al., 1999; Huisman, D. et al., 2003; Fisher, M., 2004).

The second focus of research in this subproject looks at the acquisition of new products/customers in multi-user distribution centers. The contract period in the field of contract logistics amounts from at least one year up to five years – with tendency to decrease. (Waibel, C., 2007; Wrobel, H., 2009) Since a multi-user 3PL is not as specialized in a customer as a single-user 3PL, and hence the risk of investment is lower in multi-user logistics, the contract periods in multi-user logistics are normally shorter than in single-user logistics. Thus, especially multi-user 3PLs need to look for new contracts regularly and therefore at high efficiency. To support this process, the objective is to develop a decision-model that helps salespersons to decide, which product would be good to integrate and with what kind of product the highest synergies could be realized, regarding the existing infrastructure and the current contracts. By a successive check of criteria, the model tells the 3PL, in which branch he should put more effort in to get new clients or which tender he should examine in detail.

Once a product is selected and a prospective client shows interest into shifting logistics functions to the 3PL, the capacity needs to be checked. At this stage of the model concrete numerical data (e.g., number of storing positions and required handling area) is needed to see if the selected product can technically be handled with the existing resources. Using the decision-model preserves the 3PL's resources: salespersons can easily check main criteria and concentrate on the main acquisition. Furthermore the decision-model helps finding a product that suits well to the infrastructure and the current contracts, regarding the existing resources and possible synergy effects.

2.5 Efficiency of Sorting in Light of Mission Properties

Logistics service providers, working in the parcel delivery industry, face the challenge of large amounts of shipments that have to be sorted within a very short interval of time due to transportation and service restrictions. To ensure the most efficient handling process, the providers define maximum limits of length, weight, and girth size in order to use high-speed automated sorting systems. In spite of this measure the spectrum of shipments is still very heterogeneous, including many shipments that cannot be sorted automatically as a consequence of technical restrictions. Therefore, an additional manual sorting systems is required, in which these shipments are transported from the receiving to the shipping docks.

With the help of an automatic shipment properties acquisition system, installed on the induction lines of the unloading section, this sub-project pursues the objective to increase the sorting system efficiency. For this purpose, a prototype acquisition system to recognize the shipment properties is implemented at pilot sites in real operation by the research partner AmetrasNobab GmbH. Based on the shipment properties the system automatically sorts the transported unit to the automatic or the manual sorting system. Moreover, the recorded data are stored and made available to the EcoSite manager as a life cycle (UnitCV). In addition, the recorded shipment properties are used as shipment parameters for the simulation suite.

In order to increase efficiency, as a first step it is necessary to identify shipment properties in actual operation. Based on this analysis the project partners AMETRAS nobab GmbH and Technische Universität Dortmund grouped shipment properties and clustered them into various shipment types according to their manifestations. To evaluate the resource consumption of each shipment type, the HandlingShipmentStorageIndicator (HSSI) is introduced. This indicator assigns a specific process time to each manual handling process depending on the shipment type. Based on the evaluation of the manual working stations and the shipment properties, the development of a HSSI simulation suite for the sorting systems is done as a next and main step of the research project. By using the discrete-event simulation software Enterprise Dynamics all resources of sorting systems are modeled in a very high level of detail and drawn to scale according to the layout. Parameters for technical components (e.g., speed of conveyor, buffer sizes) are adjusted as well as sending type specific process times for the manual working stations. The integrated modeling of automatic and manual sorting system enables the user of the simulation suite to determinate accurately the required resources and to identify bottlenecks within the system.

In addition, a shipment generator is developed which allows the user to analyze the sorting system behavior of future demands. Beside the change of shipment quantities, the simulation suite especially allows the user to investigate changes within the properties. The impact of a higher amount of lighter parcels can be investigated as well as an increasing amount of parcel for a particular outgoing trailer. The detailed modeling of the sorting system enables the provider to gain knowledge about the real cost in preparation of price negotiations with the customer. Beside the usage of increased efficiency in existing sorting systems the HSSI simulation suite can be used very well in the planning process of new systems. For this purpose, an automation concept is developed to rapidly create new layouts, since the microscopic modeling is very time consuming. The reduction of the modeling time, provided by the layout creator, allows the user to evaluate and compare of various solution scenarios and supports a visual understanding.

3 Conclusion and Outlook

The developed software can be used in many logistics facilities or production sites. It embeds methods of mathematical optimization, simulation, and forecasting and combines them in a so far nonexistent approach to solve logistic planning tasks. The EcoSiteManager increases the amount of available information and usable data at logistics facilities as well as leads to a better resource utilization. The project results are integrated in an application-GUI with intuitive handling and assistance systems for the operators of a logistics facility.

References

1. Caprara, A., et al.: A Heuristic Method for the Set Covering Problem. Operations Research 47(5), 730–743 (1999)
2. Clausen, U., et al.: Layout Planning of Less Than Truckload Terminals. In: Balsamo, S., Marin, A. (Hrsg.) Proceedings of the 9th Industrial Simulation Conference, pp. S.204–S.208 (2011)
3. Deepen, J.: Logistics Outsourcing Relationships - Measurements, Antecedents, and Effects of Logistics Outsourcing Performance. Physica, Heidelberg (2007)
4. Desrosiers, J., Luebbecke, M.: A Primer in Column Generation. GERAD, New York (2005)
5. Selviaridis, K., et al.: Benefits, Risks, Selection Criteria and Success Factors for Third-Party Logistics Services. Maritime Economics & Logistics 10, 380–392 (2008)
6. Fisher, M.: The Lagrangean Relaxation Method for Solving Integer Programming Problems. Management Science 50(12), 1861–1871 (2004)
7. Huisman, D., et al.: Combining Column Generation and Lagrangian Relaxation. Research in Management, ERIM Research Series, Erasmus University Rotterdam (2003)
8. Miodrag, Z.: Efficiency in Logistics Facilities. In: Proceedings of the The 3rd International Conference on Logistics and Transport & The 4th International Conference on Operations and Supply Chain Management, Malé (2011)
9. Voll, R., Clausen, U.: A Blocking Model with Bundling Effects Respecting Multiple OD-Matrices. In: Proceedings of the 4th International Conference on Experiments/Process/System Modeling/Simulation/Optimization, Athens (2011)
10. Waibel, C., et al.: "Ramp up" in der Kontraktlogistik. Fraunhofer Verlag, Stuttgart (2007)
11. Wrobel, H., et al.: Projektanbahnung in der Konktraktlogistik. Fraunhofer Verlag, Stuttgart (2009)

Integrated Air Cargo Hub (IACH) – The Air Cargo Transport Chain of the Future

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Abstract. Nowadays the role of international airports as major nodes within the transport chain between production sites and international marketplaces becomes increasingly important. The air cargo transport chain is characterized by a labor divided but collaborative organization, driven by cargo peaks over time [1] [2]. However, the companies involved, are still planning and optimizing their individual processes independently [3]. The lack of coordination and communication among each other, the individuality of their processes and missing information are some of the reasons why the constantly growing air cargo logistics locations are becoming increasingly complex and inefficient. Within the past 20 years the average duration of air cargo has not changed significantly. Within the joint research project „Integrated Air Cargo Hub" (IACH), new methods and common procedures are being developed in order to consolidate the interfaces between all participants of the air cargo transport chain and their actions respectively processes. The project´s goal is to improve the efficiency of the air cargo transport chain overall. The focal point is set upon the information flow between the participants and their handling-processes in particular. The field of research is been chosen and defined by Frankfurt Main airport, as the largest air cargo hub in Europe. The present report shows the selected approach and the first results of this governmental funded project[1].

Keywords: air cargo, networks, nodes, transportation, process, supply chain, air freight.

1 Introduction

Based on the division of labor air cargo transport is unique and quite complex. Once a transport order is placed by a consignor, pre- and post-carriage systems are being handled by numerous participants [4] and it takes several relocations and numerous handling processes until the export goods reach the cargo compartment of an aircraft. Air cargo forwarder like Schenker, Panalpina or Kuehne+Nagel have specialized sub-contractors for the last mile handling, up to the apron area. The airlines have concentrated their activities on their core competencies and leave the logistics

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preparations of the ready-for-takeoff goods to the ground handling service providers with their own airport terminals and services.

At large international airports the various land- and air-based transport networks for passengers and air cargo are logistically connected. They combine the production sites and consumer markets in densely populated areas around the world and play a crucial role in the transport chain for high-quality and urgent goods. From its origin, air cargo is aggregated at hub sites around the world and delivered to its destination, usually through yet another hub – see figure 1.

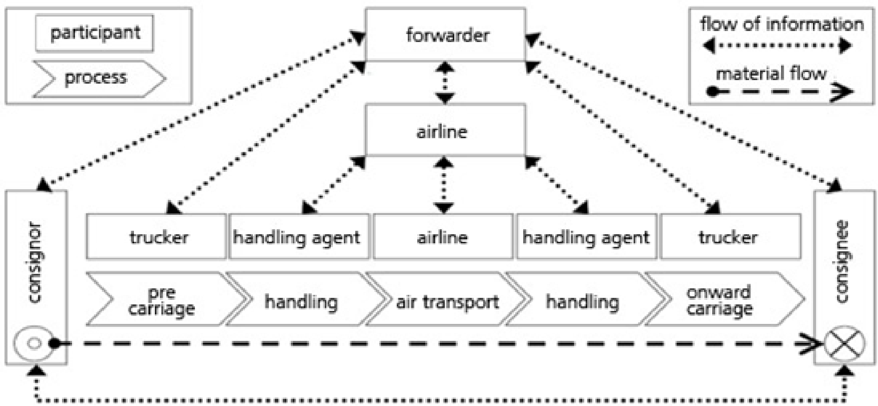

Fig. 1. General set-up of the air cargo transport chain

The air cargo volume in Germany is concentrated on few airlines, shipper [5][6] and airports [7][8]. A similar trend can also be observed on an international level [8]. The 20 biggest shippers and airlines have each a market share of about 66% [9][6]. In 2008 about 50% of the worldwide air cargo volume was handled by the 21 leading airports. The trend of hub-centralization will continue to increase in future [7]. Due to this centralization at established international hubs, the cargo handling leads to an even bigger growth at those, than they would have to face by their natural market growth alone. Current predictions show that the cargo volume will exceed the available capacities of these hubs. [10] The capacities of the airports in the USA and Europe are already reaching their limits. There are only restricted possibilities for new constructions or extensions, because of the high space-, costs- and time-requirements. [11] In order to prevent hubs from becoming bottlenecks, which could reduce or even stop economic growth, the need for optimization of resources arises [12]. To solve this problem, a high grade of innovation from all participants is required. Within this context improvement in efficiency is only realizable if the management of air cargo handling is being optimized [13]. One of the worldwide most important and largest air cargo-hubs is Frankfurt Main airport (2008: 2.1 Mio. t). As a result of the hub-concentration at Frankfurt Main airport, the available capacity is reaching its limits. With references to the surveys of the"Speditions- und Logistikverbands Hessen/ Rheinland-Pfalz e.V. ", the cargo handling-processes and -time represent one of the biggest problems [14]. This is often referable to the lack of coordination and communication between the participants. At this point continuous process optimization and infrastructural improvements are required from the individual participants for future planning activities [15]. At large international air cargo hubs, an enormous number of transport chain-participants are located. There is still a high number of participants, which are planning and performing their processes independently. Thus, due to the lack of information and communication, many processes become inefficient and lead to reduced performance with a higher need of resources. As a result, many hub locations lost their competitiveness with a negative impact to the local economy.

2 Integrated Air Cargo Hub (IACH)

As shown, air cargo requires an optimized transport management for coping with the permanent growing cargo volume. The research project IACH – "Intergraded Air Cargo Hub" belongs to one out of seven major themes of EffizienzClusters LogistikRuhr, the biggest research project in the field of logistics in Europe.

Within the scope of the joint research project IACH, new strategies for the improvement of the efficiency and requirements for a new process set-up at the interfaces between the participants are being elaborated. A comprehensive IT-platform for supporting those processes is foreseen. Different applications will help to coordinate operative processes, interfaces, and information flows between the participants. These are focused on: interfaces with truck-inbound control system, centralized truck-waiting positions, a communications- and control system, and the on-site CargoCity Logistics (CCL). The IT-integration by different applications ensures the efficient sharing of an air-sided centralized cargo-handling facility at the apron and security restricted area of the airport. The efficiency of the air cargo transport chain will increase by integrating processes of different participants, e.g. the ground handling process at a hub airport. The focus is laid upon interface processes between participants as well as on the available information regarding the shipment. Also, a consistent information flow between all partners is necessary, which will be supported by a neutral IT-Platform, as well as by collaboration and cost benefit sharing strategies. Control and information tools allow a vertical and horizontal processual conjunction between the participants for the first time.

3 Approach

The IACH schedule envisages project completion by pursuing the following working steps until May 2013:

- Analyzing processes along the air cargo transport chain, regarding value contribution and optimization potential
- Defining optimized target/to-be processes (e.g. increased utilization, reduced queues, avoiding of idle processes, …)
- Cargo community loop-/feedback regarding target processes
- Requirements towards resources / infrastructure
- Analyzing and determining Information / data (requirement specification for information provider)
- Review of existing services and of additional data needed
- Development, implementation and evaluation of pilot applications.

To achieve these defined working steps, the following five project partners have grouped up: aviainform GmbH, Fraport AG ground handling services (BVD), Fraunhofer for Materialflow and Logistics (IML) -Project Center Aviation Logistics-, Schenker Deutschland AG, and Siemens Mobility. As a market analyst with a focus on air cargo, aviainform GmbH prepares and edits the data necessary for describing and prognosticating volume, load, and structural composition of air cargo. Fraport AG renders possible an in-depth view into all functions and processes of its ground transportation services and into all interfaces between landside pre-and post-cargo transportation, as well as into all loading or unloading processes of the aircraft, including the necessary aviation security checks. In addition the Fraunhofer IML is using its profound knowhow within the field of research and development to structure, manage, and coordinate the research project, while providing at the same time its deep knowledge about the air cargo industry and its processes. Schenker Deutschland AG, one of the largest forwarders in the global logistics network provides its internal knowledge about landside processes. Besides making accessible its broad knowledge about cargo handling processes from a technical point of view. Siemens will provide the necessary resources to set-up and develop the envisaged pilot applications.

The field of research is defined by Frankfurt Main Airport. As the largest air cargo hub in Europe, it offers ideal conditions for identifying optimization solutions. The main parameters for such solutions are represented by the availability of space, the decentralized structures and systems of the participants and the mutually usable resources. In addition to these, the increasing safety requirements of the transport chain are taken into account as well. As an integrated solution IACH will enhance the productivity of the overall system and its competitiveness by considering all material and information flows and requirements. The latter could be achieved by integrating and defining the requirements for a neutral IT-platform. To achieve the defined working steps, the following scientific measures are being pursuit and observed:

- Comprehensive and consistent modeling of the air cargo transport chain in relation to all individual process partners
- Localization and quantification of optimization potentials
- Development of rules and algorithms for the implementation of decisions/ actions and the resulting allocation of benefits
- Testing and approval of applications for individually acting process partners, considering the optimization potential through cooperation.
- Evaluating and comparing the efficiency
- Knowledge exchange between entrepreneurial (OEM) led and market-driven process chain logistic provider.

4 Results

The envisaged results of identifying and analyzing optimization potentials along the air cargo transport chain, as illustrated above, will be achieved during the remaining project time until Mai 2013. Up to now, the operational data of Schenker Deutschland AG has been neutrally aggregated and analyzed and finally summarized in an anonymous data base differentiated by different parameter like volume and structure. It is ready to use for the upcoming analyzing steps and simulations. Furthermore the process chain from handing over the cargo shipment to the freight forwarder by the consignor, handling and transporting it to the aircraft and back again from the aircraft to the consignee on the other side has been gathered, by interviewing the individual operative personnel of each partner. It has been put together and completely described; covering all physical transport and handling processes differentiated by the material flow and the steering information flow. Figure 2 is showing a sample section of the process chain. Gaps within the information flow and the lack of system interfaces actually lead to a decreased efficiency of the overall system. Paper-based information exchange is still state of the art in the air cargo branch. To picture those obvious gaps, the usage of physical (paper) documents has been marked, see fig. 2.

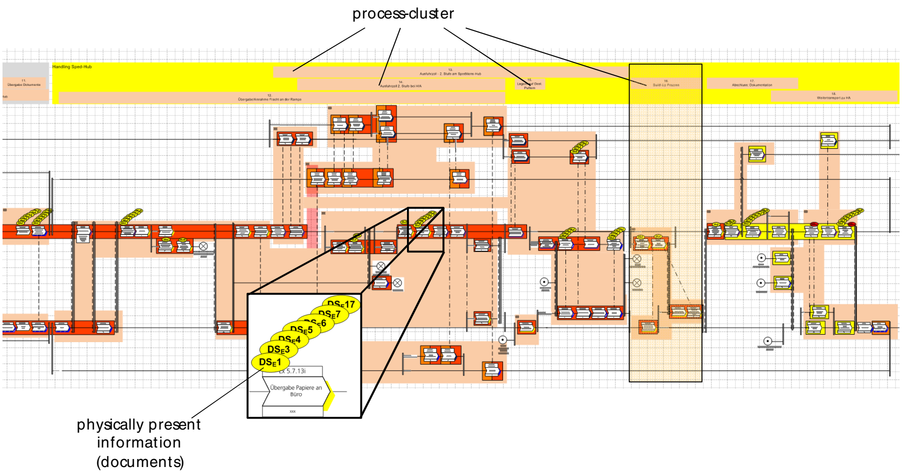

Fig. 2. Sample section of the export processes chain

Within the process chain, processes belonging content wise to the same group like steering or handling processes have been aggregated to process cluster, see fig. 2. These cluster are processing or needing certain information respectively data. According to these cluster, a table has been set-up and filled as follows. In each row another individual process cluster and its needed information are listed. The processes belonging to each cluster are listed within the same row but in different columns, see fig. 3.

With both instruments, the complete process chain and the data table, the analysis of the complete transport chain, including the information used, has been performed. By doing so, information gaps have easily been identified and process changes leading presumably to a higher efficiency are now being evaluated regarding their feasibility.

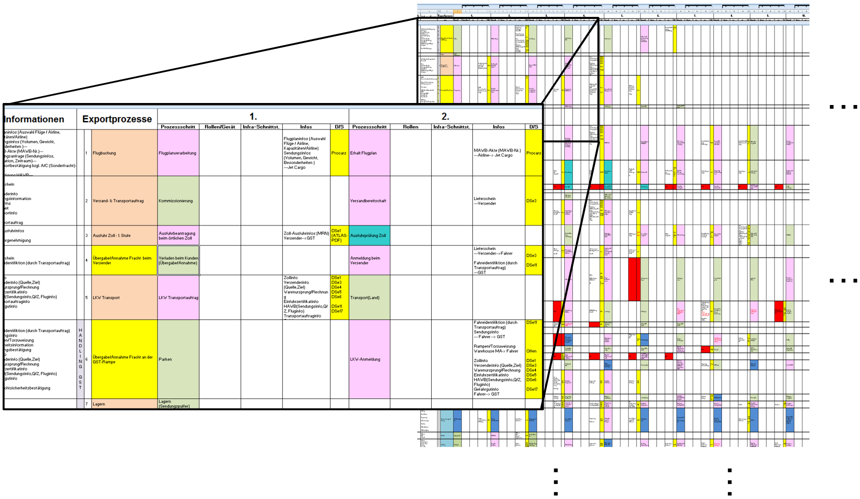

Fig. 3. Data and information sheet

5 Conclusion and Implications

The described results present a solid basis for pursuing the next project goals. Using above illustrated procedures, potentials for increasing the efficiency within the air cargo transport chain have already been identified. Within the next steps those identified potentials are going to be analyzed regarding their impact and added value in more detail. Based upon this evaluation those potentials, with the highest foreseen impact, are being selected for the development of said pilot applications.

At the current stage different applications are foreseen like centralized instead of decentralized resources, e.g. centralized truck-waiting positions or apron dolly storage areas. Those central resources, available for all participants, can be better utilized and size wise minimized, supported by a targeted use of information. For example with means of a more efficient usage of information and utilization of resources, the productivity per square footage will increase. Such measures allow increasing the specific area productivity of handling- and buffer areas as well as handling and transshipment equipment up to 30 %, other identified potentials could lead to a comparable reduction in resource depletion and handling space needed.

The defined goal of being able to cope with the future cargo volume more efficiently, calls for a high grade of innovation from all parties and cannot be found within traditional solutions, like simple capacity expansions. The result of IACH will be a consistent organizational optimization of air cargo handling, ensuring efficiency and rendering possible “the air cargo transport chain of the future”.

References

1. Lau, H.Y.K., Zhao, Y.: Joint scheduling of material handling equipment in automated air cargo terminals. Computers in Industry 57(5), 398–411 (2006)
2. Yan, S., Chen, C.-H., Chen, C.-K.: Long-term manpower supply planning for air cargo terminals. Journal of Air Transport Management 12(4), 175–181 (2006)

3. Clausen, U., Sieke, H.: Modellierung einer standortübergreifenden Frachtflusssteuerung in Luftfrachttransportnetzen. Fabrikorganisation. Wege zur innovativen Fabrikorganisation, Band 4, Clausen and ten Hompel, Praxiswissen, pp. 137–159 (2010)
4. Huang, K., Chi, W.: A Lagrangian relaxation based heuristic for the consolidation problem of airfreight forwarders. Transportation Research Part C: Emerging Technologies 15(4), 235–245 (2007)
5. Steiger, D.: Keine Chance für typische Mittelständler. Logistik inside - Spezial Sonderheft, pp. 10–11 (September 2006)
6. DVZ: Große werden größer. Deutsche Verkehrszeitung 6, 2 (January 13, 2007)
7. Frye, H.: Trends und Entwicklung. Logistik inside - Spezial, pp. 7–9 (September 2006)
8. Erdmann, C., Rappold, C., et al.: Branchenstudie. Internationale Luftfracht, HSH-Nordbank (2006)
9. Steiger, D.: Warum Größe eine entscheidende Rolle spielt. Deutsche Verkehrszeitung 68, 8–9 (2008)
10. Winkelmann, M.: Wer baut den Global Airport 2020? Logistics, 32–36 (February 2008)
11. Busacker, T.: Steigerung der Flughafen-Kapazität durch Modellierung und Optimierung von Flughafen-Boden-Rollverkehr - Ein Beitrag zu einem künftigen Rollführungssystem (A-SMGCS). Fakultät Verkehrs- und Maschinensysteme - Institut für Luft- und Raumfahrt. Berlin, Technische Universität Berlin (2005)
12. Frye, H.: Neue Ideen beim Umschlag gefragt. Deutsche Verkehrszeitung (155/156), 11 (2007)
13. Grandjot, H.-H.: Leitfaden Luftfracht, 2nd revised edn., p. 207. Huss-Verlag GmbH, München (2002)
14. Maruhn, E.: Spediteure bangen um Aircargo-Standort Frankfurt. Deutsche Verkehrszeitung 32, 1 (2010)
15. Korte, W.: Zukunftsweisende Planungen. Deutsche Verkehrszeitung 35, 8 (2010)

Multimodal Promotion – Finding and Benchmarking Resource-Efficient Transport Alternatives with Combined Transport

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Abstract. Multimodal Promotion provides companies with direct D2D routing that takes combined transport (road, rail, water) schedules and the creation of sensible new connections into account. After entering the transport quantity data, a company receives direct recommendations regarding which of its shipments can be transported sensibly using combined transport. A Web-2.0 user interface is used to enter the data. Once the transport data has been analysed, each company receives a tailored, automated evaluation of its potential savings and cooperation potentials.

Keywords: transport chain, trimodal, barge, train, road, multimodal transport, door-to-door, routing, route creation, web 2.0.

1 Introduction

Road transport volumes will increase in the coming years, while transport infrastructure capacities are already confronting their limits under the current level of utilisation and new construction or the expansion of existing facilities are difficult. Shifting from road transport to available rail and, above all, waterway transport capacities represents a possibility for handling the increase in transport traffic with today's existing infrastructure. With a lack of expansion possibilities for the existing infrastructure, spreading the overall transport volume more effectively among all the available modes of transport is the only way to avoid a transport gridlock. Companies, particularly small and medium-sized companies, often lack the information to take advantage of the available capacities and effectively shift their means of transport.

One possibility for achieving this in the future is the Multimodal Promotion platform [1] under development by the German registered association known as EffizienzCluster LogistikRuhr [2]. This consortium is comprised of the Port of Duisburg, the Port of Dortmund, VCE GmbH and Fraunhofer IML. Its objective is to provide small and medium-sized companies as well as forwarding agencies in particular with the possibility to quickly acquire an overview of affordable, environmentally-friendly tri-modal transport alternatives and to provide contacts for establishing dialogue between shippers and transport operators.

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 71–77.
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Multimodal Promotion provides companies with direct door-to-door routing that takes combined transport (road, rail, water) schedules and the creation of profitable new transport connections into account. After entering the transport quantity data, a company receives direct recommendations regarding which of its shipments can be can be transported sensibly using combined transport. A Web-2.0 user interface is used to enter the data. Once the transport data has been analysed, each company receives a tailored, automated evaluation of its potential savings. In a subsequent step, the data entered is analysed in its entirety and transport cooperation potentials are then depicted. The depicted potentials include both those for local transport tour planning and for the identification of new transport relations. The analysis of all the transport data entered identifies the potential for transport shifting; the more regional companies that participate, the better the concepts for cooperation that can be identified. With a permanent search being conducted throughout an entire region for combinable transport loads, the number of empty runs and partial-load runs is reduced.

The risk-free utilisation of Multimodal Promotion and subsequently the depiction of transport shifting possibilities for a company's transport flows are enabled by anonymous data evaluation in the interest and maintenance of data protection.

2 State of the Technology

Research on the state of the technology has shown that there are travel route programmes and freight exchanges for inland waterway navigation, but currently no corresponding cross-company planning tool exists for bundling transports. Research projects have already been conducted in the rail segment for the planning of multimodal transports, but none that take cross-company bundling into account.

One tool for supporting intermodal planning processes is Spin-ALP (Scanning the Potential of Intermodal Transport on Alpine Corridors) [3]. The tool was developed solely for utilisation by either a single shipper or operator and is incapable of executing cross-company bundling. It also fails to include inland waterway navigation in the formation of transport chains as well as the formation of new transport relations. One additional possibility is the Be-Logic (Benchmark Logistics for Co-Modality) portal [4], which provides users with an overview of existing transport schedules. However, prior knowledge is required for the portal's utilisation and the data for comparing transport chains must be entered by the users themselves. INTERIM – (Integration in the intermodal goods transport of non-EU states: rail, inland/coastal waterway modes) is aimed at increasing the integration of neighbouring eastern European countries into European freight transport. This aim is to be achieved primarily by establishing sustainable transport relations between these countries and the European Union. Its primary objective consists of the improvement of cooperation, the exemplary construction of transport chains and the provision of freight company contact data. It does not enable the bundling of transport quantities, the prevention of empty runs and the creation of new transports. [5]

A process analysis was executed for intermodal combined transport for the arrangement of the algorithms, the transport cost indication and the framework conditions to be complied with. This analysis indicated the necessary key data, actuators and resource requirements for each process step.

An important point in the Multimodal Promotion project is the comparison of the depicted transport alternatives. Numerous studies are currently underway for the calculation of CO_2 values. One such study was conducted by VerkehrsRundschau, a German transport magazine, and involved the participation of transport service providers. [6] The freight train and inland waterway navigation class calculation methods developed in the study for the strategic planning are used in Multimodal Promotion. A cost function is entered in the tool to create a transport cost indication. Expanding on the work conducted in the special research field SFB 559 [7], the cost function for tri-modal transport chains developed there was adapted and expanded to include combined transport. [8] One important factor is the determination of the cycles and the resulting resource requirements containing the calculation of all fixed costs, personnel requirements and energy consumption costs.

3 Initial Situation

Current studies forecast transport traffic growth in 2011 in all freight segments in Germany of almost 8 % and haulage capacity growth of around 6 %. [9] Over the long-term, a heavy growth trend in freight transport exceeding the forecasts of 2009 is anticipated. It is also possible that the values forecast prior to the economic crisis, for example from the 2025 transport linkage data, will be attained despite the crisis. [10]

One important growth engine in this regard is container transport. Increasing containerisation and globalisation is reinforcing this growth. Ports in particular are anticipating heavy growth. Hamburg anticipates growth rising to 25 million TEU in 2025 and a doubling in the number of daily train departures from 200 to 400 trains. In comparison: The Port of Hamburg handled some 7.9 million TEU in 2010. [11] Western ports also anticipate strong growth. For example, by 2030 Rotterdam anticipates a doubling of its 2010 handling quantities of some 11.15 million TEU. [12] In addition, transports conducted via rail and inland waterway navigation will cover around 65 % of all hinterland transports and the importance of rail and waterways as transport modes will increase. [13] This would constitute a decrease in road transport in the Modal Split of 56 % in 2010 down to 35 % in 2035, leading to increased congestion in rail and, above all, in road transport.

In addition to a lack of rail capacities, hinterland operators are also confronted with other obstacles. However, capacities of trains are currently not fully utilised. Analysis of completed studies and interviews reveals that combined transport is regarded by those surveyed as being too inflexible, too expensive and not punctual enough. A lack of knowledge about combined transport services is generally behind arguments against combined transport. Illustration 1 lists the problems and solution approaches identified in the research project.

barrier	approach
low punctuality	publishing of performance indicators
inflexibility	railway transport is inflexible but projectable
expensive compared to road haulage	customized transport solutions will lead to cost optimization
modest infrastructure / no railway siding	promotion of multimodal transport instead of exclusive railway transport
short transport routes	bundling of transport volumes can achieve advantages even on short distances
no integration in logistics concept	customized transport solutions enable the integration of transport chains in the Supply Chain
unknown offers / service provider do not offer alternatives	public presentation of transport alternatives; comparison of the different means of transport

Illustration 1: Problems and Solutions in Combined Transport

The objective of the research project is to use the presentation of alternatives, the establishment of contacts and PR work to depict the benefits of combined transport and to lower resistance to it. Data entry makes it possible to provide suitable contacts in order to enable inclusion in the existing logistics concept. The presentation of service offers and price indications demonstrate the possibilities and economic benefits. The road-rail-waterway combination makes it possible to depict a comprehensive, flexible transport network.

4 Platform Contents

One challenge the system faces is easy use. To this end, the platform is divided into one easily operated section and one password-protected section. The password-protected section allows the entry of more detailed information and enables more extensive evaluations. This section also enables the user to receive this more detailed evaluation as well as cross-company consolidation and local transport planning.

4.1 Transport Schedule Check

The most important optimisation for users is the transport schedule check. The matching of transport orders and transport schedules takes place in the transport schedule check. This means that the optimum relation is sought for the transport between the departure location and the destination location. The process includes a comparison of direct road transportation and inland waterway or railway transportation. This comparison takes pre-carriages, post-carriages and transfers into account. The calculation basis for inland waterway or railway transports is a transport schedule. The result of the algorithm is therefore always the most affordable transport chain, regardless of whether the transport is conducted directly by road or in a multimodal fashion. The formation of a tri-modal transport chain is also possible. In order to receive a realistic assertion, the algorithm also accounts for pick-up and delivery time windows, terminal business hours and legally stipulated driving time regulations.

Once the data has been entered, the transport schedule check looks for the optimum relation between the shipper and the receiver, whereby “optimum” can mean either that this is the most affordable relation, the fastest relation or the relation with the lowest emission levels. Values for the calculation of emission levels are taken from entered data, e. g. the combination of flat cars of a train, from infrastructural data or from literature. The result of the transport schedule check is presented to the user as a chart compiled of all the subsections.

Here users can also have contact data presented to them for booking a specific transport based on the evaluation. The transport schedules used for this evaluation are entered either by the provider of intermodal services or alternatively by the operator of the platform.

From the perspective of small and medium-sized companies, only a small amount of information is required for the system to conduct an evaluation in the public section. In the simplest case, this information consists of the shipment’s shipper postal code, receiver postal code and the load to be transported. The users enter this data quickly and easily in the public section of the platform and receive a simple, rough overview of the shifting possibilities to alternative transport modes for the transport in question.

To receive a more precise evaluation, the password-protected section additionally provides the opportunity to enter the exact addresses of the shipper and receiver and to specify individual positions from transport orders. The transport data entered in this manner can relate on the one hand to past transports, or on the other hand to future transports. The latter subsequently allows an evaluation of future transport flow alternatives.

This example demonstrates the benefits of the platform. In this way, users can utilise the platform for an objective evaluation without the necessity of having to enter their own transport schedules. The same applies for entering transport services prices. If there is already a price for a transport schedule, then this is the price that is used. If there is not already a price available, the platform independently calculates a realistic price indication. This eliminates a great deal of data management compared to comparable solutions.

4.2 Developing of New Routes

Furthermore, the data entered by the user is consolidated and analysed. This makes it possible for companies lacking a sufficient transport quantity for the creation of a new relation to combine transports with other companies in order to reach the critical transport quantity for the creation of such a relation. Each of the platform users is informed of the result in an anonymous fashion and the possibility of establishing contact with the other user(s) is provided.

In contrast to the transport schedule check, in the creation of a new transport schedule recommendations for new relations are calculated and corresponding transport schedules are developed. Again, the transports entered by the user form the basis for the calculation. Proceeding on the basis of the shipment’s departure location and destination locations, the consolidation at a nearby terminal attempts to compile a sufficiently high level of transport volume to be able to identify an economically efficient train or inland waterway transport relation.

In order to find a terminal that is useful as a departure location or destination location for a new relation, first all of the transports within a 150 km radius of the terminal are identified. The range of 150 km was chosen because about 75% of all TEU are transported in this range to and from terminals [14]. If a sufficiently large transport volume between two terminals is identified in this way, a transport schedule is calculated for this relation. In this case, "sufficiently large" means that the average capacity utilisation within the monitoring period must be greater than 80 % the maximal capacity of the applicable means of transport in order to serve the relation in an economically efficient manner. The transports that are relevant for this monitoring additionally depend for one on the pick-up and delivery time windows. The monitoring period is determined by the first and last transport.

If the departure locations or destination locations of transports are located within the vicinity of more than one terminal, than all of the possible combinations are calculated and first the terminal with the greatest capacity utilisation is considered. For simplification, the calculation of the transport schedule proceeds on the basis of a weekly rhythm, whereby several transport runs can nevertheless be conducted within one week.

This process includes the identification of the most affordable day in each week of the monitoring period for the acceptance deadline in the terminals. This calculation is conducted backwards from Sunday to Monday. For each day, the costs for the transport are calculated based on the volume that has to be transported. On every day the volume is aggregated for the remaining days. It can be assumed that a delivery is preferred earlier rather than later even within the time window, whereby storage costs are also taken into account as penalty costs. However, the disadvantage of this procedure is that in reality later departures might be preferred, since they allow more volume for the transport to be delivered.

4.3 Local Transport Planning

The purpose of local transport planning is the reduction of pre-carriage and post-carriage road runs. This is conducted via cross-customer tour planning. This tour planning consolidates transports to or from the terminal onto one road, while simultaneously taking the stipulated time windows and transport schedules into account. The following variations can emerge in this regard:

- Transport of a full container load (FCL) 2x20" or 1x40".
- Consolidation of two 20" FCL from more than one shipper.
- Full truck load (FTL) stored by a service provider at the port in a 20" or 40" container.
- Consolidated tour of less than full truck loads (LTL) stored by a service provider at the port in a 20" or 40" container.

In addition to the freight properties, the calculation also takes into account the pick-up and delivery time windows and also transport schedules of the haulage.

5 Summary

In summary it can be asserted that Multimodal Promotion represents a clear simplification in comparison to existing solutions. It allows small and medium-sized companies as well as forwarding agencies easily and objectively optimises their transports without the necessity of entering additional data. This can be accomplished either with a transport schedule check for shifting to alternative transport modes, or with the aid of the creation of a new transport schedule for the consolidation cross-company transports. In both cases, local transport planning is also used.

Through the company wide analysis, the system will identify possible relations for new transport offers. Subsequently a discussion between the companies and possible forwarders will be conducted by the platform operator.

Another advantage of the selected approach is that the system can be transferred without problems to other regions. Additional data is only needed for the infra- und suprastructure as well as existing schedules.

Despite the improvement of the efficiency and the modal split in favour of the Combined Transport there are also risks. The success depends on the actuality of data and user acceptance. Also the measurement of the improvements is difficult.

Overall then, Multimodal Promotion links the individual economic necessity of cost reduction and the overriding economic interest of reduced transports together with the resulting ecological benefits.

References

1. Multimodal Promotion, http://www.multimodalpromotion.de
2. Effizienzcluster LogistikRuhr, http://www.effizienzcluster.de
3. SPIN-ALP: Scanning the Potential of Intermodal Transport on Alpine Corridors, ASTRA 2007/006 (2010)
4. BE-Logic, http://www.belogic.info (checked on February 29, 2012)
5. INTERMIM, http://www.interim-online.eu/ (checked on February 28, 2012)
6. CO_2-Berechnung. Das Sonderheft zur Ermittlung von Treibhausgas-Emissionen in der Logistik. SPEZIAL (2011); VerkehrsRundschau. Verlag Heinrich Vogel, München
7. Modellierung trimodaler Seehafenhinterlandverkehre, Sonderforschungsbereich 559, Teilprojekt A13
8. Vastag, A., Klukas, A.: Einfache Transportkettengestaltung in Internationales Verkehrswesen 7+8, S. 41 (2010)
9. BMVBS, Gleitende Mittelfristprognose für den Güter- und Personenverkehr Kurzfristprognose Sommer (2011); Seite 23
10. BMVBS, Gleitende Mittelfristprognose für den Güter- und Personenverkehr Kurzfristprognose Sommer (2011); Seite 23
11. Hafen Hamburg, http://www.hafen-hamburg.de/figures/facts (checked on February 13, 2012)
12. Hafen Rotterdam, http://www.portofrotterdam.com/en/Port/port-statistics/Documents/portstatistics_2010_en.pdf (checked on February 29, 2012)
13. Grenzenloses Wachstum, aus VerkehrsRundschau, Jahrgang, Nr. 29, Seite 23ff (2011)
14. Statistisches Bundesamt, Verkehr: Kombinierter Verkehr, Wiesbaden 2010 (February 03, 2012)

Development of a Concept for Safe and Durable Transport Chains for the Steel Industry

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Abstract. The steel industry being one of the most important industries in Germany is still not meeting the latest developments in information technology. In consequence, due to the lack of information linkages between organizations, supply chains in the steel industry are unsafe and fragile. The objective of this project is to develop a concept for safe and durable supply chains for the steel industry by using state of the art information technologies.

Keywords: steel industry, supply chain management, transport chain, safety, multi-agent-system.

1 Topicality and Relevance

The steel industry is one of the most important industries in Germany, with the German steel industry employing a total of 90,000 people in 2010. In the same year the German steel industry produced a total of 44 million tonnes of crude steel and generated turnover of 40.7 billion Euros. The steel supply industry is also very important, generating a total of some 1 trillion Euros in turnover in the steel-related industry [1].

Although the steel industry is subsequently one of the largest industries in Germany, examination of the industry demonstrates that the logistics communication technology specific to the steel industry is nevertheless not up to date with the latest state of technology. Supply chains in the steel industry are often characterised by over-ordering, large material stocks, a low level of network linkages between the participants, a failure to meet agreed delivery dates and expensive ad-hoc solutions. As such, the industry is missing sufficiently implemented network linkage between its participants. Closer integration of logistics service providers in the information flows is also necessary. Particularly in the case of fluctuating transport volumes, a transparent logistics chain simplifies the challenge of being able to meet the needs of customers flexibly, safely and cost-efficiently.

To illustrate the point, according to a current examination 85% of the companies surveyed have experienced at least one interruption in their supply chain in the last 12 months [2]. The most common cause of interruptions in the supply chain are adverse weather conditions (51%) especially for the transport sector. The main cause (21%) of delivery disruptions were especially the earthquakes in the pacifics and the tsunami in japan of 2011. Volcanic eruptions in Iceland, which in 2010 caused thousands of

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 79–85.

flights to be canceled disrupting European air traffic, point the importance for more flexibly supply chain up. Often these supply chain interruptions led to delays and shutdowns in production, which in turn can have further consequences down the line for the end products on the market.

As supply chains become more complex as a result of global sourcing and the continued trend to ‘leaning-down’, supply chain risk increases. Those risks can be categorised in many different ways and from different perspectives, e.g. from a corporate governance or financial risk agenda. At its simplest there are two categories of risk(internal and external) which can be further sub-divided to produce a total five categories(demand, supply, environmental, process and control) [3].

There is one decisive prerequisite for increasing supply safety in steel logistics: cross-company informational transparency. In the case of fluctuating transport volumes, a transparent logistics chain simplifies the ability to meet the needs of customers flexibly, safely and cost-efficiently [4]. Supply chain information content that is communicated poorly, too late or not at all frequently results in friction losses on the ground.

According to a recent survey, 8% of the surveyed companies stated that all of their key suppliers are equipped with concepts to ensure the continuation of their processes in the event of supply chain disruptions [2]. In relation to the structure of their value chain, the greatest potential is seen in improved network linkage of the suppliers (86%) and of the different locations and plant facilities with one another (75%). Overall, the network concept of supply chain management is recognised as an important optimisation lever. Another finding of the study is that there is an absence of many of the prerequisites for efficient controlling. Successful implementation often fails due to communication and the absence of appropriate measures.

2 The Safe Networks Cooperative Project for Logistics

For these reasons, this research project is aimed at developing the possibilities for network linkage in the supply chain and transparency in the processes. The cooperative project “Safe Networks for logistics - Sichere Transportketten dank multimodaler Logistik” (‘- safe transport chains thanks to multimodal logistics’) was initiated within the LogistikRuhr efficiency cluster by the Fraunhofer IML Transportation Logistics Department. During the course of this project, the processes in the focus of the steel industry in the German state of North-Rhine Westphalia will be examined and optimised in terms of logistics aspects. In order to ensure the comprehensive observation of the supply chain, the following representatives from all of the value chain process steps are participating in the project:

- Fraunhofer IML
- Bilstein GmbH & Co. KG
- Salzgitter Flachstahl GmbH
- V & M DEUTSCHLAND GmbH
- Rhenus Scharrer GmbH
- Panopa Logistik GmbH
- Haeger & Schmidt International GmbH
- VCE Verkehrslogistik und Consulting GmbH

The aim of the research is to increase supply safety and the durability of the supply chain. This will involve examination of both the physical transport of the goods and products and the information flow within the transport chain. The result should produce a transparent process chain in which every partner receives all relevant information at any time and is in the position to react early to unexpected events. This will allow the companies to reduce the risks mainly in the field of supply and demand based on Christopher and Peck.[3] The developed solution will be used by associate partners to complement already existing systems. First, the system supports operational processes, before it delivers data and information for strategic decisions. The aim is to recognize disturbances along the cross-company supply chain (such as lower Rhine level, long-term blocking of a track or capacity bottlenecks) early on, to ensure supply security at any time. For the participating companies and in particular as a result of the following effects, this should include:

- increasing the supply safety of the participants
- reduction of the stocks in the entire transport chain
- increasing transparency in the transport chain
- optimisation of resource utilisation (transport and production)
- reduction of process costs
- increasing the level of customer service

3 Baseline Study and Initial Findings

A baseline study was conducted to identify all of the material and information flows that are relevant for the transport of the examined products. The study was aimed at developing an understanding for the processes in the logistics chain and for spotting any potential weak points. The primary result of this baseline study, based on the discussions, interviews and operational facility tours that were conducted, was the graphic depiction of process chains based on concrete application cases; these depictions were continuously fine-tuned and validated through continuous communication with the partners throughout the course of the project.

The baseline study placed particular analytical focus on the flow of information, or more specifically, the IT interconnectivity between the participating companies, in order to identify any information gaps or interruptions in the transmission of information. The findings of this analysis represent the basis for the further activities of the project.

The findings reveal that most of the difficulties in the logistics chain result from a lack of informational transparency and IT interfaces. This factor in particular then leads to problems when unexpected events such as short-notice changes in order quantities or data and shortages due to external influences like traffic jams or damages occur. Manual transmission and processing of information that is not automatically registered by the systems involved is both time-consuming and costly in terms of resources.

4 Challenges

These kinds of information gaps should be avoided in the future through the development of a web-based information platform which each of the partners can use to call up information that is relevant for them. It should additionally simplify order processing. The information platform should be compatible as an interface with the information systems of each of the partners, thereby supplementing but not replacing those systems.

Thereby the information platform abstracts the cause of a disruption; instead it focusses on the effects made to supply chains. The minimisation of possible disruptions is part of a supply chain risk management. The challenge is to connect the information platform with an existing risk management.

Science already offers a number of theoretical solution approaches proposing supply chain management systems for the steel industry which initially emphasises the information requirements of the individual components. They also depict for instance what information is required, the origin of this input information, what information is provided in the form of results and how the individual modules are linked with one another. [5]

One essential element of this will be an independent information and communication platform. The path to this solution constantly runs at an informational level in which all of the participants can access the relevant data. An improved flow of information and greater planning reliability could bring about an optimum supply chain and subsequently reduce logistics costs significantly [4]. However, as of yet these results have not been applied in practice.

The information platform developed in SafeNet is designed to enable order quantities and dates to be varied up to a defined point in time and to convey material requirements forecasts to facilitate better preliminary planning. Another function covers order monitoring that is designed to depict the status of orders at any given time. Additionally, proactive notifications of shortages or delivery delays are aimed at enabling countermeasures to be implemented quickly. The improved planning reliability resulting from earlier notification is aimed at reducing overly high order volumes and the build-up of larger back-up stocks.

The biggest challenge and simultaneously the innovative aspect of this system lies in particular in the complexity of the examined information flow, since all of the vertical participants in the value chain are involved. The result is a mutual planning tool for the entire supply chain. As such, this produces not only a singular connection between the supplier and the buyer, but rather a comprehensive observation of all the participants. Another challenge is the reluctance of the companies toward passing information to the other supply chain partners due to the sometimes divergent nature of each company's individual interests. This is why relatively little investment has been made in informational interconnectivity within the steel industry in the past. Since however the joint utilisation of relevant information is ultimately beneficial for all of the participating partners, the implementation of this type of information platform is possible.

5 Architecture and Specifications

The system to be implemented should follow the principles of a multi-agent system. The architecture of the multi-agent system (MAS) should be developed according to FIPA specifications. Among the factors addressed by these specifications are the architecture of a multi-agent system and the communication protocols with which the agents can communicate with one another.

Multi-agent systems (MAS) consist of several interactive software agents that work together to achieve an objective that cannot be achieved by a single agent alone [6], [7]. Up to now however, no clear definition of what agents are has asserted itself. One popular description comes from Wooldridge [8], [9]. According to this description, agents are capable of autonomously making decisions in order to achieve their individual objectives. Additionally, agents can perceive the environment in which they are settled and react to changes there, as well as take the initiative to act in the interest of attaining their objectives. Agents can also socially interact with other agents in an MAS to achieve their objectives.

6 MAS-Based Information Platform

Advanced Planning and Scheduling Systems respectively Advanced Planning Systems (APS) have become dominant in the cross-company planning of supply chains. These systems support the central planning of processes along the supply chain and are therefore designed for hierarchical coordination which can be conducted by a leading, influential partner within the supply chain. APSs can be used only to some extent for supply chains with partners which are of more or less equal standing and want to retain their individuality, and are also unwilling to publicise their production data. However, MAS is an appropriate solution for handling the above-specified characteristics. [10]

The information platform solution therefore includes the development of an MAS with which suppliers and buyers can determine shipment readiness dates together. A negotiation procedure is implemented with the help of the MAS which allows both partners to find the best possible mutually agreeable date without any knowledge of the respective other partner's production data. Only the object of the negotiation, i.e., the shipment readiness date, is publicised, allowing the partners to retain their individuality.

7 Event Management Using MAS

According to Bretzke et al. [11], supply chain event management systems consist of the following components:

- **Monitor:** Monitoring of all processes throughout the supply chain.
- **Notify:** In the event that disruptions in the processes are recognised, this component informs those in charge of the processes.

- **Simulate:** In cases of disruption, this component makes it possible to simulate the effects of the disruption or to simulate countermeasures for overcoming the disruption.
- **Control:** The implementation of countermeasures is supported by this component.
- **Measure:** This component provides for the registration of process key data, assessment possibilities and their compilation into reports.

A few attempts toward developing an event management system with the help of a multi-agent system have already been made. For example, Reinheimer and Zimmernann [12] describe a SCEM system that makes it possible to conduct proactive monitoring of milestones in a supply chain with the help of agents.

Nevertheless, the possibilities for exploiting agents have not been adequately exhausted in the existing approaches. From the perspective of artificial intelligence, the strength of multi-agent systems lies in agents' ability to act independently. As such, agents can also be designed to adapt their actions in accordance with the particular situation and even to learn from comparable situations [13]. This "reinforcement learning" is absent in today's MAS for SCEM.

From the SCEM perspective however, there are numerous implementation possibilities for a multi-agent system with learning capabilities. For example, it is conceivable for agents to be able to learn that particular situations always lead to delays. In such cases, a learning MAS can issue early notifications of disruptions. It is additionally possible that an MAS can learn from troubleshooting and automatically make troubleshooting recommendations, and in the distant future even that the MAS automatically implements such measures. But for now, examination must be conducted on the basis of concrete incidents and a corresponding data basis as to whether learning agents produce significant improvement.

Therefore, within the framework of the project, the broadest variety of machine learning possibilities and their implementation will be more precisely investigated, analysed and assessed.

References

1. Brüninghaus, B.: Medieninformation vom, Wirtschaftsvereinigung Stahl (January 18, 2012)
2. Kümmerlein, R.: Lieferketten 2011 häufig gestört. DVZ 148, 5 (2011)
3. Christopher, M., Peck, H.: Building the resilient Supply Chain. International Journal of Logistics Management 15(2),1–13(2004)
4. Kümmerlein, R.: Heraus aus dem Stahlnetz. Forschungsagenda Logistik 1, 34–38 (2011)
5. Heidrich, J.: Implementierung von Supply Chain Management Systemen in der Stahlindustrie: Konzept zur Generierung von Schnittstellen zwischen den einzelnen Ebenen hierarchischer Planungssysteme sowie dem Legacy-System. Dissertation. TU Berlin (2004)
6. Wooldridge, M.: An Introduction to MultiAgent Systems. Wiley, Chichester (2009)
7. Jennings, N.R.: On agent-based software engineering. Artificial Intelligence 117, 277–296 (2000)

8. Wooldridge, M.: Intelligent Agents: The Key Concepts. In: Mařík, V., Štěpánková, O., Krautwurmová, H., Luck, M. (eds.) MASA 2001. LNCS (LNAI), vol. 2322, pp. 3–43. Springer, Heidelberg (2002)
9. Wooldridge, M.: Agent-Based Software Engineering. IEEE Proc. Software Eng. 144, 26–37 (1997)
10. Stadtler, H.: Supply chain management and advanced planning-—basics, overview and challenges. European Journal of Operational Research 163, 575–588 (2005)
11. Bretzke, W. R., Stölzle, W., Karrer, M., Ploenes, P.: Vom Tracking & Tracing zum Supply Chain Event Management – aktueller Stand und Trends. KPMG Consulting AG (2002)
12. Reinheimer, S., Zimmernann, R.: Einführung eines agentenbasierten Supply-Chain-Event-Management-Systems. HMD 227, 76–88 (2002)
13. Sutton, R. S., Barto A. G.: Reinforcement Learning: An Introduction. MIT Press, Cambridge (1998)

Urban Business Navigation – Efficient, Resource-Conserving, Industry-Specific Navigation

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Abstract. Navigation is designed for the targeted control of processes. But navigation maps, navigation software, and above all, the integrability of communal information as well as internal company or industry content and functions has not yet been sufficiently achieved. In the interest of the efficient control in downstream networks of vehicles in business transport, the affected road traffic participants must be provided with up-to-date, dependable information that is relevant for them. Urban Business Navigation implements new concepts, procedures and algorithms in order to design navigation applications in accordance with practical requirements in a manner that is flexible, configurable and integrable. It is only in this way that industries which until now have been unable to implement an appropriate navigation solution can efficiently meet the future's increasing requirements, such as time and access restrictions.

Keywords: navigation, business transport, traffic information, truck priority routes.

1 Introduction

Navigation applications are increasingly available free of charge, Galileo is aimed at drastically increasing the accuracy and reliability of positioning, and dynamic traffic information is collected in traffic management centres and then made available. Simple positioning and navigation from A to B has long been accepted as a standard functionality and is already regarded as a prerequisite in many cases by value-added services. But demands are raising the bar for the functionality and accuracy of navigation applications not just in private user applications, but also for professional application in business transport and logistics [4].

2 Analysis of Navigation in Business Transport

The utilisation of standard automobile navigation solutions in business transport wastes the great potential of economic, city-friendly navigation and additionally leads to traffic jams and dangerous traffic situations.

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 87–92.

Since urban freight transport represents between 20 and 30 per cent of vehicle kilometers in urban areas [7], improved navigation for this sector promises high potential of raising efficiency which supports an ecological city development.

Today, virtually every road traffic participant drives in the same manner on the basis of a navigation application developed for cars, regardless of whether they are used in local cars, busses, trucks, CEP service provider delivery vehicles or construction vehicles. In 2010 alone, 3.5 million navigation devices have been sold [3]. Estimates indicate that the number of drivers being guided by their electronic helpers is increasing heavily, but not just among private users: Positioning and navigation in business transport has also long established itself as part of the day-to-day routine of freight carriers and shippers. From tour planning to truck navigation and on up to the worldwide tracking & tracing vehicles and goods, the business sector and logistics in particular have become a motor and driver in the utilisation and development of new positioning applications. In a survey of some 200 truck drivers conducted by the Fraunhofer Institute for Material Flow and Logistics together with the navigation map and solutions provider LOGIBALL, the findings revealed that more than 90 percent of the truck drivers use navigation devices today[1].

Typically, these navigation applications are used in the logistics field as stand-alone solutions with no linkage to central transport management or disposition systems; nor are they integrated into the overall concept via a telematics unit. This frequently leads to a landscape of independent island solutions that are not connected with the company software often consisting of static software components which, in the case of stand-alone solutions, run for the most part on proprietary hardware. At the company systems level, navigation data that has been generated is only processed in business processes to a limited extent. These types of solutions are currently available on the market in a variety of characteristic feature forms. The disadvantages of these systems are

- high acquisition costs in the case of complete telematics solutions
- no connection with company software in the case of stand-alone solutions
- high levels of administrative effort and expenditure in order to meet the requirements of an up-to-date map basis
- low level of scalability in the event that any possibility at all is available for expanding system functionalities
- inflexibility toward changes in the hardware configuration

3 Requirements of Business Transport Navigation

There is a gap at present between what is actually available on the market and the desire of companies for individual information and communication solutions [2]. This gap is also reflected in navigation systems. While potential customers want a stabile, durable solution on the one hand, they also still want a solution that can simultaneously be integrated flexibly into their company software environment and that is economically efficient. These requirements appear to contradict one another.

The solutions applied at present in the commercial sector that are available on the market under the designation of “truck navigation” are in fact only derivatives of the

[1] City-friendly truck navigation in the Metropole Ruhr, results of a pilot project in Dortmund and Hamm.

standard automobile solutions which have undergone rudimentary adaptation. They have only expanded to include bridge heights, tonnage limitations and a few other restrictions. This is indeed important information for truck drivers, but it goes nowhere toward adequately covering the full range of varied and specific requirements called for daily in business transport.

3.1 Multi-device Capability

Along with the software issue, the requirements on the mobile hardware used in the professional segment have always been higher than those for private user hardware. The professional use of such devices is far more intensive and the conditions they face are much tougher, with dust, dirt and sprayed water belonging to the daily routine. And if the application extends beyond normal navigation, these devices also have to be capable under certain circumstances of being operated while wearing gloves. Therefore, durable, ergonomic end devices are called for in some fields of application. A navigation application for business transport should therefore be compatible with operation of the broadest variety of end devices normally used in all the different industries.

3.2 User Acceptance

More important than the device itself however is the durability and stability of the application. Detours and delays in business transport are not only irritating; they are also always simultaneously linked with financial losses. This makes it imperative to use extremely reliable applications that provide employees with the highest possible level of support in any situation. A navigation or telematics application fully integrated into the company's processes can only perform to its fullest potential if it is properly operated by the employees. This requires that the application is accepted by the employees, that it provides the best available support for them in their work processes and that it in no way hampers them in their work. This applies in particular for navigation applications. Such applications are often overloaded with unnecessary functions and settings possibilities that provoke operating mistakes. Companies will continue to remain sceptical about investing in special truck navigation systems as long as their drivers cannot rely fully on the navigation instructions to accurately provide recommended routes that they can actually use.

3.3 Processing Static and Dynamic Traffic Information

The navigation map manufacturer approach of including as much static information in the navigation map as possible regarding restrictions for business transport so that navigation device providers can develop special applications based on this information will continue to be the preferred manner of acquiring data in the future. On the other hand however, in the recent past truck drivers have begun facing increasingly more restrictions which are difficult or impossible to include in collected data because they are not in the form of road signs. Examples include truck relief zones and the special truck priority routes developed by some cities for the city-friendly control of business transports. Such information also needs to flow into the calculation of truck routes in order to provide navigation that is both city-friendly and which ensures smooth navigation from the drivers' perspective. When applied correctly, particularly in a downstream transport network, this static information significantly increases user acceptance. The same goes for dynamic traffic information such as warnings about local hazards (for example, accidents, wrong-way drivers and lane closures) and information about construction sites or dynamic speed restrictions, as long as the information is correct and up-to-date [5]. Incorrect or delayed information about traffic flow, traffic jams or other obstacles lowers the acceptance of the navigation applications. If however the accuracy and speed of the information transmission is increased in the future, then this information can also be useful for business transport.

3.4 Integration of Company Data

Along with accurate, up-to-date information, other aspects are also useful for business transport. A significant increase in efficiency can be produced by the inclusion of customer-specific company data such as directions to large company locations, delivery points in general [6] or even instructions for individual drivers. But individual application adaptations like these are generally only possible through (complete) integration into the affected company systems. The added value that can be achieved through such integration is in large part realised in the processes positioned upstream and downstream from the navigation. In this scenario, efficient communication processes and comprehensive, consistent order processing and invoicing can yield an increase in benefits.

When the development of telematics systems first began, the primary focus was on the registration and transmission of data from mobile and moving objects to central processing systems. Due to the increasing requirements on such systems, positioning and telematics systems were developed in the past so that data could also be transmitted to the vehicle where it could be processed further. The necessity for further optimisation of logistics processes, order information and the communication of the associated destination coordinates was important in driving the development and expansion of bidirectional data transmission. This enables navigation applications that are linked with telematics systems to be supplied with destination coordinates and order information, and additionally contributes to avoiding double-entries and incorrect sources in the assumption of the information [1].

4 Solution Approach for Individually-Tailored Navigation

Up to now, providers of navigation systems for the consumer sector have migrated them to the business market in a form that attempts to achieve a single solution for as many industries as possible by enhancing the data and functions of the systems. This nevertheless contrasts with the navigation application requirements of the different business segments and professional users. For example, cities and communities find it very difficult to impossible to feed truck route recommendations and the like into the navigation maps. For other sectors, particularly in future technologies such as electromobility, navigation systems will be subjected to completely new requirements that cannot be met at all or only to an insufficient extent with the existing migrated solutions.

4.1 Industry-Specific Configurability

There is no provision whatsoever in the navigation of business transports for individual information on restrictions such as environmental zones and traffic management centre route recommendations for specific vehicles such as priority routes for trucks. A completely new type of navigation is necessary in order for business transports to be capable of using such information. This will involve new navigation applications and the corresponding algorithms and new navigation maps with new content, as well as the possibility of providing navigation map providers with access to new content. An important point for increasing the efficiency of business transport navigation up to the latest state of technical development is the individual configurability of the particular application. Requirements analyses in different industries have revealed that distinctions have to be drawn between the following elements.

Navigation application:

- Basic functionalities for all business sectors (for example, truck navigation)
- Individual functionalities for different industries (for example, speed profiles)
- Individual functionalities for different companies (for example, tour planning)

Navigation content:

- Content relevant to business transports (for example, truck priority routes)
- Industry-specific content (for example, unloading zones in inner-cities)
- Company-specific content (for example, customer delivery points)

Navigation map:

- Additional navigation-capable geometries

4.2 Improved Algorithms

In order to fully exploit the new possibilities resulting from the additional information and functions, a navigation algorithm that already utilises the truck priority routes contained in the base data of the navigation maps is being developed in the Urban Business Navigation research project. Analyses of the potential conducted in advance of the development have revealed that the following factors are relevant for this development:

- The economic efficiency of the navigation is retained for users
- No restrictions in the utilisation of suitable roads
- Road traffic effects are kept at a reasonable level
- City-friendliness of the navigation is increased

The improved navigation algorithm will take the truck priority routes as well as other navigation-capable geometries such as alternative routes into account.

5 Methodological Outlook

Interviews with representatives from a variety of industries have demonstrated that there is great potential for increasing business transport efficiency by means of an individually adapted navigation solution. But the interviews also revealed the broad diversity in the requirements and main focuses of the different industries. Initial tests with the demonstrator confirm the functionality of the selected modular approach. At the moment, analyses are underway and assessment criteria are being examined and measured for the precise evaluation of the economic and road traffic effects of the new navigation. In conclusion, qualified assessments of hard and soft factors will be conducted for estimating the increase in efficiency of economical navigation.

References

[1] Schriftenreihe Politik, Band 4, Telematik und Navigation – Anwendungen & Mehrwertnutzen, Bitkom (2009)
[2] Marktanalyse - IKT-Anwendungsbereiche in Nordrhein-Westfalen, NRW-INVEST, 13 (2009)
[3] Studie des Marktforschungsinstituts EITO (European Information Technology Observatory) im Auftrag der Bitkom, (2011)
[4] Clausen, U.: Galileo kommt – Chancen für die Logistik durch Satellitennavigation, Symposium Logistik Innovativ. Prien am Chiemsee/Aschau (Mai 07/08, 2008)
[5] Matschke, I.: Einfluss dynamischer Navigation auf das Verkehrsgeschehen in städtischen Straßennetzen, Gottfried Wilhelm Leibnitz Universität Hannover, Dissertation (2007)
[6] Menge, J., Hebes, P.: Optimization of urban deliveries: evaluating a courier, express and parcel service pilot project in Berlin. City Distribution and Urban Freight Transport 213, 200–216 (2011)
[7] Dablanc, L.: Goods transport in large European cities: Difficult to organize, difficult to modernize. Transportation Research Part A 41, 280–85 (2007)

EffizienzCluster Logistik Ruhr, DiNav – Dynamics in Navigation

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Abstract. The project "Dynamics in Navigation" focuses on improving the routing of personal navigation devices (PNDs). To achieve this goal a central and independent service has to be set up. A service providing not only data about the actual traffic situation but also traffic forecast as well as information about the roads' spare capacities. Based on this information, route choice can dynamically adapt to the current and forecasted traffic situation. In addition to that, this approach also offers the possibility to respect route recommendations and traffic management strategies by local authorities. By all these means we expect a more efficient usage of the road network and lower travel times.

Keywords: Traffic, Congestion, Dynamic routing, Traffic simulation and forecast.

1 Overview

The project "Dynamics in Navigation" deals with an everyday problem, well known by anyone who drives a car or a truck: traffic congestions. In the region of North Rhine-Westphalia one third of all traffic jams on German motorways in Germany are observed.

Thereby, traffic jams create immense economic loss. They cause emotional strain and harm the environment.

It is a challenging question to researchers how to solve these problems as our road network is a limited resource and traffic will increase further. Answers to this challenge are needed.

Personal navigation devices (PNDs) with a receiver for the traffic message channel (TMC) offer a solution to this problem. But they only have a narrow base of

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information; they often relocate congestions from the main road network to secondary roads. For TMC traffic information only deals with disturbances in the motorway system and there is no information about traffic conditions on minor roads at all. Often information is either missing or sent with a significant delay [1].

Better services are based on probe speed information (e.g. GPS-data from floating cars). They do, however, not take into account a road's maximum capacity. So, under free flow conditions they cannot distinguish between nearly empty roads and roads with significant traffic load yet still in free flow condition. The traffic load in the latter case can be close to the capacity limit.

With respect to these problems, "Dynamics in Navigation" has two new approaches.

First it aims to set up a central service which provides PNDs with the current state of the road network and an additional forecast of the state 30 minutes in the future. This will be achieved by considering the actual distribution of density and spare capacities within the network. The second approach offers public authorities the possibility to influence the routing of navigation providers.

The effect of both mechanisms will be examined by accompanying simulations.

The project is carried out by the following three partners:

1.1 PTT – Chair of Physics of Transport and Traffic, University of Duisburg-Essen

The Chair of Physics of Transportation and Traffic at the University of Duisburg-Essen conducts basic and applied research in the field of modeling transport processes. One focus is the modeling of road traffic by cellular automata based on the Nagel-Schreckenberg model [2] [3]. With these models, the online simulation of large networks is possible: On behalf of the state of NRW, the group developed a simulation of the motorway network in North Rhine-Westphalia [4] and operates the traffic information platform www.autobahn.nrw.de

In collaboration with the research group of Reinhard Selten (University of Bonn) a study of the reaction of road users on traffic information had already been performed [5].

1.2 TRC - Transportation Research and Consulting

TRC Transportation Research and Consulting was founded in 2006 as a spin-off of the University of Duisburg-Essen. The company's expertise is based on studies, research and developments that have been done as part of the founders' activities at the Institute of Traffic System and Traffic Construction at the University of Duisburg-Essen. In recent years, numerous relevant studies have been conducted successfully for various clients. For example, in the area of traffic management systems, TRC has been used as a neutral expert for quality control of the reports about the traffic situation from the "Ruhrpilot" over two years [6].

1.3 TomTom Development Germany GmbH

Founded in 1991, TomTom is one of the world's leading provider of in-car location and navigation products and services.

The Production Unit Traffic in Berlin is responsible for research and development of products based on historical data ("IQ Routes") and the live traffic services ("HD Traffic"). *http://www.tomtom.com/livetraffic/*

2 Data Basis

Within the test area PTT can access data from 275 locations with inductive loop detectors for every lane of the motorway. The data is aggregated over 60 seconds and includes mean velocity, flow and occupancy for two vehicle classes (car or truck).

Additionally, TomTom has combined floating car and floating phone data made available for this project.

A comparison of the mean velocity on motorway sections shows a slight deviation, which probably result from the different measuring methods. Such a comparison is shown in Fig. 2 below.

A combination of both data types gives us a significant advantage in this project.

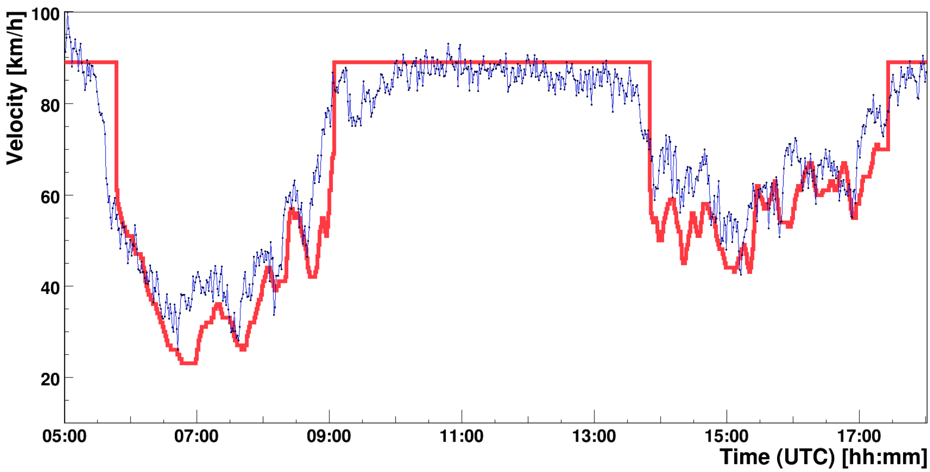

Fig. 1. Comparison between mean velocities on a motorway section of the motorway A40 aggregated over 60 seconds. The thicker red line shows the velocity calculated from TomTom Floating Car travel times in comparison to the thin blue line, which shows the velocity averaged from four stationary loop detectors situated on the track.

TRC has done an extended analysis of the IGVP[1] model and transformed that model with average daily traffic volumes in an hourly model. Using the data from different automatic traffic counts the model will adapt dynamically to the count values by an iterative route based correction algorithm. In the minor road network the capacity is often determined by junctions, which are usually controlled by traffic lights. So the important junctions are considered more detailed with their signal setting (cycle time, green time) and geometry such as number of lanes. So for each direction the capacity or rather the free capacities can be calculated dynamically and provided for the routing.

[1] Integrated overall transportation planning of North Rhine-Westphalia.

3 Approach

To provide traffic information about certain road sections, one is in need of a location referencing system like OpenLR [7], which is, unlike TMC, not limited to a few selected way segments, but can handle individual spatial information for the whole road network.

OpenLR was invented as an open source software project launched by TomTom International B.V. in September 2009. It provides a royalty-free dynamic location referencing method which enables reliable data exchange and cross-referencing using digital maps of different vendors and versions. Within the project "Dynamics in Navigation" OpenLR has been further developed, so that the necessary information can be transmitted easily.

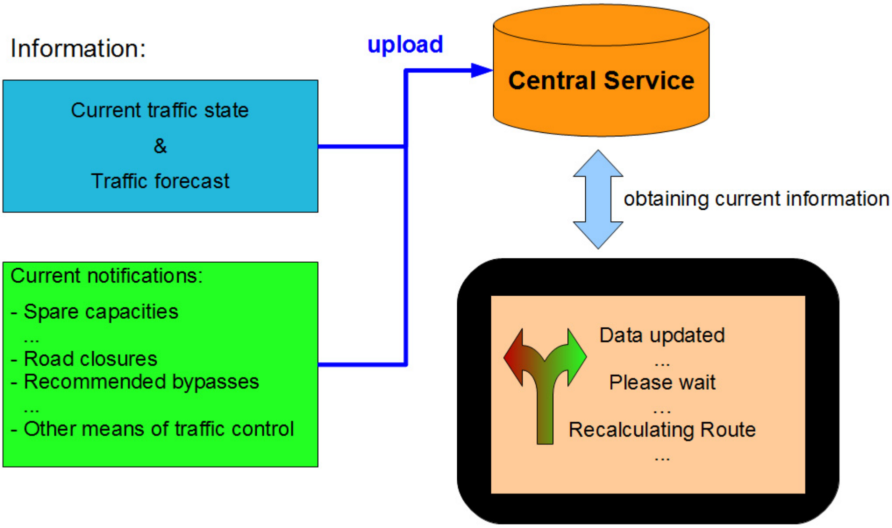

Fig. 2. The schematic framework of the communication chain

As already mentioned, there will be two services to distribute traffic related information, as shown in Fig. 2.

In practical, the data exchange will be done via two xml files, one for each type of information. The files are on a public server and will be updated on a regular basis.

A modified TomTom PND will able to use this additional information and implement it in the routing algorithm.

For the current traffic state and the traffic forecast the xml file follows the pattern presented below:

```
<traffic_situation>
   -<time sql_utc="2012-02-24 09:59:00+00">
      -<section otdf_id="A001-NO-HF-082">
         -<reference openlr="CwV0ISSsrwECQwelDNsBcA0o">
            <vendor_ids>
               {702760048157677, ... ,702760048078330}
```

```
        </vendor_ids>
            <length_teleatlas>3162.2</length_teleatlas>
            <pos_offset>0</pos_offset>
            <neg_offset>18</neg_offset>
            <length_w_offsets>3144.2</length_w_offsets>
            <length_ptt>3100</length_ptt>
            <corr_factor>1.014</corr_factor>
      </reference>
      -<current>
            <flow>58</flow>
            <density>34.204601</ density >
            <mean_velocity>102</mean_velocity>
            <travel_time>109</travel_time>
       </current>
      -<prognosis minutes="30">
            <flow>63</flow>
            <density>39.69</density>
            <mean_velocity>96</mean_velocity>
            <travel_time>115</ travel_time >
       </prognosis>
    </section>
    ...
    ...
    ...
  </time>
</traffic-situation>
```


The second xml file providing the information of the local authorities follows mainly the same schematic.

By using OpenLR for the geospatial reference such a service is fully vendor independent.

4 Outlook

We plan to evaluate the communication chain for such a service in a field test. This will be done under realistic conditions with a working PND prototype and the ability to change the available information during operation.

In parallel, PTT will study the benefits of such a service for individual drivers. They will extend their simulation framework to investigate how routing recommendations can influence the distribution of traffic flow within the road network. Their agent based vehicles in the simulation are extended by the ability to follow routing instructions, which can be adjusted by the information from the central service. Theoretical studies by Chuanfei Dong et al. [8] and Bokui Chen et al. [9] support the project's approach as an effective mean to reduce traffic congestion.

References

1. Wischoff, L., Ebner, A., Rohling, H., Lott, M., Halfmann, R.: SOTIS - a self-organizing traffic information system. In: The 57th IEEE Semiannual Vehicular Technology Conference, VTC 2003-Spring, vol. 4, pp. 2442–2446 (2003)

2. Nagel, K., Schreckenberg, M.: A cellular automaton model for freeway traffic. J. Phys. I (France) 1992(2), 2221–2229 (1992)
3. Pottmeier, A., Thiemann, C., Schadschneider, A., Schreckenberg, M.: Mechanical restriction vs. human overreaction: the modelling of synchronized two-lane traffic. In: International Symposium of Transport Simulation 2006 (ISTS 2006), Lausanne (2006)
4. Schreckenberg, M., Selten, R. (eds.): Human Behavior and Traffic Networks. Springer, Berlin (2004)
5. Schadschneider, A., Knospe, W., Santen, L., Schrecken-berg, M.: Optimization of highway networks and traffic forecast. Physica A 346, 165–173 (2004)
6. Schönharting, J., Tetzner, S., Barwisch, T., et al.: Ruhrpilot: Untersuchungen zur Qualität der Fahrzeitermittlung innerorts, Schlussbericht. Auftrag der Projekt Ruhr Besitzgesellschaft mbH, Essen (2006)
7. TomTom International, B.V., Deutsches Zentrum für Luft- und Raumfahrt e. V. (DLR,German Aerospace Center), OpenLR™ White Paper Version: 1.5 Revision 2 (2012), `http://www.openlr.org/documents.html`
8. Dong, C., Ma, X.: Dynamic weight in intelligent transportation systems: A comparison based on two exit scenarios. Physica A 391(8), 2712–2719 (2012)
9. Chen, B., Xie, Y., Tong, W., Dong, C., Shi, D., Wang, B.: A comprehensive study of advanced information feedbacks in real-time intelligent traffic systems. Physica A 391(8), 2730–2739 (2012)

Research Project ePOD@Home: Electronic Proof of Delivery at Point of Delivery

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Abstract. The rising interest in the internet throughout the world is attributable to its broad spectrum of applications. One business sector that is increasingly gaining more attention is E-Commerce. Increasing demand as well as the expansion of the range of articles will change the demands on logistics processes in the future. In particular, it is shippers and logistics service providers that will have to answer these new, individual demands and examine their existing ordering and delivery processes. Against the backdrop of products that are sensitive or expensive for customers, the topics of security and efficiency are gaining importance in the ordering and delivery process for shippers and customers alike. In order to further increase the appeal of E-Commerce and activate undeveloped potential, more consistent ordering and delivery processes are required. The ePOD@Home research project supports this approach through the development of an economically credible overall process.

Keywords: electronic proof of delivery, point of delivery, delivery process, E-Commerce, online mail order, electronic identification document, nPA, electronic identification, mobile offline eID system.

1 Introduction

The importance of the internet has increased rapidly since its inception. International development demonstrates that the number of people spending time on the internet is increasing and that the "World Wide Web" has become a standard. From 2002 to 2011 alone, the percentage of private households with internet access in Germany rose from 42% to 77% [1]. "Electronic Commerce" is a sector that private individuals are increasingly taking note of. In general, Electronic Commerce (E-Commerce) is perceived as a part of "Electronic Business", which comprises the buying and selling of goods and services via electronic connections [2]. In the following sections, E-Commerce is viewed as is commonly the case in its correlation with the Business-to-Consumer (B2C) business relationship, in particular the ordering of goods in an internet shop. Similar to the general development tendencies of the internet itself, the number of people who have placed a purchase order on the internet has also grown. While in 2002 only 20% of Germans confirmed having conducted at least one E-Commerce transaction, by last year 2011 this number had risen to 66% [3]. These

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figures clearly attest to the increase of E-Commerce at the consumer level. The figures on companies that sell their goods and services on the internet and as such are also conducting E-Commerce have also demonstrated growth rates. While in 2003 only 10% of all companies offered their products for sale on an electronic network, within eight years this number had more than doubled (22%) [4], [5]. E-Commerce sales figures also indicate success within B2C trade. With 2011 online sales totalling 21.1 billion € [6], online mail order in particular is profiting from these figures.

The spectrum of articles offered on the internet stretches meanwhile from clothing articles to expensive electronics articles and on up to food products. Closer observation of online sales as relates to the different product groups according to shipper groups reveals the particularly high growth rate within the pharmacy mail order sector. While this sector's sales stood at approximately 210 million € in 2009, sales grew within a space of only one year to 280 million € in 2012. Only the manufacturer-shipper group demonstrated a higher total growth rate [7]. The fact that the pharmacy sector is in all likelihood not just experiencing a one-time trend can be explained with the help of findings on the demographic changes in Germany. As a result of the increasing number of older persons in our society, it is anticipated that the demand for medications and pharmaceuticals will also rise simultaneously in the future. Added to this is the fact that the affinity of the aging generation to the internet is also consistently growing and that these persons will use the internet as a purchasing platform.

The only argument challenging increasing development in the online mail order business sector is the security concerns that end consumers have. Surveys show that the full potential of E-Commerce is not completely exploited because one-third of internet users reject the concept of online purchases due to security concerns [8]. In view of the increasing importance attached to the discussion regarding data protection on the internet, this problem could expand further for E-Commerce. The still relatively low percentage of companies offering and selling their products online (22%) indicates enormous potential for improvement in the order processing processes on the internet. The anxieties related to E-Commerce consist primarily of insecurity regarding the authenticity of the business and simultaneously the sense of security as to whether the technical function is protected from external attacks and manipulation [9]. For the advancement of E-Commerce in the B2C market, it is therefore important to reduce the security risks. Attention should be given in this regard to ensuring that both participants in the ordering process can trust the respective other partner through standardised, broadly acknowledged procedures. For health care sector articles, this security awareness is even more important. Furthermore, in the mail order pharmacy or prescription pharmaceuticals segment, the process is decisively dictated by today's paper prescription procedure. The mail order pharmacy must first physically present the paper prescription for orders to be processed, which entails a longer reaction time for mail order pharmacies compared to local pharmacies.

After the ordering process, the delivery process for the ordered goods is the second-most important process in the customer processing procedure. With the constantly increasing growth rates of online trade in private customer business, the demands on shippers and package delivery services also increase, and not just in terms of quantity and subsequently financial risk. The customers of tomorrow will also have more specific demands and expect an expanded range of services. In the future this will also affect the delivery sector, particularly since the price alone is no longer the decisive factor for whether an internet buyer chooses a particular package delivery service. The logistics aspect of the secure delivery to the correct person is also constantly growing in importance against the backdrop of expensive, sensitive goods.

To improve the entire customer processing procedure in the online mail sector, new approaches have to be taken and the necessary conditions both in terms of ordering processes and of delivery processes must be developed. The "ePOD@Home - electronic proof of delivery at point of delivery" project acts on these demands and has set as its objective the development of a secure ordering and subsequent delivery process that satisfactorily resolves the security requirements and range of services demanded by both sides. This will involve the examination and development not only of the ordering process, but rather and in particular the entire associated logistics process right up to the delivery to the door. Efficiency and security are two important aspects that will be subjects of examination and subsequent evaluation in the development of the process.

2 State of the Art

2.1 Ordering and Delivery Processes

The sequence of the accustomed, widespread internet ordering process today requires every customer to register with the shipper prior to placing the actual order. The process involves the shipper requesting personal data such as name, address and e-mail address, for example. Data protection advocates criticise this, asserting that with many providers the business purpose of this is not directly discernible and that many data are gathered unnecessarily. For both providers and customers, it is difficult to check the authenticity of the opposite party. In the worst case, customers convey their confidential data to an unknown, unauthorised person over the internet. For companies, there is a financial risk: It is difficult for shippers to check whether customers have provided the correct information or have in fact intentionally or mistakenly given false information. Particularly in sectors trading in sensitive and expensive products, the company takes a financial risk or creates insecurity with the customer.

The following logistics delivery process to the recipient's front door has existed since the invention of the mail order catalogue and ordering by phone. The delivery process has since moved on from a signature on paper to today's accustomed signature on a delivery confirmation device from the service provider. However, this standard procedure does not fulfil either the legal demands or the future individual demands of the customers. In particular with expensive and sensitive goods like those in pharmacy mail order, it is important for customers and shippers that the right recipient receives the goods and that there is documentation of this process. Logistics service providers have recognised this problem and established solutions for it on the market. One of the first concepts requires that recipients can only receive delivery of their packages if they can provide a PIN during the delivery process which they have received previously on their mobile phones. This is intended to ensure that only the right recipient can receive the package [10]. Another service provider checks the identity and age of recipients by visually inspecting their identification documents and manually transferring the personal information into a mobile data entry device [11]. The disadvantage of these two added-value services is the lack of consistency, the efficiency of the processes and the limited degree of service for both customers and shippers. The ePOD@Home concept addresses these weak points with the research objective of designing the ordering and delivery process more efficiently, resulting in cost savings while improving security in the process at the same time.

3 Content and Initial Results

The ePOD@Home project researches and develops this topic in the following three project phases:

- Preparation phase,
- Conception and development phase
- and pilot phase.

Initially, a thorough analysis is conducted of the existing processes, structures and technical components required for the ordering and delivery process today, respectively, which could also be used in the future. This is followed by a conception and development phase in which the concept for the targeted processes and the basic IT infrastructure are worked out. Building on the defined processes and concepts, the software-related technical development of the necessary components ensues.

3.1 Preparation Phase

The aim of this phase is to register the current actual situation in regard to the existing processes and framework conditions. The emphasis of this step is on the search for a technical aid to support the targeted, as-yet-undefined processes. Electronic identification documents were examined in this framework as the primary technology for support of the process. In this regard, requirement criteria were defined, providing a basis on which a process of selection was conducted:

- Availability on the market,
- Penetration rate on the market,
- Functionality and
- Security.

Within the framework of the examinations, the choice was made from among the range of available electronic identification documents (for example, the electronic health insurance card, the new electronic identification document, the electronic signature card, the electronic passport) selecting the new electronic identification document (nPA) as the supporting technology. In addition to the availability of the technology, the rate of penetration within the population is very important for logistics processes designed to be offered throughout Germany. Due to the nPA's inherent function as the official national identification document, it is not only available, but compulsory for every German citizen. Foreigners living in Germany will also be obligated in the future to carry the electronic residence title (eAT) analogous to the nPA as their identification documentation. The nPA has been available since November of 2010 and will have a very high rate of penetration in 10 years because its predecessor will no longer be issued [12], [13]. In terms of security, the nPA integrates the latest technological findings, ensures the highest possible level of physical and electronic security and is the international leader in this segment at this time [14], [15], [16]. In addition to the conventional means of presenting the identification document as verification of identity, the nPA also offers new electronic functions. The ePass application serves in electronic identity verification for authorised official posts and cannot be used by the commercial sector [17]. The eSign application serves in creating legally valid electronic signatures. It is also not under further consideration, since its utilisation means additional annual costs for the owner of the identification document and it is not expected to be widely used. Use of the eID application is not associated with any additional costs whatsoever for the owner of the identification document and is available for the entire period of validity of the identification document. The eID application will therefore be prioritised during the continuing course of the project. The eID application possesses the electronic identification document functionality on the internet which enables a service provider to call up personal data. Service providers are defined as natural and legal persons requiring verification of identity via the identification document's eID application for the fulfilment of their own business purposes [12]. Private service providers (for example, companies with a web shop) fundamentally require an authorisation certificate which legally and technically enables them to communicate with the eID application contained within a nPA. The issuing authority for authorisation certificates (VfB)[1] requires an application process in which it examines whether a service provider is suitable for receiving an authorisation certificate for communication with electronic identification documents and whether the necessity exists for the access rights to nPA data that are a component of the authorisation certificate [12]. This official issuing process ensures that only legitimised persons read-out the identification document data and that only release-approved data are permitted to be read out. In the process, the consumer always retains the control over his or her own data. The release of the data ensues via the entry of a 6-digit PIN number on a certified read-out device in combination with eCard API software [18], [19]. Along with identification document data such as last name, first name(s), date of birth, place of birth, address, issuing country and expiration date, additional functionalities such as age verification and testing of the lock property can be executed for the ordering and delivery process [17].

3.2 Conception and Development Phase

On the basis of the actual processes that were registered and analysed, new targeted processes were developed for the ordering and delivery procedures in the field of online mail order. The eID function provided by the electronic functionalities contained in the nPA are integrated and used throughout this overall process.

[1] Vergabestelle für Berechtigungszertifikate (VfB).

Fig. 1. ePOD@Home overall process

The process already provides for the secure placement of the order by the customer with the support of the nPA. This includes the registration and log-in process. Electronic age inspection can also be executed as needed for specific products or product groups. Within the framework of the ordering process, the type of delivery service can optionally be selected by the customer or stipulated by the shipper. Three new types of delivery services were defined within the framework of the project:

- ePOD@Home Standard,
- ePOD@Home Dedicated and
- ePOD@Home Age verification.

The ePOD@Home Standard delivery service type enables delivery of the goods to be made at a predefined place, whereby delivery to a substitute recipient at a predefined place is also possible (for example, relative or neighbour). ePOD@Home Dedicated service provides for delivery only to the stipulated recipient and excludes delivery to a substitute recipient. ePOD@Home Age Inspection can be offered optionally in addition to the first service type and enables the age of the recipient to be inspected during the delivery. The nPA data will be read out according to the chosen type of delivery service during the delivery and subjected to a matching process with the order data as required. Once the inspection has been completed successfully, the delivery person receives authorisation to hand over the goods.

From a technical point of view, the existing technical nPA infrastructure can be accessed in the ordering process, since this provides the possibility for a network connection to the public key infrastructure (PKI) (cp. Figure 2). An important component in this regard is the so-called eID server, which assumes the task of eID authentication for the service provider's web service [20]. One important intermediary result that was discovered during the project and which must be accounted for in the work conducted on its further development is that it is not always possible in the delivery process to ensure a network connection with the required eID server due to the surrounding environment (for example, in a cellar or in rural regions). As such, the delivery service could only be implemented to a limited extent and not comprehensively under real conditions (cp. Figure 2).

In concrete terms this means that the logistics service provider's delivery device must be expanded in order to be able to communicate with the nPA without a network connection. In such case, the delivery device must read-out the recipient's eID data and be able to allocate the type of service and the data on the customer and the shipment data in a manner that is in line with the specific purpose. For this a mobile,

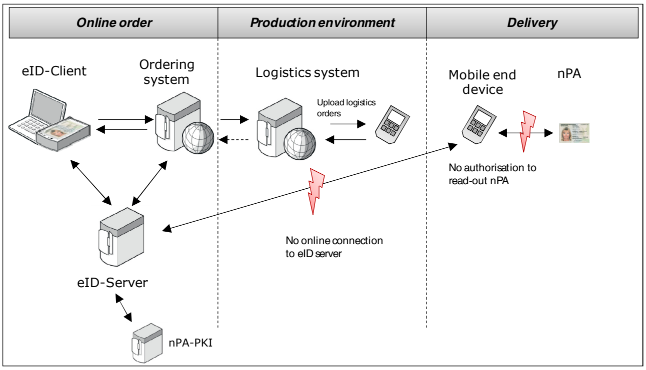

Fig. 2. Challenges in the mobile delivery process

offline eID system must be developed which, from a practicability perspective, represents the more flexible and, ultimately, the only way. Based on the current state of technology, this is an innovation. While previous tests and concepts have addressed eID applications in an offline system or in a mobile online environment, this does not apply for implementation in a mobile, offline environment [21], [22]. ePOD@Home represents the effort to attain a completely new area of application for the nPA which has not been considered in the previous concepts. For this reason, new processes, concepts and the necessary technical IT components must be modified and developed.

Utilisation of the Near Field Communication (NFC) transmission standard for the contact-free read-out of the data by a mobile end device is not sufficient, since it is not secure against attacks by third parties on the basis of the customary definition [23]. eID authentication is based on the Extended Access Protocol (EAC) in accordance with German Technical Guideline TR-03110 [16]. Extended Access Control enables mutual authentication between the terminal and chip consisting of additional sub-protocols, whereby authorisation is conducted via the public key infrastructure (PKI). In the online eID system a terminal is made up of components consisting of a certified card reading device, eCard API software for controlling eID authentication and the eID server that conducts the eID authentication. The online system is supplied with the necessary data via an automated interface. The mobile, offline eID system is lacking this connection and therefore cannot acquire the necessary data via the interface. The offline eID system must therefore integrate the terminal to be able to conduct authentication self-sufficiently. In the end, the mobile end device must assume the function or partial function of the eID server, the eCard API software and the card reading device. The challenge consists of integrating these components, physically as well, into the mobile end devices and meeting the stipulated demands. In addition to the aspect of data storage in the mobile delivery device, the aspect of data provision (key material, lock lists, authorisation certificate) to the mobile end device must be ensured during the preliminary run-up by means of an organisational process. The concept builds on today's process sequences of the logistics service provider. This data provision process should by all means be integrated into the daily loading processes at the shipping centres and the order upload to the delivery devices. In this regard, a yet-to-be-developed supply station (cp.

Figure 3) should assume the data provision, also again assuming a partial function of the eID server analogous to the mobile end device. The supply station acquires the necessary data from the PKI and can then upload the data to the mobile delivery devices. This procedure has the advantage that the certificates can run with shorter validity terms and therefore also authorise the reading out of a nPA for a shorter period. The risk of abuse using the mobile delivery devices on the basis of theft or loss can be reduced in this way to a minimum. Additionally, simply owning such a mobile delivery device does not therefore facilitate the random read-out of identification documents, since the entry of a PIN by the person in question is required.

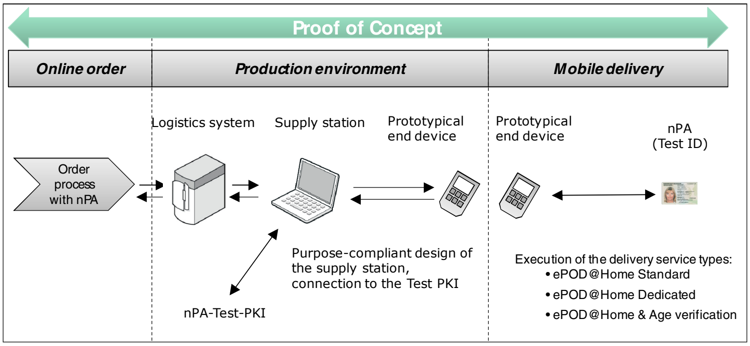

Fig. 3. Proof of concept

4 Summary

The objective of the ePOD@Home project is to develop a consistent, secure process for the ordering and delivery process in order to make a contribution to the future's increasing security requirements and the individual demands of customers and shippers in the E-Commerce sector. Existing barriers should be broken down and existing potential in E-Commerce should be raised in the process. The integration of the new electronic ID will ensure an optimum level of security and ultimately almost full-coverage access to the overall process. In addition and as requested by the political world, the first commercially applicable solution in the new electronic ID segment will emerge and will play no small role in the ultimate success of this innovative technology.

Along with the build-up of new processes, within the framework ePOD@Home new software components and the necessary technical components for supporting the overall process are also being developed. However, the integration and provision of technical components is not helpful to the objective if the efficiency and benefits for the participants cannot be realised and presented. For this reason, the prototypical construction of a testing ground should offer help in the economical and technical assessment of the overall process. This proof of concept offers shippers and logistics service providers the opportunity to conduct preliminary assessment of the demands they face in the development of ordering and delivery processes that fulfil the necessary requirements and subsequently to apply sustainable solutions in actual practice.

References

1. Statistisches Bundesamt: Informationsgesellschaft in Deutschland (February 22, 2012), http://www.destatis.de/
2. Hess, T.: Electronic-Commerce (E-Commerce), 2. Aufl., Wiesbaden. In: Sjurts, I. (Hrsg.) Gabler Lexikon Medienwirtschaft (2011)
3. Statistisches Bundesamt. Private Haushalte in der Informationsgesellschaft – Nutzung von Informations- und Kommunikationstechnologien (February 23, 2012), http://www.destatis.de/
4. Hauschild, W., Tenz, B.: Informations- und Kommunikationstechnologie in Unternehmen, Statistisches Bundesamt (February 22, 2012), http://www.destatis.de/
5. Statistisches Bundesamt: Nutzung von Informations- und Kommunikationstechnologien in Unternehmen (February 22, 2012), http://www.destatis.de/
6. Bundesverband des deutschen Versandhandels: Jahresprognose für den interaktiven Handel (February 23, 2012), http://www.versandhandel.org/
7. Bundesverband des deutschen Versandhandels: Umsätze mit Waren nach Versender-Gruppen (February 23, 2012), http://www.versandhandel.org/
8. Czajka, S., Mohr, S.: Einkäufe privater Haushalte über das Internet, Statistisches Bundesamt (February 23, 2012), http://www.destatis.de/
9. Grimm, R.: Vertrauen im Internet – Wie sicher soll E-Commerce sein? In: Müller, G. (ed.) Sicherheitskonzepte für das Internet. Springer (2001)
10. General Logistics Systems Germany: IdentPin Service (February 24, 2012), http://www.gls-group.eu/
11. Deutsche Post AG: Identitäts- und Altersprüfung (February 24, 2012), http://www.dhl.de/
12. Gesetz über den Personalausweis und den elektronischen Identitätsnachweis (Personalausweisgesetz, PersAuswG) (June 18, 2009)
13. Verordnung über Personalausweise und den elektronischen Identitätsnachweis (Personalausweisverordnung, PersAuswV) (November 01, 2010)
14. Löer, T.: Neue Identitätskarten – aktuelle Trends und ein Blick in die Zukunft aus. In: Bub, U., Wolfenstetter, K.-D. (eds.) IT-Sicherheit zwischen Regulierung und Innovation. Vieweg + Teubner Verlag (2011)
15. Dagdelen, O., Fischlin, M.: Technische Universität Darmstadt, Studie Sicherheitsanalyse des EAC-Protokolls (October 11, 2010), http://www.bmi.bund.de/SharedDocs/Downloads/DE/Themen/Sicherheit/PaesseAusweise/sicherheitsanalyse.html?nn=294838 (February 28, 2012)
16. Bundesamt für Sicherheit in der Informationstechnik – BSI (Hrsg.): Technische Richtlinie TR-03110 - Advanced Security Mechanisms for Machine Readable Travel Documents - Extended Access Control (EAC), Password Authenticated Connection Establishment (PACE), and Restricted Identification (RI). Version 2.05 (October 14, 2010)
17. Bundesamt für Sicherheit in der Informationstechnik – BSI (Hrsg.): Technische Richtlinie TR-03127 - Architektur Elektronischer Personalausweis. Version 1.13 (Oktober 18, 2010)

18. Bundesamt für Sicherheit in der Informationstechnik – BSI (Hrsg.): Technische Richtlinie TR-03112 - eCard-API-Framework. Version 1.1 (July 15, 2009)
19. Bundesamt für Sicherheit in der Informationstechnik – BSI (Hrsg.): TR-03119-Anforderungen an Chipkartenleser mit ePA Unterstützung. Version 1.2 (May 27, 2011)
20. Bundesamt für Sicherheit in der Informationstechnik – BSI (Hrsg.): Technische Richtlinie TR-03130 - eID-Server. Version 1.4.1 (October 08, 2010)
21. Gilles, T.: Analyse der technischen Umsetzbarkeit von Offline Systemen zur Authentisierung und Altersverifikation über die eID-Anwendung des elektronischen Personalausweises, FernUniversität in Hagen (September 12, 2011)
22. Horsch, M.: Mobile authentication using the new German identity card, Technische Universität Darmstadt, Fachbereich Informatik (Juli 2011)
23. DIN ISO/IEC 15408: Informationstechnik - IT-Sicherheitsverfahren - Evaluationskriterien für IT-Sicherheit (November 2011)

Urban Retail Logistics – Research into the Bundled Urban Store Deliveries of the Future

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Abstract. The efficiency of Retail Logistics is threatened by increasing regulation and up-coming consumer requirements concerning urban deliveries. A typical feature of morning deliveries to the retail outlets is the extensive traffic jams they encounter on their way – and there seems to be no improvement in sight, unless the basic system can be improved in some way. But just how can today's retail logistics be changed? Urban Retail Logistics is presented as a new research approach to find answers to this question by following the idea of collaboration among retailers for bundling their urban store deliveries.

Keywords: EffizienzCluster Logistik Ruhr, retail logistics, bundling store deliveries, cooperation, Urban Hub, Urban Information System.

1 Introduction

Over the last few decades logistics has taken up an important role within retail companies. It comprises the planning, handling, designing and controlling of all material and information flows between a retail company and its suppliers, as well as within a retail company and between a retail company and its customers and/or subsidiaries [1,2]. Due to increasing cost pressures and because its portion of costs is up to 15,9% [3] retail logistics is often declared to be a core competency of retailers [4]. It is regarded as a relevant instrument for improvements in productivity on the one hand, and could generate a unique selling proposition in terms of e.g. delivery service on the other.

The success of a retail logistics network is typically measured by its efficiency, which is defined in this context as the interaction between input (i.e. costs) and generated output (i.e. service) [5]. The optimized interaction between these two factors is responsible for the logistics performance.

However, the efficiency of retail logistics is threatened when it comes to urban deliveries. Currently it is impacted by two main factors:

First of all, the delivery quality for inner city retail outlets is suffering from the increasing number of rush hour traffic jams. [6] This traffic congestion will continue

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to grow as urbanization increases, with the latest forecasts predicting that more than 65 % of the world's population will be living in urban areas by the year 2050. [7] This also has an influence on the environment: in many European city centres the increase in traffic has led to negative impacts due to pollution. The European economy is losing almost 100 billion Euros every year because of this, i.e. around 1 % of GDP. [8,9].

Secondly, new trends from the retailers are giving new impetuses to logistics as well: new local branch concepts are being put to the test in city regions, new "corner shop" style stores, drive-in-concepts and even pop-up stores are leading to changes in sales area ratios and store sizes, as well as to product ranges, which in turn mean logistics services have to face changing order quantities and delivery frequencies [10]. This has to be regarded as a new dimension of urban delivery and is in addition to developments over the last decade such as just-in-time-concepts and the steady conversion of storage rooms in store areas [e.g. 11, 12]. The outcome of this is that consignment structures become more dynamic, delivery quantities shrink, vehicle capacity utilization drops and distribution costs rise due to less efficiency and, in future, even more costs might be incurred when driving into city-zones.

On the bottom line, retailers have to transport ever fewer products, more and more frequently, through streets which are becoming busier and busier. Conventional concepts cannot fulfill these new requirements efficiently anymore. Maintaining the old system would also mean more commercial traffic which would lead to an even greater burden on the traffic situation, thus counteracting all governmental efforts to reduce emissions. [13] It is widely recognized that especially efficient urban goods movement is crucial for the competitiveness and the economic vitality of urban areas [14,15,16]. Therefore, it is necessary to develop new concepts to fulfill these new requirements efficiently.

2 Research Field – Urban Retail Logistics

In the following chapter the variety of definitions concerning transport and logistics in urban areas as well as relevant approaches for designing consumer goods distribution are discussed. On that basis the research topic Urban Retail Logistics is defined and distinguished from previous research approaches.

2.1 Research Topic Urban/City Logistics

Consumer goods, assembly parts, building materials, waste, parcel and mail deliveries are just a few examples of the variety of urban goods flows [17]. In the research landscape, different research terminologies and approaches are used when considering the urban supply and delivery of goods. Most of them can be summarized under the terms "urban freight transport" or rather "urban goods movement" as well as "city logistics". On an international level these terms are often used synonymously. [18]. Whereas "urban freight transport" is mostly used in anglophone publications, "city logistics" is the most widespread, especially in Germany.

There is no consistent scientific definition of these terms. For example, Odgen [19] defines urban goods movement as "the movement of things (as distinct from people) to, from, within, and through urban areas". OECD [20] defines it as the delivery of consumer goods (not only by retail, but also by other sectors such as manufacturing) in city and suburban areas, including the reverse flow of used goods in terms of clean waste".

The same applies to the term "city logistics". In Germany, the term was developed in the 1990's. For instance, Wittenbrink [21] defines it as "all operational and planning tasks which are tailored to suit a market need in terms of type, quantity, time, space, environmental factors balanced with efficient supply and disposal of goods in a city". An international definition is given by the Institute of City Logistics as "the process for totally optimizing the logistics and transport activities by private companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption within the framework of a market economy" [22]. Due to this variety of definitions, Quak [18] developed a consistent framework for describing research projects and studies in the field of city logistics/ urban freight transport.

2.2 Research Topic - Consumer Goods Distribution

The high number of consumer goods suppliers and the even higher number of retail outlets, shops or markets represent sources and points of delivery which form a logistics network characterized by a tremendous degree of complexity [23]. Generally, there are two basic approaches to designing such logistics networks [24]. Firstly, the configuration of a logistics system which determines the structural dimensions in terms of spatial, technical and personnel features [25]. Secondly, the coordination of a logistics system which concerns the arrangement of operational material and information flows within a determined structure [24, 25]. Moreover, the concrete design of a logistics system is mostly carried out according to three parameters: centralization vs. decentralization (infrastructure), bundling vs. separating (process) and demand-oriented vs. forecast-oriented (process) [26].

It is also possible to recognize mutual dependencies between these three design parameters and two design dimensions [23,24,25]. Therefore, a logistics system must find the right balance within these design options in order to realize cost reductions and the delivery service which is desired. The efficiency of a logistics system in terms of potential cost reductions mostly depends on the exploitation of bundling [27]. According to these assumptions four main flow types have been developed by retailers and their suppliers: Direct-to-store, regional/central warehouse or Cross Docking 1 and 2 [28].

Considering further research approaches and innovative concepts in terms of retail logistics or rather consumer goods distribution, Efficient Consumer Response (ECR) is widely investigated in the scientific and practitioner communities. It could be understood as a Supply Chain Management (SCM) philosophy which develops and implements strategies and actions within the supplier and retailer value chain. Suppliers, retailers and consumers are integrated in this approach. ECR focuses on the vertical cooperation between supplier and retailers here [1, 29]. Basic principles for generating cost reductions are Efficient Unit Load and Efficient Replenishment [1].

Moreover, the Consumer Goods Forum is developing a framework for future consumer goods distribution. In their publication “Future Value Chain 2020” [30] in particular, strategies for collaborative distribution logistics are described and a future supply chain model is set up. The idea is based on supplier cooperation based on shared warehouses and urban cross docking centers.

2.3 Defining the Research Field Urban Retail Logistics

Urban Retail Logistics is a research field which picks up on state of the art research in terms of urban freight transport and city logistics as well as collaboration. Currently, retailers are the most important players when distributing goods to their stores in urban areas. In addition, retail chains increasingly control the complete supply chain and physical distribution of goods from the supplier’s warehouse to the stores [6, 18, 31, 28, 23]. For over 80% of deliveries in Germany, the regional or central warehouse of a retailer is the starting point for distributing goods into urban areas [28].

This is why a German initiative consisting of Fraunhofer IML, Metro Group Logistics, Rewe Group, Lekkerland, Capgemini, DOEGO, Landgard and GS1 has set up a new research project within the EffizienzCluster LogistikRuhr named Urban Retail Logistics. In comparison to the ways city logistics has grown so far, the retail trade is itself a driving force behind the new concept. Until now, most city logistics research approaches were set up by local authorities without the sufficient involvement of retailers.

The consortium developed the following definition of the research field:

> Urban Retail Logistics is a cross-retailer approach to an efficient logistic re-organization of urban supply structures and individual urban retail logistics concepts. In addition to solving economic and ecological challenges, in particular the changing social and political requirements are to be taken into account. In this context the deployment of key technologies and innovative services are to be considered as significant success factors.

The main point of Urban Retail Logistics is the cooperation between competitors for bundling urban goods flow in order to assure the efficiency of retail logistics networks according to future framework requirements. In contrast to general design approaches it provides a holistic design process which considers cross-company as well as public requirements. Compared to ECR and the Future Value Chain Initiative, it is a horizontal cooperation of retailers in terms of urban store deliveries.

3 Research Approach

In order to investigate this complex field, a holistic research approach within the project was chosen. The idea of Urban Retail Logistics focuses on the design of urban logistics processes as well as the development of an urban information system (see Figure 1). Therefore, all determining factors and restrictions have to be considered such as legal, consumer/store and technological requirements. The fulfillment of these requirements is necessary in order to make collaborative urban delivery feasible.

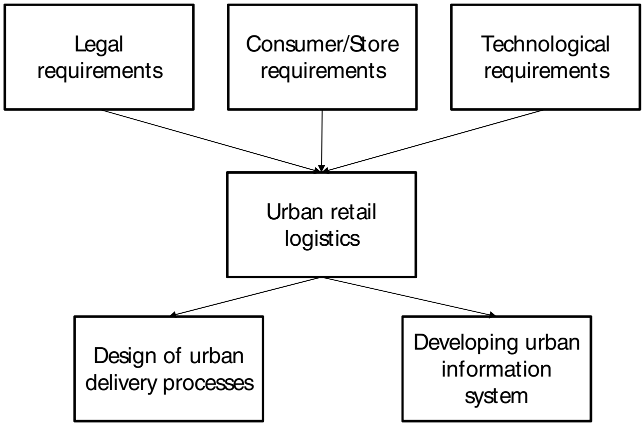

Fig. 1. Research approach Urban Retail Logistics

3.1 Legal Requirements

Urban delivery is considered in most countries as a local issue and thus is strongly affected by regulations set by local authorities [17, 20]. Nevertheless there are directives and guidelines on an e.g. EU level which are very important when dealing with urban supply. For that reason, the consortium analyses the latest and future influences as regards the legal aspects. One of the first steps in the project was to investigate the legal situation and the impact of laws at EU, federal and state levels. This phase has resulted in the creation of a complete collection of the laws which must be adhered to for urban transportation.

3.2 Consumer and Store Requirements

In order to develop new retail logistics concepts, future developments of consumer trends and retail concepts have to be taken into account. Besides the legal requirements, an analysis of customer and store requirements was conducted. Articles, surveys and books were screened to identify relevant future consumer trends and store requirements which affect retail logistics. A bundle of theses were formulated regarding the trends thus identified. These theses were then rated by different retail companies in order to set up a picture of future requirements.

3.3 Technological Requirements

An in-depth study was conducted of national and international research projects dealing with technologies in terms of urban distribution logistics. Moreover, information platforms e.g. bestufs.net were used as a knowledge database for identifying interesting technologies, e.g. low noise reduction equipment or pick up stations.

3.4 Design of Urban Logistics Processes

For rethinking urban supply processes and designing new and innovative urban logistics processes a multi-stage approach with different methods was used (see figure 2). The aim was to set up a standardized process which could be applied in periodic innovation cycles e.g. every 2-5 years and in different urban areas or cities. The following paragraphs explain the different parts of the design process shown in Figure 2.

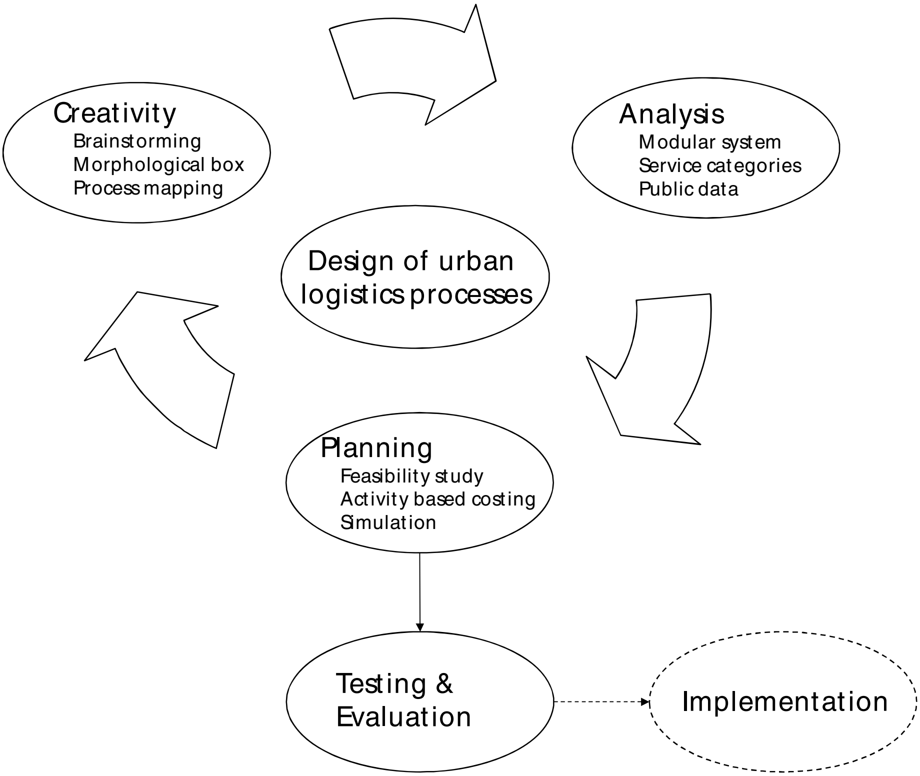

Fig. 2. Design of urban logistics processes

Step1 - Creativity: After investigating legal, technological and customer requirements surveys, the first step, entitled “creativity”, aimed towards an open-minded process of thinking about new possibilities in urban supply e.g. combining home delivery with health care services. Besides using brainstorming techniques, a morphological box was used to develop innovative scenarios in terms of bundling different urban goods flows as shown in Table 1. It facilitates the various possibilities of the bundling potentials of different retail formats by listing relevant criteria such as retail channel, retail type, present assortments, flow types and the logistical units used.

Table 1. Example of a morphological box

Criteria	Specifications							
Channel	Hypermarket	Supermarket	Small stores	Convenience	Pick-up	Consumer	...	
Type	Grocery	Drugs	Electronics	OTC	Parcel	DIY	Furniture	...
Assortments	Frozen	fruits&vegetables	Dry	Non-Food	chilled	beverages	bakery	...
Flow types	Warehouse	CD1	CD2	...				
Logistical unit	pallets	picked pallets	parcel	...				
...								

Step2 - Analysis: By choosing a scenario for an urban bundling commodity flow two central questions are revealed immediately: What are the impacts of a specific bundling scenario? Which goods are particularly suitable for cooperation in urban store delivery? This especially concerns the resulting quantities for further logistical planning. Moreover, researchers have already stated that it is difficult to get detailed and reliable data on urban logistics [32,33]. Following on from this, a comprehensive analysis was carried out of the commodity flows which could be bundled in an urban region. It is certainly not possible to bundle all ranges of goods or every type of commerce equally well into one delivery route or at one hub. That is why the question of which logistics requirements and performance profiles had to be differentiated between for each retail format and assortment of goods was always in the foreground during the analysis. The results of this provide the basis for outline plans and reveal where there is more or less potential for bundling, which quantities are too much or too little and what just cannot be bundled at all.

Step3 - Planning: In this step scenarios are quantified with activity-based costing and the feasibility has to be checked. In addition, every scenario is rated by different Key Performance Indicators (KPI) such as delivery time, bundling factor, ton-kilometers, etc.

Step4 - Testing: If ideas prove to be promising on paper, they will then be successively installed in a pilot scheme and undergo practical tests. Within the research project this will happen at the beginning of 2013.

Step5 - Implementation: If these systems pass the practical tests to be carried out at the end of the project, then retail companies and other suppliers will benefit from this, as the nightmare delivery scenarios described at the beginning would be a thing of the past. This could lead to new methods of goods delivery for the consumer and see service providers offering more new services as well.

3.5 Developing an Urban Information System

IT is seen as a key enabler for setting up collaborative urban retail logistics. After defining bundling scenarios and requirements the functional specifications of an Urban Information System (UIS) were carried out. This new UIS must be able to take retailers, suppliers and other partners into the network at a moment's notice and to include them in store deliveries. That creates extremely high demands and can only function if communication standards (EDI/EANCOM) are used as well as auto.ID technology. In such a system the preliminary planning has all the necessary information at hand on time, route scheduling only needs short lead times and goods can be unloaded and loaded more quickly and efficiently. These are also vital requirements if this form of urban handling has a chance of being implemented, as both costs and time are significant factors.

4 Intermediate Results

By following this process in the Urban Retail Logistics research project, a series of logistics concepts as a result of step 1 are currently being discussed and analyzed before they are put into testing operation.

For example, the plan is to design new urban supply processes via an "urban hub". This is a logistics location with an optimized infrastructure which will serve as a "hot spot" for delivery processes, including other possible urban supply partners, such as parcel services, regional suppliers or even the local pizza service. The greatest challenge here is to achieve very fast movement of goods at acceptable costs. Another approach is the idea to redeploy deliveries from the main traffic times to the late evening or even to the night, which would raise the challenge of unloading trucks quietly so as not to disturb the neighbors. This project is looking into an approach using a "mobile incoming goods cell" with which goods can be delivered quietly, and simultaneously be protected from theft, by using a swap body system.

Another business case is "Logistics for the Corner Shop 2.0". It refers to the consideration that logistic requirements for delivering to branches with a small floor area and for delivering to end customers are very similar when it comes to the delivery quantities involved. The aim is to develop a concept which combines logistics for static and virtual retail business.

Moreover, the analysis (step 2 of the design process) of public data offers first results especially in terms of restrictions for urban store delivery.

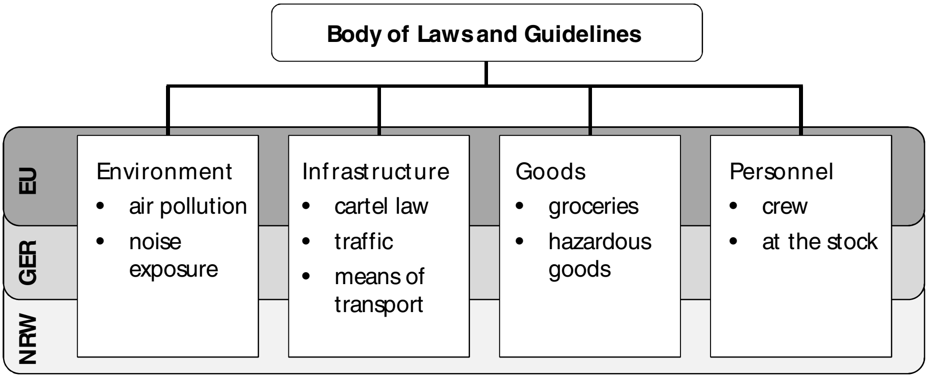

Fig. 3. Body of Laws and Guidelines

The legal requirements illustrated in Figure 3 have been classified in four main issue categories: environment, infrastructure, goods and personnel. Each of them can be divided into more detailed aspects as shown in Figure 3. In addition, all legal requirements act on different administrative levels such as European Union (EU), national (Germany) or regional (e.g. NRW- North Rhine-Westphalia) levels. By distinguishing between laws, guidelines, by-laws and miscellaneous, such as commendations, rules, agreements etc., the significance of the different conditions is highlighted (see Table 2).

Table 2. Numbers of legal requirements classified in main topics and forms of restriction

	legal requirement	body of laws			guidelines			by-laws			miscellaneous		
main topic		EU	GER	NRW	EU	GER	NRW	EU	GER	NRW	EU	GER	NRW
environment	air pollution		1	1	2				2			1	
	noise exposure		5	1	3				2			1	
infrastructure	cartel law		1					3					
	traffic								2	1			
	means of transport		1					2					
goods	groceries				3			4	4		1	3	
	hazardous goods		3		1				3	1	1	1	
personnel	crew		1					1	1		1	1	
	at the stock		1									3	

5 Conclusions

After completing the creativity, analysis and planning phases in the first two years of the project, work on designing logistics services to carry out the bundling and deliveries to both local branches and end customers will be substantiated and evaluated. Requirements catalogues for technological developments for follow-on projects and software development for this project will also be compiled. Then in 2012 a prototype software system will be developed and in 2013 the pilot installation will be set up for the first application of logistics concepts and software systems in a test version of the urban hub. This pilot installation will mainly serve to evaluate the modules which have been developed. After the close of the project the aim is to develop the prototypes to market readiness so they can be installed in real retail logistics. The modules also support the development of completely new business models for service providers, such as transport and handling services or supporting IT services.

References

1. Lange, V.: Handelslogistik. In: Arnold, D., Isermann, H., Kuhn, A., Tempelmeier, H., Furmans, K. (eds.) Handbuch Logistik, pp. B 8.1. Springer, Berlin (2008)
2. Kotzab, H.: Handelslogistik. In: Klaus, P., Krieger, W. (eds.) Gablerlexikon Logistik: Management logistischer Netzwerke und Flüsse, pp. 169–174. Gabler, Wiesbaden (1998)
3. Straube, F., Pfohl, H.-C.: Trends und Strategien in der Logistik: globale Netzwerke im Wandel. DVV Media Group, Hamburg (2008)
4. Gudehus, T., Brandes, T.: Logistik: Kernkompetenz des Handels. Dynamik des Handel 1, 70–71 (1997)
5. Pfohl, H.-C., Zöllner, W.: Effizienzmessung der Logistik. Die Betriebswirtschaft 3, 191–194 (1991)
6. Auffermann, C., Mahlstedt, K., Schneider, S., Kempcke, T.: Trends in der Handelslogistik 2011: Ergebnisse einer Befragung führender Handelsunternehmen in Deutschland, Österreich und der Schweiz. EHI Retail Institute GmbH, Köln (2011)

7. Department of Economic and Social Affairs (UN/DESA), Population Division: World Urbanization Prospects: The 2009 Revision, United Nations, New York (2009)
8. EU Commission: Green paper: towards a new culture for urban mobility, Brüssel (2007)
9. Anderson, S., Allen, J., Browne, M.: Urban Logistics: How can it meet policy makers' sustainability objectices? Journal of Transport Geography 13(1), 71–81 (2005)
10. Schulz, F., Klewar, J., Froessler, D.R.: Einzelhandel im Wandel: Innovative Nahversorgungskonzepte für eine bewohnernahe Versorgung, 2nd revised edn. Innovationsagentur Stadtumbau NRW, Düsseldorf (2009)
11. Drewes Nielsen, L., Jespersen, P.H., Petersen, T., Hansen, L.G.: Freight transport growth: A theoretical and methodological framework. European Journal of Operational Research 144(2), 295–305 (2003)
12. Vleugel, J.M., Janic, M.: Route Choice and the impact of logistic routes. In: Taniguchi, E., Thompson, R.G. (eds.) Logistics Systems for Sustainable Cities, Proceedings of the 3rd International Conference on City Logistics, pp. 221–234. Elsevier, Amsterdam (2004)
13. Erdmenger, C., Carey, P.: Urban road charge in European cities: A possible means towards a new culture for urban mobility?. Report of the Joint Expert Group on Transport and Environment on urban road pricing schemes in European cities of the EU Commission, Brüssel (2010)
14. Allen, J., Anderson, S., Browne, M., Jones, P.: A framework for considering policies to encourage sustainable urban freight traffic and goods/service flows. Transport Studies Group, University of Westminster, London (2000)
15. Munuzuri, J., Larraneta, J., Onieva, L., Cortes, P.: Solutions applicable by local administrations for urban logistics improvement. Cities 22(1), 15–28 (2005)
16. Browne, M.: Freight transport and the city. In: ECMT (eds.) Roundtable 109. OECD Publications Service, Paris (1999)
17. Dablanc, L.: Goods transport in large European cities: Difficult to organize, difficult modernize. Transportation Research Part A 41(3), 280–285 (2007)
18. Quak, H.J.: Sustainability of Urban Freight Transport: Retail Distribution and Local Regulations in Cities. Erasmus University Rotterdam, Haveka, Rotterdam (2008)
19. Odgen, K.W.: Urban Goods Movement: A Guide to Policy and Planning. Ashgate, Aldershot (1992)
20. OECD: Delivering the goods: 21st century challenges to urban goods transport. OECD working group on urban freight logistics, Paris (2003)
21. Wittenbrink, P.: City-Logistik: Neues schönes Zauberwort. DVZ 17, 7 (1992)
22. Taniguchi, E., Thompson, R.G.: City Logistics I. Institute of City Logistics, Kyoto (1999)
23. Petzina, T.: Chancen und Grenzen der Supply Chain Collaboration in der Konsumgüterdistribution: Konzeption und Bewertung von Gestaltungsalternativen in der Logistikkette zwischen Industrie und Handel. Universität zu Köln, Wirtschafts- und Sozialwissenschaftliche Fakultät, Köln (2007)
24. Delfmann, W.: Industrielle Distributionslogistik. In: Weber, J., Baumgarten, H. (eds.) Handbuch Logistik: Management von Material- und Warenflussprozessen, pp. 181–201. Schaefer-Poeschel, Stuttgart (1999)
25. Klaas, T.: Logistik-Organisation: ein konfigurationstheoretischer Ansatz zur logistikorientierten Organisationsgestaltung. Universität zu Köln, Köln (2002)
26. Pfohl, H.-C.: Logistikmanagement: Implementierung der Logistikkonzeption in und zwischen Unternehmen, Funktionen und Instrumente (Band 1). Springer, Berlin (1994)
27. Erdmann, M.: Konsolidierungspotenziale von Speditionskooperationen: eine simulationsgestützte Analyse. Universität zu Köln, Köln (1999)

28. Thonemann, U., Behrenbeck, K., Küpper, J., Magnus, K.-H.: Supply Chain Excellence im Handel. Gabler, Wiesbaden (2005)
29. Heydt, A.: Efficient Consumer Response. Peter Lang, Frankfurt/Main (1998)
30. Consumer Goods Forum: Future Value Chain. Building Strategies for the new decade, Paris (2011)
31. Van der Vlist, P.: Synchronizing the retail supply chain. ERIM, Rotterdam (2007)
32. Ambrosini, C., Routhier, J.L.: Objectives. Methods and Results of Surveys Carried out in the Field of Urban Freight Transport: An international Comparison. Transport Reviews 24(1), 57–77 (2004)
33. Browne, M., Allen, J.: Urban freight data collection: Synthesis report. TREN/04/FP6TR/S07.31723/506384, BESTUFS II (2006)

Development of a Concept for Inner-City Delivery & Supply Utilising Electromobility

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1 Introduction

Topicality and relevance. In these times of climate change and the shortage of limited resources, electromobility is increasingly receiving greater focus from large, industrialised nations, cp. Clausen (2008, Pg. 16ff.) 1. Within the framework of the National Electromobility Development Plan that was ratified in August of 2009, the Federal German Government plans to have one million electric vehicles conducting transports in Germany by 2020. The financial support of 500 million Euros provided by the Federal German Government is aimed at supporting the short-term goals of the plan. In addition, this funding will support a three-phase plan advancing the viable marketability of electric vehicles, in particular research and development of electric vehicles and their components. Since 2009, mobility projects have been sponsored in eight model regions in Germany in the first phase of the development plan. These projects examine the implementation of a vehicle charging infrastructure, the application of electric vehicles and new city logistics concepts. Nevertheless, it remains to be seen whether electromobility can still be regarded as a key for solving the problems related to the environment and climate against the backdrop of the ongoing energy transformation in Germany. The electromobility public passenger transport systems and commercial transport already in widespread use today appear to have an astonishingly low level of priority in this discussion at the moment. Up to now, delivery vehicles have only played a subordinate role to cars in these electromobility projects, cp. Swantusch (2010, Pg. 22f.) 2, Simon (2009, Pg. 29) 3, Becker (2010, Pg. 148) 4. The often more clearly defined application purposes and radiuses of such vehicles in comparison to modes of individual transportation, i.e. cars, suggest a tendency for greater potential benefit, justifying and necessitating that new supply and disposal concepts for cities integrated with the inherent characteristics of electromobility delivery vehicles be taken into consideration, cp. Clausen (2011) 5. The application of electromobility makes particular sense in the functional areas of inner-cities and population centres due to the specific environmental situation; its application requires an expansion or reinterpretation of the concept of city logistics, cp. Kümmerlin (2009, Pg. 6) 6. A new concept arose in this regard in the 1990s which was aimed at bundling inner-city delivery flows, but it did not demonstrate sustainable economic success and subsequently was increasingly left by the wayside, cp. Allemeyer (2003, Pg. 5f.) 7 and Kümmerlin (2009) 8.

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 121–127.
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For the authors, the application of electromobility represents an opportunity to reanalyse how cities are supplied from a new perspective. The conceptual idea of city logistics is the basis for such new concepts. The analysis also examines the extent to which such supply concepts are feasible with today's technology and what prospects these technologies have in the future.

2 State of the Technology and Principles

The following sections deal with the scientific principles of the topics of city logistics and electromobility. Their findings provide the basis thereafter to draw conclusions relating to possible "electromobility inner-city delivery & supply".

Electromobility. There is no generally accepted definition for the term "electromobility". In Germany, the topic of electromobility ("Elektromobilität") is first mentioned in 2007 in the Federal German Government's Integrated Energy and Climate Programme (cp. Bundesumweltministerium (2007, Pg. 8) [9]. The context of the national development plan includes electric road passenger vehicles, smaller utility vehicles, two-wheeled vehicles and light vehicles. It also mentions city busses and other vehicles that are not more precisely specified. The drive concepts referred to for these vehicle groups are limited to purely electric battery vehicles commonly known as battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV) and electric vehicles equipped with range extenders and called range extender electric vehicles (REEV). Fuel cell technology-based drives are generally excluded from funding by the German government's NIP programme, which handles hydrogen and fuel cell technology, cp. Federal German Government (2009, Pg. 6ff.) 9, Helmers (2009, Pg. 14) 10. We will nevertheless also include these types of vehicles in our examination framework of delivery and supply concepts, since they also represent a form of electromobility. The following well-to-wheel analysis (Fig. 1) depicts the applied limitations. The work does not focus on vehicle classes that serve primarily in passenger transport.

3 City Logistics

In order to be able to provide a functional concept for inner-city transports, all of the factors affecting the topic must be included in the analysis. The organisational, personnel-related and infrastructural components and their interfaces must be extensively examined and analysed.

Particularities of the functional area, "inner-city". An increasing number of people are living in urban centres. The population uses individual transport, needs a supply of food and clothing and requires disposal services. While these types of transports are able to run smoothly alongside one another in less densely populated areas, many cities are confronted with growing traffic problems. In addition to the efficiency losses resulting from traffic jams and road accidents, residents of urban centres are increasingly voicing their concerns about air and noise pollution.

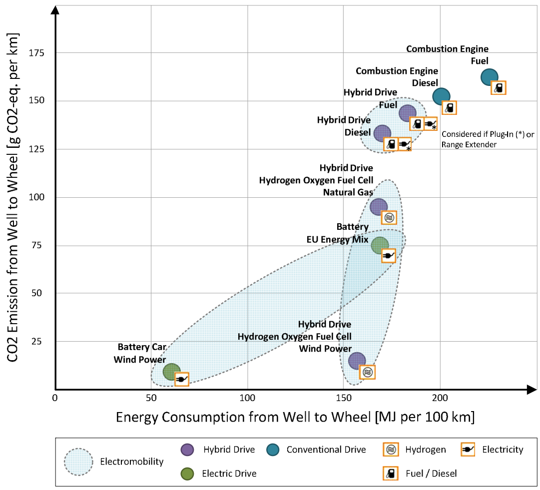

Fig. 1. Well-to-Wheel analysis[1]

It is inner-cities in particular, where the previously-mentioned difficulties are additionally complicated by time-related or space-related access restrictions or even access bans, which should be the focus of the analysis. In this regard, electromobility offers a range of solution possibilities including low-noise delivery, which can be conducted locally with no pollutants. By consolidating a variety of service and goods providers, a more efficient form of delivery can also be achieved.

Potential electromobility city logistics concepts. The deployment of local, emission-free vehicles in city logistics makes it possible to support the ecological objectives of "green logistics" and to reduce the level of pollutants in the inner-city.

A city logistics concept can also generate positive image effects for providers of goods and services resulting from joint, environmentally-friendly delivery. These effects can be increased even more through the deployment of electric vehicles.

Along with the specified benefits generated by the application of electromobility, there are also new restrictions in route planning, for instance due to the more limited range of battery-operated vehicles.

4 Analysis of Electromobility Inner-City Concepts

Explanation of the analysis. In the analysis, a comparison was conducted of the requirements profiles of the commercial transport user groups and the fulfilment profiles of the vehicles identified in market research investigation. The user groups

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[1] Source: Peitl, S., Entwicklung eines Konzepts zur Innenstadtbelieferung mittels Elektromobilität, TU Dortmund, Institut für Transportlogistik, 2010 (based on Daimler AG (2009) "The Road to Emission-free Mobility" (http://www.daimler.com) and Daimler AG (2010) (http://www.optiresource.org).

and vehicles were examined on the basis of the broadest range of parameters, including minimum range, charging possibilities and maximum speed.

Definition user groups. One of the bases for the parameterisation of the individual user groups was the study commissioned by the Federal Ministry of Transport, Building and Urban Development, "Motor Vehicle Traffic in Germany 2002" (KiD 2002). Zehle's "Verkehrsteilnehmer des Wirtschaftsverkehres in der Stadt" ('commercial traffic participants in the city') was also used as a reference for the definition of the following user groups. It must be noted that some user groups represent potential city logistics participants (cp. Zehle (1997, Pg. 157) 11). The following user groups were included in the analysis: skilled trade services, community services, car-sharing models, CEP service providers, disposal services and fresh goods delivery services.

Within the framework of the analysis it was demonstrated that the first four user groups named show a particularly high level of compatibility with the restrictions that the electric vehicles demonstrate. As regards CEP services that are not conducted within the inner-city, the longer ranges that are required cannot yet be met by electromobility vehicles.

5 Conception of a Handling and Charging Base

Especially for the user groups defined in the analysis, but also for private persons, the traffic and supply situation in urban areas requires new concepts for the distribution of goods and the stationary traffic. Therefore it is possible, that in future, the streets are not lined up with parked cars anymore, because they are parked in space-saving automated car park systems, graphically depicted in Fig. 2:

Fig. 2. eBase4Mobility[2]

[2] Source: D. Doulis, Großewinkelmann GmbH.

eBase4Mobility. To meet these requirements, a fully automated urban car park with additional functions will be developed. It can also be used to store, to pick up and to deliver goods and it offers the possibility to charge electric and hybrid vehicles. Based on the concept of high bay warehouses, the vehicles are transported and stored driverless on pallets into the car park. The pallet has an integrated charging station whose charging cable can be connected to the vehicle by the driver or - in future – fully automated. (cp. Danigelis (2011) [13])

The storage of goods will be done similar to the vehicle storage. As the parking structure will be mounted on pillars, the floor level can be accessed even by heavy Lorries. These vehicles will then be discharged using forklifts. The infrastructure of the floor level can be designed freely and in accordance to the proposed usage of the space. The transhipment processes will be implemented in the fashion of a cross-dock. The functional principle of a cross-docking facility is the unloading and transhipping of goods from one vehicle to another. This is often done to connect long distance and short distance traffic relations.

The pallet storage system however is only suitable for cars and goods and will not be used to store Lorries. Charging processes will be conducted both on the pallets and on ground floor level.

Potential for automated car park systems. This concept offers a lot of advantages to the people in urban areas: Parked cars disappear from the streets and are protected against vandalism at the same time. In addition, new bases for CEP services to handle goods and for car-sharing providers to park their fleet are generated. Therefore the car park can be seen as a starting point for modern, electromobile commercial transport in urban areas. If the roof and the façade of the building are additionally equipped with photovoltaic systems, the car park could also support the power system security as a local energy storage.

The authors are aware of the fact that automated car park systems are a fairly new idea and therefore are not well known. There are some automated parking structures in Germany, but they are very scarce and do not play an important role in the public perception. "Wöhr", a German manufacturer of car parking systems, for example has implemented several automated parking structures in Germany and other countries. (cp. Woehr (2012) [14])

Although many purchasers might at first be reluctant to award a contract for this kind of parking structure, the authors are positive that the high degree of novelty will eventually attract investors.

6 Summary and Outlook

In conclusion it can be said that the combination of city logistics concepts and electromobility is fundamentally possible. However, adaptations must be implemented in the planning due to technology-related restrictions in the various vehicle concepts. Additionally, when a combination ensues with the supply of cities and delivery within cities using city logistics, the indicated benefits of both concepts can be realised:

- An increased ecological levering effect resulting from low-noise, low-pollution transports as well as positive image effects.
- The attainment of regulatory special permits such as night delivery, access to environmentally sensitive zones or access to areas under time restrictions.
- Spreading of the increased investment costs for electric vehicles through the formation of cooperations.

The analysis of the vehicle market also produced an assessment of the three different electromobility vehicle concepts. There is currently an entire range of BEVs available on the market, while only a few hybrid and fuel cell vehicles that have advanced beyond the prototype stage were able to be identified. At the same time however, there are fewer restrictions to be considered by the user with these technologies. This led the authors to the following conclusions, graphically depicted in Fig. 3:

- Hybrid electric vehicles could be a short-term to middle-term transitional solution along the path to high-performance BEVs and fuel cell vehicles that are ready for the market. Hybrids use their emission-free drive in the functional area “City”, and can take advantage of their conventional drive when required to expand their range beyond this functional area (short-distance stretches on local highways and main motorways).
- BEVs might serve as a middle-term prospect in cities or in population centres for short trip urban traffic.
- Fuel cell vehicles offer the potential in the long-term to extend their range beyond the functional areas of cities and population centres to also include applications in fields requiring greater ranges and higher performance (long-distance motorway transports).

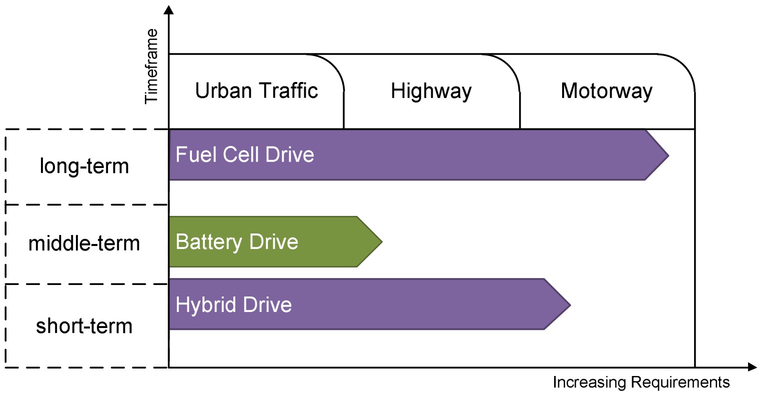

Fig. 3. Mobility scenario for electromobility commercial transport[3]

[3] Source: Peitl, Stefan, Entwicklung eines Konzepts zur Innenstadtbelieferung mittels Elektromobilität, TU Dortmund, Institut für Transportlogistik, 2010.

References

1. Clausen, U., Hesse, K.: Klimawandel – Folgen für Energieeffizienz von Logistikprozessen. Dortmund: Jahrbuch Logistik 2008, pp. 16–22 (2008)
2. Swantusch, R.: Wann wird aus dem Diesel ein Stromer? Verkehrsrundschau 2, 22–24 (2010)
3. Simon, H.-W.: Autobauer unter Strom. Entsorga Magazin 11, 29 (2009)
4. Becker, J., Rudschies, W., Vigl, M.: Die Spannung steigt. ADAC Motorwelt 8, 16–24 (2010)
5. Clausen, U.: Wirtschaftsverkehr 2011 – Modelle – Strategien – Nachhaltigkeit. In: Reihe Logistik, Verkehr und Umwelt. Verlag Praxiswissen, Dortmund (2011) ISBN 978-3-86975-041-5
6. Kümmerlin, R.: Langfristig bis 3 Prozent Wachstum. Deutsche Verkehrszeitung DVZ - Deutsche Logistik Zeitung 60, 6 (2009)
7. Allemeyer, W., Malina, R., Peistrup, M.: Leitfaden City-Logistik. Erfahrungen mit dem Aufbau und Betrieb von Speditionskooperationen. Netzwerk Stadtlogistik. Instiut für Verkehrswissenschaften der Universität Münster (2003)
8. Kümmerlin, R.: Wirtschaftlichkeit steht bei ökologischen Zielen an erster Stelle. Deutsche Verkehrszeitung DVZ - Deutsche Logistik Zeitung (2009)
9. Bundesumweltministerium (BMU): Das Integrierte Energie- und Klimaprogramm der Bundesregierung. Herausgegeben von Bundesumweltministerium, BMU (2007), http://www.bmu.de
10. Bundesregierung Deutschland: Nationaler Entwicklungsplan Elektromobilität der Bundesregierung (2009), http://www.bmwi.de
11. Helmers, E.: Bitte wenden Sie jetzt. Das Auto der Zukunft. Wiley VCH, Weinheim (2009)
12. Zehle, I.: City-Logistik. Chancen der koordinierten Versorgung von Städten. Pro Universitate Verl. (Uni-Schriften), Sinzheim (1997)
13. Danigelis, A.: Black Friday Parking Pain: A Solution. An automatic parking system could keep cars off the streets and recharge EVs at the same time. Discovery News (2011)
14. http://www.woehr.de/index_en.php (last checked May 10, 2012)

Minimal Invasive Construction Sites – An Approach to Reduce Resource Consumption in a Building and Maintaining Infrastructure

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Abstract. On motorways worldwide the environmental and economic impact of construction sites can be felt daily. Time is spent on waiting, resources are wasted and the infrastructure is not appropriately used as possible. Minimal invasive construction sites approach this nonefficient usage and tries for the reduction of impacts on environment and traffic flow, by developing practical applications for the planning and construction phase of major construction sites.

Keywords: construction site, construction site logistics, traffic jam, impact on environment, push-, pull strategy, supply chain management.

1 Construction Sites for Better Construction Sites

The impact of construction site on its environment has miscellaneous aspects. Thinking of a resident living close to a major construction site, it will be easy to list some of the consequences he might suffer in everyday life. Air pollution by dust rising from demolition works, loud noise of construction machines, engines and workers, e.g., reversing a truck for a delivery service, are only few core points that are mentioned in usual discussions between residents and the construction manager.

Attempting to decrease the global impact of construction works on regional infrastructure there are various issues to be solved.

The research project "Minimal Invasive Construction Sites" sets itself three major objectives during the planning phase, i.e. the reduction of the ecological impact of construction sites on their surroundings.

Construction sites have a major influence on the surrounding traffic. Possible causes are the supply of operating companies, the incorrect planning of storage areas or for instance, uncoordinated time slots for deliveries. A 15% reduction of this impact has to be achieved while implementing the tools developed as part of the research project. The "Auto Club Europe" assumes that construction sites on motorways in Germany provoke traffic jams at a length of approximately 110.000km per year[1]. Official contracting terms in awarding construction performance contracts

[1] Study: ACE 2011 Auto Club Europa e.V. www.ace-online.de

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 129–133.
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grant operating companies the liberty to develop their own supply chain and storage system on construction sites.[2] The contractor has to provide a tidy site that enables all subcontractors to deliver their contractual obligations. These legal circumstances lead to large onsite storage areas. Assigning this issue to construction sites on motorways an enormous impact on the traffic flow can be defined.

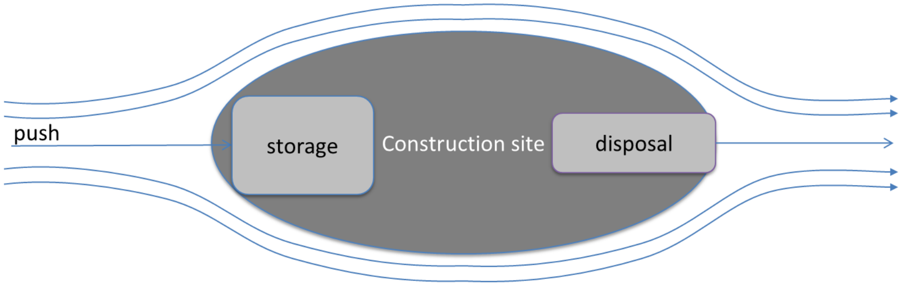

Fig. 1. Schematic illustration presenting the impact of a construction site on traffic flow

Figure 1 displays the common situation on construction sites. Deliveries are made to large storages. The central storage area is equipped with a "push-system" that provides construction workers with material based on the calculated forecast. This system generates a large onsite stock introducing various risks, e.g., material once delivered, can be damaged, lost or even get stolen. These are some examples for a loss in capital and resources, commonly occurring on inappropriately organized sites.

This state-of-the-art for common construction sites was reviewed by analysing the planning steps till the last step of billing by the subcontractors. A common process chain was defined and provided as a basis for the following research steps. As a specific approach to achieve the first goal of "Minimal Invasive Construction Sites", a strategy change has to be evolved. The inefficient utilisation of resource "storage area" needs has to be improved and included in the new process chain "optimized delivery". These prementioned objectives are resolved by the idea of "Minimalinvasive Baumaßnahmen (MIB) Ramp Up". This achievement is defined by a significant acceleration of the traffic flow, which can be obtained by improving construction sites logistics.

Analysing the new process chain, now specific delivery appointments are discussed and material requests are made by construction workers. Deliveries can also be made to a central storage (close to) at the construction site first. The onsite stock is reduced and allocated to several dynamic storage areas that need specific agreements and monitoring, in order to minimize the dissipation of open area resources onsite.

Moreover a construction site logistics manager is responsible for the entries to the site, so that every transport needs to be declared and is bound to a specific delivery time-slot. This newly developed structure guarantees a reduction of congestion caused by trucks queuing up to the site access.

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[2] VOB/B §4 Abs.1-4.

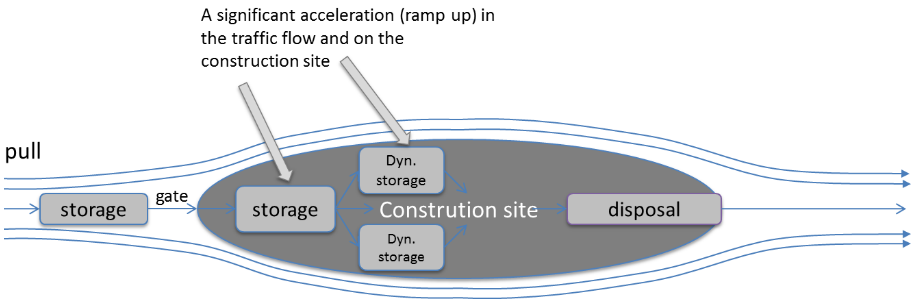

Fig. 2. Schematic illustration of the improved construction site

The change of delivery strategy can improve the surrounding traffic flow, but therefore, technical installations onsite have to be done and, furthermore, an acceptance of the new process chain must be achieved.

New technologies which improve this acceptance can be, e.g., the application of information terminals and web-based systems on the sites.

The second and third major aims of the research project are a 10% reduction of the environmental impact and a 5% reduction of the construction time. Both issues are closely interrelated. For instance, reducing pollution by achieving the global aim of minimizing single deliveries can be mentioned here. Each delivery causes emissions and time is spent by various workers on accepting the delivery. By lessening the impact to the onsite workers, the sites environmental impact is reduced simultaneously.

Serving as another example the quickwin of a "tidier construction site" can be presented as combination of achieving the goal of having less environmental impact and shortening the construction time. As construction workers receive the ordered material in appointed timeslots and defined places, they spend less time on searching it. A study conducted by TU Dortmund in 2007 says that only about 35% of a construction workers onsite time is spent on his main task[3]. The rest is divided into time spent on transports, searching, disruptions and breaks.

The accessible potential of optimisation on the consumption of resources has been presented and the first possible accesses mentioned. While heading towards practical solutions, the approach on requirements engineering was deployed.
This method can be applied while concretising specific tasks which have to be solved by new products. As a basis for the developing phase the process chain was analysed in depth and three specific products planned.

Figure 3 presents the three products: MIB Terminal, MIB Traffic and MIB SOA including their process interfaces at a construction site. As applying the method of requirements engineering the products are each reduced to a black box which is accentuated in dark grey as seen in figure 3. [4]The black box represents the boundaries of

[3] 2010 – Study Fraunhofer IML & TU Dortmund
`http://www.iml.fraunhofer.de/de/themengebiete/umwelt_ressourcenlogistik/baulogistik.html`

[4] Ebert, Christof. 2010. Systematisches Requirements Engineering. Heidelberg : dpunkt.verlag GmbH, 2010.

the new system, which is going to be defined by the requirements set to it. The stakeholders to the new products were defined in the previous engineering phase. They are indirectly represented by the interfaces between process chains and the new products in figure 3. The relations and operations among the products are matched in the following steps to a superior list of requirements, which is classified by decisive criteria.

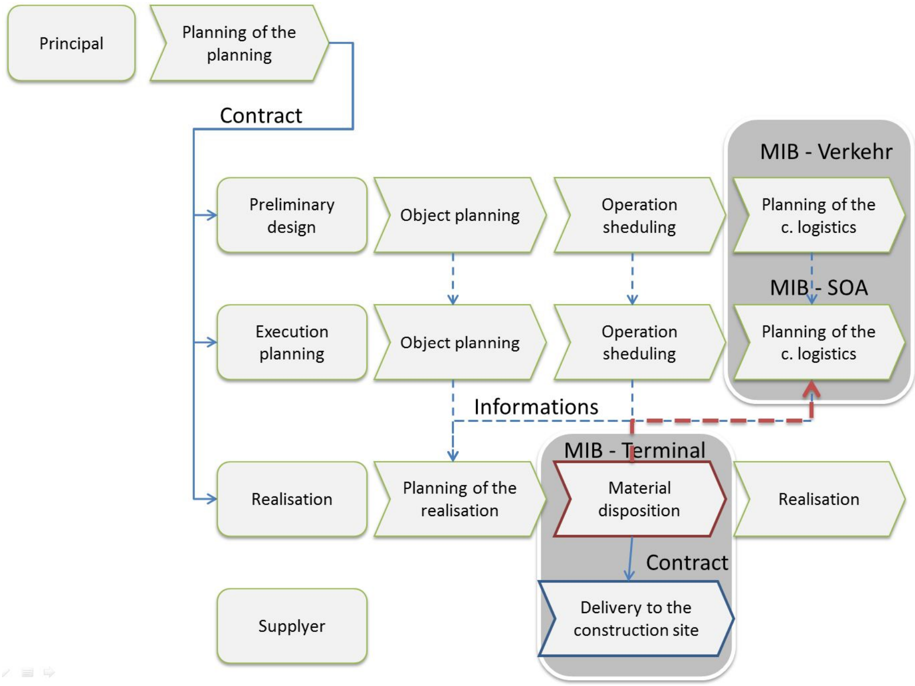

Fig. 3. Schematic illustration of a construction site development

2 Three Solutions Applied on Major Aims

The major aim of optimising the utilisation of resources will be approached by three specific tools. As platform for all project participants, a web-based platform builds the foundation for programming, future project communication and data exchange.

MIB SOA stands for *service oriented architecture* which describes the structure of the complete system. SOA offers a basis for all services which will serve the major aim of a more efficient construction site. During the first project phase, i.e. the planning phase, MIB SOA can already supply a communication and exchange platform to all participants. Therefore a communication application was developed and included to the web-based system. This platform maybe also understood as a continuum during the whole building process.

While the next phase more applications can be embedded to the system and provide more efficient support to the construction site.

As a new service to construction sites ‘coordinating an application’ called MIB LOA is developed. Its main target is the scheduling and documentation of storage areas. This can be visualized on any internet connected system. The service was programmed in the common language for the web-based system MIB SOA. The integration of a sensor unit can provide the SOA system with occupancy data of the storage area. This system leads to dynamic storage areas which accelerate the traffic flow as presented before.

MIB Terminal is the only physical product developed in this research project. The application of new technologies on construction sites, especially when the construction worker is the one who makes use of them, is usually difficult. This statement relies on the argument that workers commonly prefer using their well-known systems and avoid changes to their process chains. Usually orders are made by a simple phone call. This issue implements the risk of misunderstanding and missing documentation for each party in this mere spoken delivery contract. This issue was defined as a requirement for the new product and verbalised in “handling must be as easy as a call”. For instance, further requirements where documented: the system needs to be vibration-proof, resistant to splash water and difficult to be stolen from a site.

As result a robust desktop system was chosen. The system is embedded in a stainless-steel case which protects the easy to use touchscreen. All process steps are easy to handle and orders, resource accounting or a short review on a layout plan can easily be done. The accessibility of the system is guaranteed by a UMTS connection which provides the terminal with the information from MIB SOA.

The impact on surroundings provoked by transports to and from the construction site can be reduced by routing. As discussed before, suppliers may develop their own supply chain and provide the construction site in a way that is economical for them. Routing rarely considers the impact on surroundings of a construction site or the route itself. Noise, vibrations and the most exhausting traffic jams are usually not anticipated by suppliers.

MIB Verkehr/Traffic is a planning application designed to assist the party issuing the invitations to bid. A construction company may propose routes once the project has started, but the enforcement can only be achieved in an economical way, as long as the necessary information is retrieved while the planning phase. Respecting various criteria, routes a determinated in MIB traffic and recommendations can be made to the planning party.

3 Conclusion

The applied load on the existing infrastructure combined with necessary maintenance and development, require more efficient construction sites. Maintenance on motorways may not have such an expensive impact on neither the traffic flow nor the surroundings.

Once a superior construction site logistics is planned and designed, there are outstanding economic and environmental goals to achieve. The reduction of not necessary expenditures, e.g. single transport, does not only minimize the environmental impacts, but also has lucrative effects on each party at the construction site.

Green Logistics: Comparability of the Environmental Effects of Logistics Services

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Abstract. The identification of relevant control levers is required for the realisation of logistics services that are efficient in terms of resources and energy. In the "Green Logistics" project, a standardised, comprehensive and usage-related method for the ecological assessment of logistics processes and systems is being developed, i.e., a method that integrates the segments of logistics real estate and business premises, intralogistics and transport. This method will create the necessary transparency. The methodology and instruments to be developed and/or further developed for this purpose will be transferred into a certification system. A system definition was conducted on the applicability of the existing methods and standards in which the relevant gaps were identified that are to be closed through "Green Logistics". These include the availability of valid data sources and key data. Electricity consumption measurements will be conducted to produce key data for the usage-related apportionment of the electricity consumption at logistics facilities locations.

Keywords: carbon footprint, certificate, eco efficiency, electricity consumption, emission, environmental performance, freight transport, greenhouse gas, LCA, logistics, method, standard, real estate, scope.

1 Introduction

The limited capacity of our ecosystems, the shortage of raw materials and the subsequent cost pressure as well as altered political and social framework conditions are leading to a fundamental change in our economic processes. Companies have to increase the resource efficiency of their products and design their systems and processes in ways that are more sustainable and environmentally-friendly in order to retain long-term market competitiveness.

The optimisation of logistics systems is not a new field of endeavour; indeed, it has progressed in a variety of ways now for decades. However, these optimisation processes have previously only been limited to the economy, with ecological aspects playing a subordinate role, if any role at all. But the aim must be to establish the ecology as an additional, equally valuable objective. At present, a standardised procedure for the ecological assessment of logistics systems and processes does not exist as a basis

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for achieving this end. While there have been norms for environmental management and life-cycle assessment since the 1990s, their applicability for logistics systems and processes is limited due to their heavy orientation on products and the high level of complexity of logistics systems.

The objective of the "Green Logistics" project [1] as part of the LogistikRuhr efficiency cluster [2], which is funded by the German Federal Ministry of Education and Research (BMBF), is to comprehensively determine for the first time the ecological effects of logistics systems and processes on a usage-related, standardised basis and to develop methods and instruments for the assessment of associated elements ranging from storage to distribution to reverse logistics. Twelve partners, i.e. DB Mobility Logistics, Deutsche Post, Fiege Deutschland, Fraunhofer Institute for Material Flow and Logistics, Goodman Germany/Arcadis Deutschland, Lufthansa Cargo, Schmidt-Gevelsberg, TÜV Rheinland, United Parcels Service Deutschland, Vanderlande Industries, and Wuppertal Institute for Climate, Environment and Energy, are working together on this topic and will integrate principles that already exist for the respective sub-segments. Gaps that exist will be closed during the course of the project and the integrative observation of the logistics real estate and business premises, intralogistics and transport segments will be enabled. Besides, the project partners will develop and realise eco-efficient logistics solutions within GreenLogistics. The respective approaches are pointed out in the article "Green Logistics: Optimisation Approaches for Resource-Efficient Logistics Services".

The following section sheds light on the current state of the available science in the field of ecological assessment in general and of logistics in particular: This comprises the methodical framework, the information technology support via software tools as well as certification systems and eco-labels. Building on this, there is a depiction of the respective approaches by which a solution for identified deficits can be achieved within the framework of the "Green Logistics" project.

2 Ecological Assessment of Logistics Systems

In the past, numerous different norms, (industry) standards, methods, guidelines and instruments (hereinafter individually referred to as "method") for the assessment and improvement of company environmental performance were developed which augment the existing economics methods by encompassing environmental policy aspects. In relation to the approach of standardised, ecological assessment of logistics systems and processes pursued on the basis of the project objective, these methods are however hardly useful at all, or at least only to a limited degree, thus serving at best as a basis for sub-segments of logistics and requiring corresponding linkage and further development for a comprehensive approach that applies to logistics as a whole.

2.1 Methods for the Assessment of Environmental Effects

Life Cycle Assessment is a method of systematic registration, analysis and assessment of the environmental effects of production and services systems. The methodology, by which the environmental effects associated with the life cycle of a product or service are estimated (i.e. for the manufacturing, usage and disposal phases), is formulated for example in the norms DIN EN ISO 14040 [3] and 14044 [4]. The methodology of life cycle assessment is not suitable for the ecological assessment of complex logistics systems for the following reasons:

- A life cycle assessment always has a relative character, i.e., it involves the comparison of numerous products or services fulfilling the same utilisation in regard to their environmental effects. In contrast, the "Green Logistics" project proposes to also make individual logistics chains or entire networks individually assessable, with no correlation to other networks or systems.
- The preparation of a life cycle assessment is always done on the basis of statistical reference processes that a product or service goes through during the course of its life cycle. In contrast, processes in complex logistics systems are dynamic and are subject to stochastic predictors which can only be depicted to a limited degree in a life cycle assessment, if at all.
- The preparation of a life cycle assessment inherently requires a significant quantity of data and subsequently significant data collection measures, even for relatively simple systems. In order to reduce the data collection measures as much as possible for the ecological assessment of complex logistics systems, the systems have to be so heavily simplified or the examination framework has to be so significantly limited that a comprehensive, accurate depiction and assessment is rendered impossible.

Against the backdrop of increasing discussions on climate change, the assessment of greenhouse gas emissions today is focused on the so-called carbon footprint. The approach of determining the carbon footprint of a product or service represents a section of a life cycle assessment in its pure observation of climate change as an altered effect.

The Greenhouse Gas Protocol Initiative [5] was started in 1998, developing a standard for processing the preparation and publication of greenhouse gas emissions by companies. It was published in 2001: the Corporate Accounting and Reporting Standard known as the Greenhouse Gas Protocol [6], which was supplemented afterwards by other standards including the methods published in 2011 for the product-specific greenhouse gas life cycle assessment throughout the entire life cycle of a particular product (Product Life Cycle Standard) [7] and for the estimation of the GHG emissions throughout the whole of the value chain (Corporate Value Chain (Scope 3) Standard). [8]

Together, these standards are the guidelines for the delineation of the system set to undergo life cycle assessment (for example, of the core company), for data acquisition and safeguarding the data quality, for allocation of the emissions and measurement uncertainties as well as for the publication of the results. The framework is formed by the structural breakdown of a company into scopes. The six Kyoto greenhouse gas emissions (i.e., CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) [9] are to be calculated for each of these scopes and listed for the company as direct and indirect emissions.

Scope 1 comprises a company's direct emissions: The company owns or controls and is responsible for the processes causing the Scope 1 emissions, for example its own boilers, vehicles, process technologies for chemical production processes and so on. Scope 2 emissions are those indirect emissions caused by the externally acquired energy that the company consumes (i.e., in broad terms electricity, heating, cooling and process steam). All additional indirect emissions are allocated to Scope 3. These represent emissions caused by the company as a result of its acquisition of raw materials, products or services (upstream) and the distribution and additional processing of products (downstream). [8]

These GHG Protocol standards are aimed at establishing a universal framework for the life cycle assessment of greenhouse gas emissions and they explicitly call for the development of concrete, industry-specific life cycle assessment standards (for example, for the logistics industry) with the respective as yet to be defined processes, calculation regulations, etc. [10]

The GHG Protocol was referenced in 2005 by the ISO (International Organization for Standardization) and, in 2006/2007 a general life cycle assessment of greenhouse gas emissions was published in the international standards ISO 14064 ([11], [12], [13]) and 14065 [14]. This portion of the ISO 14000 family is designed to provide participants, i.e. companies as well as governments, with a framework for quantifying, depicting and monitoring the reduction of greenhouse gas emissions. However, no concrete procedure is recommended in these norms.

In late 2008, the CEN TC 320/WG 10 European Committee for Standardization was established to develop a norm for energy consumption and greenhouse gas emissions in relation to transport services (freight and passenger transport). The draft of this norm [15] was published in 2011 and is currently undergoing revision in response to public comment. Publication of the actual norm is not anticipated before the end of 2012. The norm draft that has already been published provides the first standardised approach which will subsequently be acknowledged in Europe for the ecological assessment of transport services for all modes of transport as well as documentation of the results. This will increase the transparency of ecological life cycle assessments, fulfilling a prerequisite for the subsequent comparability of ecological assessments results. This comparability, like the comprehensive assessment of logistics systems, is still missing for the following reasons:

- All of the transport aid processes and the location-related processes in logistics real estate objects are excluded from the norm; this means that essential components cannot be depicted via the life cycle assessment results at this time.
- While a recommendation is indeed provided for the data principles to be used (i.e., individual measurement values, vehicle-specific/route-specific average values or fleet values of the transport service provider, standard values from databases), the choice of these data principles is left up to the users and the results are based on different detail provision levels.
- The life cycle assessment values to be listed are greenhouse gas emissions [kg CO_2e] and energy [MJ]. Other logistics values that could be of environmental relevance such as local environmental effects like noise, sulphur oxide and particulate matter are not taken into account by the norm.

On the basis of the presented norms, standards and other factors, additional methods, guidelines and studies (for example, [16]-[25]) have been published that form a general or industry-specific framework for the assessment of logistics processes and systems. As illustrated in greater detail in the following sections, these guidelines and studies are to be expanded to encompass all relevant processes and types of consumption.

2.2 Eco-efficiency Assessment of Logistic Processes and Systems

On the basis of today's scientific approaches, the calculation methods, norms and standards deemed to be suitable within the framework of "Green Logistics" will be expanded so as to integrate the interdependencies and close the existing gaps between the segments of transport, logistics real estate and intralogistics. This "system definition" comprises the following essential steps.

Establishment of the life cycle assessment scope and its time-related focus

The focus of the observation is decisive in determining the necessary detail provision and as such also the level of effort involved in the ecological assessment: This focus can consist of the company, the supply chain, the product or the service.

Due to the comparatively lower level of effort involved, the project consortium „Green Logistics", in line with the GHG Protocol [6], endorses the company-based approach. The life cycle assessment scope is therefore the company with all its products and services. The data are gathered for the company. Some of the detail provision is automatically revealed (for example, electricity consumption registration at the company premises level) or ensues via key data or allocations (for example, for products/services).

Furthermore, the life cycle assessment must account for all direct and indirect emissions. Referencing existing methods and norms, this means for example accounting for the environmental effects of all scopes 1-3 [6] or from well-to-wheel [15].

A uniform timeframe for the life cycle assessment is additionally required in order to enable the comparability of environmental effects between different logistics systems. This timeframe must be a uniform basis for all logistics services and must also rule out any possible manipulation. Seasonal effects are also accounted for in the selection of the life cycle assessment timeframe of one year. Additionally, company data are generally registered and reported in relation to a specific year.

Emissions categories and environmental effects

Furthermore, the relevant effects categories for the ecological assessment of logistics service providers are defined, whereby it must be ensured that the methodology is both practicable and scientifically well-founded. Examination is conducted to determine whether, for example, it is permissible to focus solely on greenhouse gases, as is customary in the procedures of many companies and published methods at present, or whether additional emissions such as particulate matter or noise must also be taken into account. This is because even though progress has been made in the segment of transport emissions in recent years, transport nevertheless continues to have a large influence on local air quality. The European Environmental Agency [26] attributes 58% of all nitrogen oxide emissions and 20% of the respective additional pollutant emissions to transport (utility and private vehicles). The differentiation between modes of transport also provides an interesting insight: For example, almost all SO_2 and 10% of the $PM_{2.5}$ transport emissions can be attributed to shipping transport according to the EEA. Noise also remains a relevant environmental effect in the transport sector ([26]-[29]). The investigations in "Green Logistics" reference existing findings and procedures from the current norms and guidelines and observe their relevance or tranferability to the application case here.

Process observation

In order to ensure the comparability of the eco-efficiency of logistic services, the processes that exercise a significant influence on the environmental effects and subsequently require life cycle assessment must be defined. This encompasses the respective life cycle phases (manufacture, utilisation and disposal phases in accordance with DIN EN ISO 14040 and 14044) of the transport, building shell and intralogistics segments as well as the guarantee of the same level of detail provision for all processes. For instance, it is impermissible to neglect sub-processes for a particular mode of transport (e.g., rail [shunting stretches] or water [lubricant consumption]) only on the basis of possibly insufficient data while parallel sub-processes are accounted for in the life cycle assessment of road transport (for example, arrival drives/empty runs), as this would yield incomparable and as such distorted results benefiting a particular mode of transport. Within the framework of "Green Logistics", all conceivable sub-processes and aid processes are researched or estimated using model calculations generally based on real application by the project partners: Examples of this are specified here below:

- The share of manufacturing and disposal phases for intralogistics systems (for example, discontinuous or continuous conveyors, storage and retrieval units)
- The influence of administration, garages and employee drives (commute, company travel),
- Lubricant requirements (water), shunting stretches (rail), de-icing agents (air), packaging and transport aids (business premises).

Calculation regulations, allocation and key data

The system definition must include the description of how the environmental effects (for example, CO_2e emissions) are calculated on the basis of each of the types of company data to be gathered (for example, energy carrier consumption, specification of distances). The majority of the available preliminary work is compiled, standardised and illustrated with sample calculations. This equally encompasses the linkage of the reference values and performance objects in the transport (lorry, swap body, TEU etc.) with those at the business premises (for example, shipment, pallet, package, weight).

In addition, allocation regulations must be defined by which the environmental effects are attributed to the respective service objects. As such, these allocation regulations establish for instance how much of the total CO_2e emissions are allocated to one customer, one product group or one business premises location.

The key data developed within the framework of the "Green Logistics" system definition should in turn provide the participants with default values for the calculation and allocation of the environmental effects. Additionally, they create transparency regarding the calculated environmental effects with which the control levers for resources and more energy efficient logistics services can be identified in the next step. They also make an internal and external benchmark possible.

Procedure and documentation

Along with the pure calculation regulations and framework conditions, the system definition will also contain a targeted procedure and define which documentation requirements are necessary for an ecological life cycle assessment of logistics services. Furthermore, the form of the documentation must be established.

3 Key Data for the Ecological Assessment of Logistics

The selection of suitable standard values from databases

The environmental effects linked with logistics activities cannot be measured directly. Instead, they must undergo life cycle assessment and then be estimated. In order to keep a reasonable level of effort, a variety of data sources and software tools have been provided for this purpose in recent decades. Already back in 1999, Schmidt et al. [30] referred to the careful selection of the data sources and software tools to be used in the assessment of transport-related environmental pollutants. Both the providers and the users of such applications must keep an eye on whether such are up to date and their areas of application in order to ensure the desired credibility of the life cycle assessment results.

The range of data sources available on the market either for free or via licensing has increased even more, whereby the quality of such sources varies greatly in the view of the "Green Logistics" partners. For this reason, the framework of "Green Logistics" included testing and evaluation of more than 30 databases [31] and an additional 30 software tools [32] published worldwide in the ecological assessment of products and services segment in regard to their areas of application, their data basis and in relation to how up to date their applicability is.

While many of these databases and tools are useful for the preparation of product life cycle assessments, their application for the ecological assessment of logistics systems and processes can generally only be recommended with reservations. For instance, logistics processes are only accounted for in the form of external transport processes (lorry, rail, [inland] waterway, aircraft) with insufficient or no observation of warehousing transport processes, hub transport processes and in-house transport processes. The depiction of real multimodal chains is not uniformly possible, since modes of transport are not linked and/or relevant aid processes and sub-processes are neglected. Furthermore, the allocation of the emissions to the functional unit (for example, vehicle tours) or the depiction of stochastic values in the process sequence is not possible.

In order to further illustrate the existing methodical and data-technical diversity that persists in the databases and tools that are available at present, a comparative calculation was conducted within the framework of "Green Logistics". This assessed the GHG emissions in real transport performances by our partners Deutsche Post AG, UPS and Schmidt-Gevelsberg for ten relations from Germany's Ruhr region to southern Germany or northern Italy, including observation of the return transports. The observed transport performances totalled 120 million tonne-kilometres per year and were conducted throughout the year (daily or twice a week tours in overnight transport).

The “Handbook Emission Factors for Road Transport” (HBEFA v3.1) [33] served as the basis in the comparative calculation and assisted in the comparison of all the results. The results for the overall transport performance indicate a spread of almost 60%, i.e., the maximum calculated emissions (with Umberto 5.5) exceeded the HBEFA result by 42% while the minimum emissions (with Gemis 4.7) came in below it by 14%. Some of the causes for the large discrepancy in the results can be attributed to the highly varied aggregation degree of the emission factors (for example, the number of vehicles and the pollutant classes) as well as the possibility for depicting real parameters such as the load level or distance, for instance.

In addition, the life cycle assessment results were compared with the reality in the companies. To this end, the actual fuel consumption was documented and evaluated over the course of several months. This comparison confirmed the validity of the choice of the HBEFA data as the basis for the comparative calculation and as a solid basis for additional life cycle assessments of transport processes: The emissions based on the actual consumption yielded the same order of values as those estimated with HBEFA.

The examinations demonstrate that (even) the life cycle assessment of CO_2 equivalents in road transport continues to conceal measurement uncertainties that can lead to varying results and statements. The standardisation efforts already progressing in this segment (for example, DIN prEN 16258) do indeed contribute significantly to transparency, but due to the diverse spectrum of decision possibilities they do not solve the problem of producing the comparability that is so urgently required. As such, the previously mentioned demand by Schmidt et al. for exercising care with the data sources remains valid.

Electricity consumption measurements at logistics business premises locations

At present, electricity consumption at logistics business premises locations can rarely be allocated to the operative logistics processes (conveyance, storage, commissioning, etc.) or superordinate consumer groups (for example, lighting, administration). Generally, there is only one (digital) main meter at a business premises location, sometimes augmented by an analogue sub-meter. This knowledge gap renders impossible or only imprecisely possible the usage-related allocation of business premises location emissions (resulting from electricity consumption) to tenants or product groups etc. This also prevents the identification of the relevant control levers for increasing the resource efficiency and energy efficiency of logistics systems and products.

Within the framework of “Green Logistics”, this knowledge gap is closed with the help of electricity consumption measurements. The electricity consumption measurements are conducted in the active operations at different logistics business premises locations such as air freight centres, letter and package distribution centres and industry-specific warehouse and storage facilities. To this end, the Fraunhofer IML procured measurement equipment (Janitza, Chauvin-Arnoux) with which the electricity consumption can be identified over a defined measurement timeframe (e.g., 4 weeks) and including relevant parameters (idle power, active power and apparent power, phase angle) without “disconnecting” the current conductor.

The result enables the usage-based apportionment of all the electricity consumption according to selected sectors such as conveyance technology, storage technology (storage and retrieval units for highbay warehouses, forklifts), lighting, air conditioning, IT, and administration.

On the basis of the initial measurements conducted at a Deutsche Post sorting centre key data was able to be obtained for the electricity consumption for letter sorting and for lighting, while additionally concrete power savings measures were able to be deduced: These measures will reduce the annual emissions of Deutsche Post AG letter sorting centres in Germany by some 1 million kWh in the short-term.

4 Eco-label and Certification Systems

4.1 Environmental Performance Certification of Companies

Eco-labels or environmental symbols have become established on the market alongside the certification systems for the environmental performance of companies. In contrast to companies' "green" symbols or their own environmental declarations, these eco-labels are awarded by independent institutions, interest groups or testing institutes. The most recognised environmental symbol in Germany is the "Blaue Engel" ('blue angel') [34], which was the world's first environmental symbol and has been awarded since 1977. In addition to the Blaue Engel, there are other national and international eco-labels, for example in the bio industry, textile industry or for construction products. Some examples of international eco-labels are the EU Ecolabel, Nordic Swan and Greenguard for low-emission products.

At present there are no environmental symbols that exclusively and explicitly account for logistical performances (systems and processes). Eco-labels are generally product-related and in the assessment for the labelling, logistics only play a subordinate role. For example, with the Austrian environmental symbol UZ 26 "Mehrweggebinde und Mehrwegbechersysteme" ('reusable packaging drums and reusable cup systems'), logistics are only considered in regard to the ecological optimisation of transport modes and vehicles.

In the 1990s, the Environmental Management System (DIN EN ISO 14001) [35] and the "Eco-Management and Audit Scheme" (EMAS - Directive [EU] No. 761/2001) represented the establishment of two certification systems for environmental management in companies. Both types of environmental management systems are aimed at the constant improvement of environmental performances and are applicable to any type of organisation. From a corporate strategy perspective, the main difference between these two environmental management systems is that the ISO 14000 norm series is acknowledged worldwide, while EMAS is only acknowledged and applied throughout Europe.

One preparation possibility for validation in accordance with EMAS or certification in accordance with DIN EN ISO 14001 is the ECOPROFIT concept, a comprehensive environmental maintenance and economic development programme. The concept was developed in Graz (Austria), initially as a project for preventing waste and emissions. In 1998/1999, the city of Munich took the concept on board; adapted to German circumstances. Today, the city of Munich coordinates the ECOPROFIT activities in Germany.

There are at present a variety of voluntary international assessment systems for certification of the sustainability of real estates. These include the British BREEAM Certificate [36], which has been on the market now for twenty years, and the LEED Certificate [37] which was introduced in 1998 and is awarded by the US Green Building Councils. In 2008, the Deutsche Gesellschaft für nachhaltiges Bauen e.V., or DGNB ('German registered society for sustainable construction') [38], developed a German certification system together with the Federal German Ministry of Transport, Building and Urban Development (BMVBS). These different systems are also fundamentally applicable to logistics real estate objects, but they use different information sources, systematic approaches and assessment criteria. This produces assessment results that can deviate significantly depending on the system used. According to their definition, these approaches focus on the real estate sector and as such do not provide for any comprehensive assessment of logistics systems and processes. However, with an eye on the objectives of the project "Green Logistics", they nevertheless form the essential foundation for the logistics real estate objects sector.

"Green Logistics" will make a significant contribution to the further development of the aforementioned environmental management systems, in particular for the ecological certification of logistics service providers. In regard to this field of application, the environmental management systems described must be adjudged to be too far-reaching or as unsuitable for the following reasons:

- The aim of such systems is generally very far-reaching. Along with the registration and supervision of the environmental effects, other issues such as environmentally responsible conduct and procedures as well as the constant improvement of the company's environmental performance are also observed.
- Environmental management systems have a long-term character, whereas the methodology that remains to be developed should make it possible to ecologically assess the logistics network over the course of a limited timeframe.
- The management systems are additionally designed for the rationalisation of the environmental parameters within a single organisation, and thus do not observe any linked systems as is required for the logistics industry.

4.2 Certification System for Logistics Service Providers

The objective in "Green Logistics" is to develop a certification system enabling logistics industry companies to have their logistics systems, processes and services certified in regard to their ecological efficiency by a neutral, third-party certification authority. Three steps are envisioned for achieving this:

Establishment of the requirements place on the certification system

In the first step, suitable approaches for the registration and assessment of the aspects that are important for logistics will be extracted from existing (environment-related) certification systems, and the mutual interdependencies and influences for the transport, intralogistics and logistics real estate segments will be integrated.

Development of the certification system

On this basis, the actual certification system will be developed and the design of its procedures sequence and the criteria catalogue for the certification of logistics services providers will be prepared. The aim here is the establishment of the certification's area of application and target groups. Building on and following this is the definition of the certification's sequence of procedures (for example, the auditors, audit frequency, measures to be executed and the forms of reporting). This also encompasses the preparation of checklists, criteria catalogues and indicators. Equally, the framework parameters for certification and the requirements placed on the certification and the accreditation authorities must be established. This involves the establishment of the prerequisites for certification, the regulations and the use of trademarks. Furthermore, the authorisations, the qualifications required of certification and accreditation organisations or persons and the requirements for the structure of a register listing certified companies must be determined. Also, the definition of the necessary update timeframes for examining the standards in light of future further developments (for example, new fuel-saving or low-emission transport systems) will ensue in regard to the continued development of the standards. In conclusion, a monitoring concept for monitoring the quality of the certification will be prepared. This will include the influx of experience from previous certification systems in which positive results have been witnessed with such monitoring for the reduction of weak points.

Validation and testing of the certification system

The validation will evaluate whether the developed certification system fulfils the stipulated requirements. This will encompass the examination of a variety of things including the correct and sufficiently extensive choice of assessment criteria, the suitability of the procedure for distribution of the measurement data for assessment and, finally, examination of whether the content of the certificate issued accurately reflects reality in a manner that fulfils the requirement of comparability. The key data that are developed will be evaluated regarding their suitability, applicability and usability, and modified where necessary. The findings for the improvement of the certification system discovered within the framework of the validation will be fed back into the certification system in a third step.

Furthermore, the certification system will be tested with the partner, Lufthansa Cargo AG. This testing will focus on the applicability of the certification system, including its checklists, criteria catalogues and the registration of measurement data and indicators. Possible weak points will be discovered in the process and improvements will be made in the certification system. The results of this testing of the developed certification system will also reveal the necessary qualifications that its advisors and auditors must possess.

5 Conclusions

The identification of relevant control levers is required for the realisation of logistics services that are efficient in terms of resources and energy. The transparency required for this can be created with the assistance of a standardised, comprehensive and usage-related method for the ecological assessment of logistics processes and systems. This is the objective of the "Green Logistics" project, additionally relying in the process on prior scientific examinations and findings as well as generally acknowledged norms and standards. The method requiring further development encompasses the establishment of the life cycle assessment scope, environmental effects, relevant processes, data sources, calculations and allocation regulations as well as the documentation of the results. Furthermore, key data must be provided in order to ensure the manageability of the life cycle assessment, even in the absence of company-specific data. These key data will be prepared by means of conducting electricity consumption measurements at logistics business premises locations within the framework of the project, for example. In addition, a certification system will be developed to provide logistics companies with certification by a neutral party of the eco-efficiency of their logistic services. The work will be accompanied by examples of cases in which the participating partners design eco-efficient logistics systems and validate their performance capability in actual practice.

References

1. Green Logistics, `http://www.green-logistics-network.de/`
2. Effizienzcluster LogistikRuhr, `http://www.effizienzcluster.de/`
3. Norm DIN EN ISO 14040: Umweltmanagement - Ökobilanz - Grundsätze und Rahmenbedingungen (October 2006)
4. Norm DIN EN ISO 14044: Umweltmanagement - Ökobilanz - Anforderungen und Anleitungen (October 2006)
5. Klöpffer, W., Grahl, B.: Ökobilanz (LCA). Ein Leitfaden für Ausbildung und Beruf. Wiley-VCH, Weinheim (2009)
6. World Resources Institute; World Business Council for Sustainable Development (eds.): The Greenhouse Gas Protocol. The GHG Protocol for Project Accounting, USA (2005)
7. World Resources Institute; wbcsd: Greenhouse gas protocol. Product life cycle accounting and reporting standard. World Resources Institute; World Business Council for Sustainable Development, Washington, DC, Geneva, Switzerland (2011b), `http://www.ghgprotocol.org/standards/product-standard` (checked on February 7, 2012)
8. World Resources Institute; wbcsd: Greenhouse gas protocol. Corporate value chain (Scope 3) accounting and reporting standard: supplement to the GHG protocol corporate accounting and reporting standard. World Resources Institute; World Business Council for Sustainable Development, Washington, DC, Geneva, Switzerland (2011a)
9. Vereinte Nationen (ed.): Kyoto Protocol to the United Nations Framework Convention on Climate Change, New York, Annex A (1998)
10. World Resources Institute, wbcsd, p. 9 (2011a)
11. Norm ISO 14064-1: Greenhouse gases - Part 1 - Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals (March 1, 2006)
12. Norm ISO 14064-2: Greenhouse gases - Part 2 - Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements (March 1, 2006)
13. Norm ISO 14064-3: Greenhouse gases - Part 3 - Specification with guidance for the validation and verification of greenhouse gas assertions (March 1, 2006)

14. Norm ISO 14065: Greenhouse gases - Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition (April 15, 2007)
15. Europäische Norm prEN 16258:2011 (D): Methode zur Berechnung und Deklaration des Energieverbrauchs und der Treibhausgasemissionen bei Transportdienstleistungen (Güter- und Personenverkehr) (March 28, 2011)
16. CO_2-Berechnung. Das Sonderheft zur Ermittlung von Treibhausgas-Emissionen in der Logistik. SPEZIAL. VerkehrsRUNDSCHAU. Verlag Heinrich Vogel, München (2011)
17. Benz, M.: Umweltverträglichkeit von Transportketten. Eine vergleichende Betrachtung des Energieverbrauchs und der Schafstoffemissionen von ausgewählten Gütertransportketten unter Berücksichtigung der Veränderungspotenziale durch Verkehrsverlagerungen und Logistik-Konzepte. Dissertation. Technische Universität, Berlin. Fachbereich Wirtschaft und Management (1999)
18. Choudhury, R.: Well-to-Wheel Analyse des Energieverbrauchs und der Treibhausgas-Emissionen von fortschrittlichen Kraftstoff-/Fahrzeug-Systemen. Studie
19. Dobers, K.: Bewertung der Ökoeffizienz von Logistiksystemen am Beispiel der Biomassebereitstellung. Verl. Praxiswissen, Dortmund (2011)
20. Flämig, H., Seipold, P., Drewes, P., Wolff, J.: Leitfaden für Unternehmen zur Umsetzung von Nachhaltigkeitsprojekten. Reduzierung von gütertransportbedingten CO_2-Emissionen. Gefördert vom Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 2.0th edn. Technische Universität Hamburg-Harburg, Institut für Verkehrsplanung und Logistik, Hamburg (2009)
21. Kranke, A., Schmied, M., Schön, A.D.: CO_2-Berechnung in der Logistik. Datenquellen, Formeln, Standards, 1st edn. Vogel, München (2011)
22. Mc Kinnon, A., Piecyk, M.: Measuring and Managing CO_2-Emissions of European Chemical Transport. Edited by Cefic -The European Chemical Industry Council. Heriot-Watt University, Logistics Research Centre, Edinburgh, `http://www.cefic.org`
23. Schmied, M., Knörr, W.: Berechnung von Treibhausgasemissionen in Spedition und Logistik. Begriffe, Methoden, Beispiele. Edited by Deutscher Speditions- und Logistikverband e.V. Öko-Institut e.V.; ifeu - Institut für Energie- und Umweltforschung Heidelberg GmbH, Köln (April 2011)
24. Spielmann, M., Bauer, C., Dones, R., Tuchschmid, M.: Transport Services. Data v2.0 (2007). Paul Scherrer Institut; ESU-services Ltd. Villigen, Uster (ecoinvent report, 14) (2007)
25. Verband der chemischen Industrie e.V. (ed.): VCI-Leitfaden zur Ermittlung der CO_2-Emissionen in der Logistik der chemischen Industrie. Frankfurt (2010)
26. European Environment Agency: Laying the foundations for greener transport. TERM 2011: transport indicators tracking progress towards environmental targets in Europe. Office for Official Publ. of the European Communities, Copenhagen (2011)
27. Europäische Kommission (ed.): Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. White Paper. COM (2011) 144 final (2011), `http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0144:FIN:EN:PDF` (checked on February 13, 2011)
28. Althaus, H.-J., de Haan, P., Scholz, R.W.: Traffic noise in LCA. Part 1: state-of-science and requirement profile for consistent context-sensitive integration of traffic noise in LCA. International Journal of Life Cycle Assessment (14), 560–570 (2009a)
29. Althaus, H.-J., de Haan, P., Scholz, R.W.: Traffic noise in LCA. Part 2: Analysis of existing methods and proposition of a new framework for consistent, context-sensitive LCI modeling of road transport noise emission. International Journal of Life Cycle Assessment (14), 676–686 (2009b)

30. Schmidt, M., Knörr, W., Patyk, A., Höpfner, U.: Evaluierung gängiger Datenmodelle zur Ermittlung verkehrlicher Umweltbelastungen. In: Haasis, H.-D., Ranze, K.C. (eds.) Umweltinformatik 1998. Vernetzte Strukturen in Information, Umwelt und Wirtschaft. Tagungsband - 12. Internationales Symposium "Informatik für den Umweltschutz" der Gesellschaft für Informatik (GI), Bremen 1998, pp. 280–293. Metropolis Verlag, Marburg (1999), http://enviroinfo.isep.at/UI%2098/PDF%20-%20UI-98/280-293%20Schmidt_Kn%F6rr.pdf (checked on February 12, 2012)
31. z. B. HEBFA v3.1 (INFRAS, Bern), ecoinvent v2.2 (ifu Hamburg GmbH), ProBas (Umweltbundesamt, Öko-Institut), GEMIS 4.7 (Öko-Institut)
32. z. B. GaBi (PE INTERNATIONAL), Umberto (ifu Hamburg GmbH), SimaPro (PRé Consultants/GreenDeltaTC GmbH), TEAM (PricewaterhouseCoopers/Ecobilan), ecoTransIT World (Schenker, D.B., et al.), map&guide (PTV AG), Defra/DECC tool (Defra/DECC)
33. Handbuch für Emissionsfaktoren des Straßenverkehrs (HBEFA) Version 3.1, http://www.hbefa.net/e/index.html
34. Der Blaue Engel, http://www.blauer-engel.de/
35. Norm DIN EN ISO 14001: Umweltmanagementsysteme - Anforderungen mit Anleitung zur Anwendung (June 2005)
36. BRE Global Ltd.: Building Research Establishment Environmental Assessment Method (BREEAM), http://breeam.org/
37. U.S. Green Building Council: Leadership in Energy and Environmental Design (LEED), http://www.usgbc.org/
38. Deutsche Gesellschaft für nachhaltiges Bauen e.V.: DGNB-Zertifikat, http://www.dgnb.de/

Green Logistics: Optimisation Approaches for Resource-Efficient Logistics Services

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Abstract. Today, appropriate measures can already simultaneously reduce costs, improve process sequences and reduce the effects on the environment. With optimisation approaches, for instance in the sectors of network, fleet and container management, tour planning and intermodality, the "Green Logistics" partners demonstrate the practicability and potential of environmentally-friendly logistics services. This paper provides a detailed description of the approaches, "Pollutant emission tracking for transports" and "Resource-efficient logistics real estate", and an explanation of the respective procedures and initial results. In addition to the development of concrete green products, "Green Logistics" also deduces action recommendations and guidelines that support other logistics industry participants in applying the "Green Logistics" successes to their own business processes.

Keywords: eco-efficiency, transport, networks, tracking, greenhouse gas, CO_2, energy consumption, building shell, intralogistics, real estate.

1 Introduction

The prevention of environmental effects caused by the logistics industry is a task for the participants in the entire value chain and one requiring that they all work together. There are numerous approaches for the reduction of effects on the environment that can be of a technological, operative, organisational or political nature, for example. There are numerous approaches and even some products that can be used to make logistics sub-segments more energy-efficient and environmentally-friendly [1], but none of these are as yet widely used. The reason for this is that the ecological and economic effects within the broad range of existing individual measures in transport, intralogistics and logistics real estate segments are not transparent. Standardised ecological processes and a systematic assortment of ecological design alternatives for logistics processes and systems are missing. This uncertainty regarding the actual

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ecological effects coupled with a lack of knowledge on possible ecological alternatives under specified border conditions and the economic effects make it particularly difficult for small and medium-sized companies and even for large companies as well to design their logistics in an eco-efficient manner.

It is the objective of the “Green Logistics” project plan comprehensively to determine for the first time the ecological effects of logistics systems and processes on a usage-related, standardised basis and to develop methods and instruments for the assessment of associated elements ranging from storage to distribution to reverse logistics. More commentary on this is presented in the article, “Green Logistics: Comparability of the Environmental Effects of Logistics Services”.

Another of the project plan’s main priorities is the development and realisation of eco-efficient logistics solutions. In addition to the depiction of Best Practices, guidelines and checklists will be prepared with which eco-efficient solutions for the logistics real estate, intralogistics and transport segments can be identified and implemented.

2 Approaches for Green Logistics

The “Green Logistics” project will conduct cross-company case study examinations for optimising approaches in the segments of transport and logistics business premises locations, i.e. logistics real estate, and intralogistics. The process will include the development of eco-efficient solutions and the validation of their performance capability in actual practice. These include

- Ecological network management
- Eco-efficient tour planning
- Eco-efficient fleet management
- Measure to promote intermodality
- Eco-efficient container management
- Pollutant emission tracking
- Resource-efficient logistics real estate

While this paper provides detailed presentation of the scope of the examination, the procedures and initial results on pollutant emission tracking and resource-efficient logistics real estate, the additional “Green Logistics” optimisation approaches are briefly outlined in the following sections. Please refer to other sources for more extensive information (for example, [2], [3], [4]).

Ecological network management

In 2010, the level of load capacity utilisation of the available load capacity in domestic German transport was only 60%. [5] Ecological network management has the objective of reducing the number of transports and subsequently emissions by optimising load capacity utilisation while retaining an equally high level of quality. The examination points consist of the challenges and the respective contribution to be made toward increasing eco-efficiency, for example by

- cross-shipper transport disposition (for example, the consolidation of hub points, load and flow analyses, swap box management)
- larger means of transport (for example, road trains (i.e. gigaliner), volume boxes)
- deceleration by means of altered shipment conduct on the part of customers, for example
- cooperative long distance transports (for example, freight exchanges)
- operational approaches such as fuel-saving driving conduct and the supervision of vehicle deployment
- technological opportunities in the unit loads segment

The optimisation measures to be examined will be conducted within individual companies and on a cross-company basis in order to generate the greatest possible potential for transport reductions. The investigations focus on medium and long-distance transport. Taking the example of road trains, for which preparations are currently underway to conduct field testing in parts of Germany, theoretical and actually achieved savings potential will be determined.

Eco-efficient tour planning

Taking the example of the model region of Dortmund, Germany, a layout of the district that also observes ecological criteria will be conducted for the first time in the "Green Logistics" project [6]. The main areas of delivery in the district will be determined on the basis of logging and analysis of present UPS tour routes. This will form the basis for a new layout of the district that takes both economic and ecological aspects into account. For example, for ecologically optimised tour planning, the examination will look at a reduced number of vehicle tours as well as alternative disposition possibilities such as the deployment of helpers and the utilisation of vehicle trailers, bicycles and gas-driven and electricity-driven vehicles for delivery in inner-city areas with designated pedestrian zones. [4] The first tests on alternative disposition system (for example, e-bicycle) will begin in mid-2012.

Another aspect is improvement of the delivery rate in private sector delivery. This addresses shipments that the carrier is unable to deliver directly to the recipient and which currently imply up to three delivery attempts and subsequent storage at the distribution centre. Both repeated delivery attempts and package pick-up drives by recipients are causes of additional transports, respectively, individual transports and corresponding emissions. Examination will therefore be undertaken to determine the extent to which the utilisation of modern communication possibilities is suitable for further increasing the delivery rate, thereby preventing multiple delivery attempt drives and individual transports.

Eco-efficient fleet management

Technological approaches with a focus on alternative drive technologies and regenerative fuels will be examined in detail within the framework of eco-efficient fleet management: At present, UPS, Schmidt-Gevelsberg and Deutsche Post service their networks predominantly with diesel-powered vehicles. The deployment of electric drive vehicles, respectively, hybrid-drive vehicles or more climate-friendly fuels is only limited to individual cases and is not implemented on a large scale within the fleets. The examination is aimed at creating the principles for ecological fleet management in urban, suburban and rural distribution and in medium and long-distance network transport.

On the basis of the results, logistics service providers can identify eco-efficient solutions for their fleets in line with their particular primary activities (for example, urban/suburban distribution and medium and long-distance network transport). Furthermore, logistics industry requirements on the drive technologies and infrastructure for utility vehicles will be formulated.

Intermodality

Along with the previously-mentioned environmentally-friendly transport concepts for individual transportation modes, modal shifting of freight transport (from road transport to rail, inland waterway) offers additional potential for increasing the logistics industry's efficiency in regard to resources and energy [7]. Today 82% of the goods transported in Germany are transported using road transport, with only 11% handled by rail and 7% transported via inland waterways. [8] Within EU-27 in 2009, total sea transport played a greater role accounting for 40% of the total transport performance (3% inland waterway, 37% short sea shipping), while 10% of transport performance was conducted by rail. [9]

According to the Federal Statistical Office of Germany [10], in 2010 6.7 million tons transported in containers on German roads (i.e., 895 TEU) would have qualified in principle for shifting as defined within the concept of combined transport. For increased development of shifting potential, two case studies highlight the topic of intermodality, which focuses in particular on rail transport that could meet the needs of bulk goods transport and package logistics for long distances. The partners participating in the studies identified the following obstacles to shifting: From the perspective of transport service providers, load capacity utilisation is the most significant obstacle in structuring a transport. A basic minimum load is indispensable for the economic feasibility of a transport relation. From the forwarding companies' perspective, three criteria are decisive in selecting the mode of transport: costs, reliability and the duration of the transport. A short duration of the transport and a high level of transport reliability are particularly necessary for transporting bulk goods and packages in the short timeframes that customers require.

Simultaneously, CO_2 measurement of the DB Mobility Logistics intermodal network is increasing transparency in the ecological assessment of intermodal transport chains and is preparing related methodical questions, starting points and proposals for transport shifting within these types of networks. The first step involves the measurement of a section of the combined transport networks within DB Intermodal with embarkation and destination points in the greater Ruhrgebiet area along Germany's north-south corridor via greater Munich with connection to the economic region of northern Italy. The methodology and procedures developed here are to be applied to the entire DB Intermodal network upon conclusion of the project.

Eco-efficient container management

Swap boxes are used in package and letter logistics main delivery routes. These flexible load carriers form the interface between transport and intralogistics. While the logging of arrival and departure times has already been implemented in many cases using local systems, the potential offered by the detection and monitoring of position-related data has not yet been exploited. Innovative container management based on the linkage of yard logistics and route management is aimed at producing an ecologically optimised consolidation network to be tested in a Deutsche Post pilot trial on the basis of 12,500 swap containers on the main routes. It is anticipated that the optimised repositioning of containers will enable the container inventory to be reduced by 3-5%. Improvements are expected in the inflow of empty swap boxes, the loss rate and in the availability of the swap boxes. [3]

3 Pollutant Emission Tracking for Transports

3.1 Industry Background - Motivation

Particularly in the bulk goods transport industry, the bundling of transports and the attainment of a high load capacity utilisation rate of the vehicles is the most easily pursued approach for increasing economic and ecological efficiency, both in local transport and in long-distance transport. But the tight delivery schedule deadlines so common today prevent the efficient bundling of the transports. 24/48 hours turnaround times have become the rule with domestic German transports, and due to the broad range of forward products from bulk goods transporters and CEP service providers, even shorter turnaround times have to be provided, albeit with a surcharge. All of this has resulted in forwarding companies having very short timeframes for planning their transports, a situation which encumbers efficiency.

There has been no incentive up to now for forwarding companies to decelerate their delivery chains. Short-term express shipments cause lower load capacity utilisation of the vehicles, and therefore more transport runs and the associated higher emissions. As a consequence of the today's deficiency in the (standardised) measurability of transport emissions there is no kind of sanctions for such conduct. On the contrary, since forwarding companies charge extra for express shipments, short-term planning by customers is even in their interest to some degree.

Forwarding companies only have a very low level of contact with their end customers. Nevertheless, the pressure exerted by their clientele, i.e., the persons or parties commissioning the shipments, is on the increase, since they certainly do have frequent contact with end customers and are increasingly required to provide statements on the carbon footprints of their products, supply chains etc. [11] [12] Transport, particularly in complex supply chains, generates a not insignificant share of a product's total carbon footprint. [13] As a result, shippers are increasingly demanding reliable statements from their service providers regarding the environmental impact of transports that are scheduled or have already been conducted.

If shippers therefore were in a position request hard, understandable key data from their service providers, this would achieve the required market transparency and the growing demands of the clientele would be met. The emissions actually linked to a specific shipment would be quantifiable and it would be possible to make a decision on the basis of both economic and ecological factors. This is the point where the present "Pollutant emission tracking for transports" (short: "ecoTrack") case study, with its proven procedure for emissions calculation, proceeds from. This will be implemented in the demonstrator, "CO_2-Tracker".

3.2 "ecoTrack" Case Study Approach

The principle behind the "ecoTrack" case study is to create measurability and comparability of the eco-efficiency of transports and to attain the highest level of both economic and ecological efficiency. While in the past emissions have only been determined retrospectively, the procedure to be developed will work with live data with which a significantly higher level of precisions is anticipated in the results. The assessment of approaches that have already been developed shows that some of them only work on the basis of thin data, and still the conclusions drawn from this unrepresentative cross-section taken from an entire network have been excluded.

The procedure to be developed for determining emissions fulfils the following requirements:

- The determination of emissions is conducted on a usage-related and shipment-related basis.
- The focus is on the bulk goods transport industry, but the procedure can also be applied to other logistics segments.
- The procedure can be used throughout the industry by small and medium-sized companies alike.
- The data is collected, documented and transmitted in real-time using on-board units.

The developed measurement and calculation method should consequently be transferred into a guideline for the determination of emissions in the bulk goods transport industry and into a demonstrator in the form of software which will be capable of automatically preparing selected test data from external sources and establishing an emissions database. The expectation for this demonstrator is that at the conclusion of the research work it will be able to be expanded into a comprehensive tool with which a complete network database can be created.

The procedure will be developed and validated using a representative Schmidt-Gevelsberg bulk goods transport network augmented by network sections from the bulk goods transport cooperative partner CargoLine. The objective is the fully automated registration of consumption data. During the conception and testing phase in particular, the integration of the drivers in the form of qualified feedback will represent an important component.

3.3 Procedure and Outlook

Selection of test relations for data acquisition

The very broad range of diversity in source-sink relations between local transport districts and long-distance transport relations within the network requires the selection of reliable, proven and representative examination cases, i.e., test relations. This led to an analysis of the quantity structure both for the long-distance transport departure point and for the local transport. Independent of the additional parameters (for example, the willingness of the partner/subcontractor to participate), these data provide initial findings on the districts where a critical mass can be attained enabling an assessment of the calculations to be conducted.

This led to the following selection: The districts of "Solingen" and "Remscheid" cover medium distances and tonnage in urban areas in the local transport segment of Schmidt-Gevelsberg GmbH. These districts are supplemented by the more rural district of "Plettenberg", which has a lower stop density and where many customers with highly specific weight requirements are located. Transports are additionally included to a selection of large customers whose daily quantities cannot be covered with the regular tour vehicles and are instead serviced with swap boxes in shuttle transport.

The long-distance transport segment will be observed over regularly run main routes between a selection of partner depots whose inclusion is being coordinated at the moment. Hub and overhang transports are excluded from observation in the conception phase due to their lower level of relevance.

Integration of the existing IT infrastructure

The emissions calculation should be embedded in the existing IT infrastructure so that automatic registration, analysis and assessment of the measurement data can be conducted on a basis that is specific to the particular tour and shipment. To this end, the Schmidt-Gevelsberg IT infrastructure was integrated; it currently encompasses the following relevant segments:

- Transport Management System (TMS):
  - Today: Active logistics
  - In the future: New development of forwarding company ERP including TMS on the basis of the Microsoft Dynamics AX (Anaxco Solutions) ERP solution
- Order management in local transport: psv3 system (TIS GmbH)
- Telematics solution for the company's long-distance transport vehicle fleet: ComlogFlex (ComlogVehco)

The current redevelopment of the forwarding company ERP provides a unique opportunity within the framework of developing this software for executing the development of TMS-side calculation and measurement modules featuring significant benefits in flexibility and costs. In addition, Microsoft Dynamics AX is a recognised ERP solution that enjoys widespread use and allows for the modular development of the demonstrator, subsequently ensuring its applicability later on for other users. The current development also accounts for the fact that corresponding interfaces and wildcards must be integrated. This means that right from the beginning, the corresponding TMS components will already be equipped to handle future emissions data.

The main focus in regard to determining the data in the vehicles will be on the psv3 solution. This solution is only being used at present for order management, but has far greater potential. The fact that it is a mobile solution is particularly important. This ensures that it can be used without any problems in subcontractor vehicles. Most telematics systems are supplied as fixed components, greatly restricting their application in subcontractor vehicles since the subcontractors are generally not enthusiastic about changes being made to their vehicles. The TIS solution provides the opportunity to connect a small box to the fleet management interface which then communicates via Bluetooth with the driver's mobile data registration unit. In turn, the driver's mobile data registration unit is in continuous contact with the TMS via a mobile telephone connection. The FMS interface allows access to a broad range of information about the vehicle, including information that is relevant to emissions and consumption. The system interface is designed so that all the registered data is transmitted. Additionally, the interface is already accounted for in the future ERP system and will be implemented in its entirety.

The ComlogFlex telematics system is only used in the company's own long-distance transport vehicle fleet, since this is a fixed component system. This system also allows for the registration of all consumption-relevant values from the vehicle, but an additional interface to the TMS must be implemented for this system in order for all the data to be used.

Methodical framework of the emission tracking

The method developed in the "Green Logistics" project for ecological and economic logistics systems procedure will be transferred into the present bulk goods transport emissions tracking system. The parameters and data required for the usage-related allocation of emissions to transport orders and customers must be defined. The actual calculation should be embedded in the company's IT systems and should be executed and displayed automatically.

CO_2-Tracker pilot trial

In "Green Logistics", a pilot trial for validation will be conducted starting in 2013 on the basis of the previously defined test relations and both the methodological and technical concepts that have been developed for tracking emissions. A simultaneous comparison between tracked, usage-related emissions and emissions calculated on a rounded-off basis (i.e., today's accustomed ex-post observation) will also be conducted from which new findings and necessary adaptations for both the CO_2-Tracker and the methodology involved can be derived. The central research question on this issue is how large is the percentage deviation between the two, and what conclusions can be drawn from the identified deviations?

Since the implementation is to be conducted analogous to existing tracking & tracing approaches, its transfer into an online system is equally planned here. The objective of this system is to depict the emissions from each of the transports via different sub-processes. It is furthermore planned that customers will also receive the possibility of determining the emissions that will be generated by the transport they are planning on the basis of past usage-related values reflecting real situations in advance of actually commissioning the transport. In addition, the company will also be capable of determining its annual emissions allocated to each customer, shipper and service provider. This creates the required transparency and liability for the emissions within which a general awareness regarding emission reduction on the part of customers (for example, via deceleration of the transports) can be developed.

4 Resource-Efficient Logistics Real Estate

4.1 Objectives and Procedures

In the case study on resource-efficient logistics real estate (short: “ecoHub”), for the first time the implementation of ecological technologies is to be taken into account in the conceptual design of a “typical” logistics hub centre in the interest of a comprehensive approach. Previous approaches have focused on selected hub centre segments, such as building erection (the application of renewable raw materials, a high level of heating and thermal insulation technology usage, etc.) and/or building services engineering (heat recovery ventilation for the heating and air conditioning equipment, usage-related and energy-saving lighting technology, etc.). Within the framework of this case study, all the relevant segments, i.e. the building, building services engineering, intralogistics facilities and the processes of a hub centre will be examined in regard to their specific eco-efficient optimisation potential, and the interactions and interdependencies between the segments and different technological approaches will be analysed. Building on these findings, a modular system for eco-efficient solutions designed for various utilisation purposes (for example, distribution centre, package distribution centre, air freight hub centre) and framework conditions (for example, new construction or optimisation of the existing property) will be developed which will enable comprehensive planning and realisation both for the erection and the operation of an eco-efficient hub centre.

4.2 Status of the Work and Initial Results

Systematisation of logistics real estate and relevant processes

Against the backdrop of the broad range of diversity in the types of logistics real estate and their different utilisations concepts, i.e., “Logistikimmobilie ist nicht gleich Logistikimmobilie - Eine differenzierte Betrachtung” (‘Logistics real estate is not simply logistics real estate - a differentiated observation’) [14], type designation of the real estate object itself and the definition, respectively, delineation of the processes within the entire logistics chain is necessary. The system boundaries and the essential in-house operational processes were identified as the basis for system boundary definition and determination of the ecological effects for five exemplary hub centre types that are also operated in this form by the participating project partners Lufthansa Cargo, Fiege and Deutsche Post. The in-house operational logistics processes are divided into the main segments

- Receiving
- Transport and Sorting
- Storage and Handling
- Dispatch

This enables the processes to be differentiated and detailed on a case-by-case basis (see Illustration 1).

Processes \ Hub centre type	Standard hub centre	Air freight hub centre	Package centre	Letter centre	Multi-modal hub centre
System border: Ramp/gate					
Receiving					
Yard logistics	x	x	x	x	x
Goods received	x	x	x	x	x
Weigh, scan, measure (x-ray)	x	x	x	x	x
Goods separation		x	x	x	x
Transport/Sorting					
Production of conveyance capability		x	x	x	x
Storage/Handling					
Production of storage capability	x				x
Assembly	x				x
Packing	x				x
Commissioning	x	x	x	x	x
Consolidation	x	x	x	x	x
Transport/Sorting					
Dispatch					
Securing loading units	x	x	x	x	x
Container loading (swap boxes, dollies)	x	x	x	x	x
Load inspection	x	x	x	x	x
Identification	x	x	x	x	x
Yard logistics	x	x	x	x	x
System border: Ramp/gate					

Illustration 1: Matrix of the hub centres and processes

Inventorying was conducted in which the possible different forms of logistics real estate and intralogistics facilities and components were structured and specified for the segments "Building" and "Intralogistics" using morphological boxes. These morphological boxes form the basis for future libraries with standard modules comprising the technologies currently available on the market, and they provide access to the each of the parameters and key data that are relevant for an ecological assessment.

Data basis for the ecological assessment of intralogistics processes

At present however, these libraries demonstrate significant gaps in regard to relevant consumption parameters (for example, electricity consumption under real conditions). For this reason, research, manufacturer surveys and concrete measurements will be utilised throughout the entire course of the "Green Logistics" project to register this data in a uniform manner and to process them for process-related observation.

Both the actual utilisation phase and the manufacturing of the facilities must be observed in the ecological assessment of intralogistics facilities.

Consumption-specific values must therefore be provided for the utilisation phase: energy consumption (for example, electrical energy in kWh) related to the handling unit (for example, pallet with a 500 kg load) and the logistics process (for example, horizontal transport in metres). Up until now, the determination of the level of energy consumption has generally been conducted using theoretical apparent power values and power output data that only reflects the actual consumption values with a certain degree of uncertainty. For example, the Association of German Engineers Guideline VDI 2698 [15] defines "typical" application cases for determining consumption in floor conveyor units. The task now is to take this "theoretical" key data and compare and assess it against data obtained and identified in practice within the framework of measurements in real operation. The previously mentioned library for intralogistics solutions offering reality-based key data related to the specific logistics performance unit will be a part of the result.

The ecological effect of the manufacturing phase of logistics facilities is insufficiently documented at present. For this reason, the "Green Logistics" project conducted exemplary life cycle assessments in which the essential manufacturing processes for transport facilities, sorting facilities and other facilities underwent evaluation at the material life cycle assessment level in regard to their greenhouse gas emissions, and the production of the semi-finished products was roughly estimated. The comparison with the utilisation phase demonstrated that some 5% - 10% of all the life cycle emissions are attributable to the manufacturing phase. This appears to be a relatively low figure, but it nevertheless exceeds the normal ecological life cycle assessment cut-off criterion limit of 2%. These statements have also been confirmed by other sources [16] and must therefore undergo closer examination within the overall context of complex logistics systems. The share of total freight sector emissions contributed by freight operation locations is estimated to stand at 13%. [13] According to exemplary examinations and calculations conducted by Fraunhofer IML, the share contributed by logistics facilities to freight operation location emissions is in the range of 10% to 40%, depending on the level of automation. As such, the share of emissions in the manufacturing phase of logistics facilities stands at 0.07% to 0.5% of the total emissions and is therefore rather negligible. The more extensive detailed examinations and calculations conducted during the further course of the "Green Logistics" project will demonstrate whether these statements can be confirmed or not.

Resource-efficient logistics real estate concept

An important part of "ecoHub" consists of the assessment of the eco-efficiency of existing logistics real estate objects and the design of future eco-efficient logistics real estate objects. The concept is executed in the form of a scenario analysis accompanied by the ecological assessment of the respective scenarios.

Considering the future viability, implementations of future real estate should not only be decided on the basis of investment costs, but also by taking the life cycle costs and life cycle assessment into account. To this end, LEGEB software is used by the project partner arcadis for the integral calculation of buildings: This is a software tool for the analysis and assessment of buildings, i.e., their erection and operation. On the basis of a detailed description of the building in question with its individual components and technical systems, this tool determines the manufacturing and life cycle costs and the energy requirements, and it evaluates the materials used in its manufacture in an ecological life cycle assessment on the basis of ISO 14040 [17] and 14044 [18]. The basis for the ecological life cycle assessment data is "ecobau.dat" from the German Federal Ministry of Transport, Building and Urban Development (BMVBS). [19]

The conceptional development of this future logistics real estate shall pursue the following individual targets:

- The construction of a plus-energy industrial property
- To reduce the energy requirements of the property to approximately 40 kWh/a*m² (without process energy requirement)

- Generation of photovoltaic energy to cover the total energy requirements of the property
- To transform excessive energy to H_2 and transfer it to the neighborhood via decentral gas stations networks, power supply networks or heat networks
- Marketing model with a gross rent including heating with a guaranty for energy costs.

In order to reach these targets it is necessary to consider the property as a whole. This comes along with a reduction of the energy requirements during operation. According to this final energy requirement the technical equipment that needs to be installed will be dimensioned. That includes energy producing equipment on the one hand and energy consuming on the other hand. Such a concept is subject to the energy production that is necessary for the required processes at the property over a yearly cycle. This energy is generated by means of renewable energies. Relevant to the location different concepts can be taken into account (geothermics, wind power, photovoltaic, biomass, etc.). Climax of this conceptioning is an energy-self-sufficient logistics building which also saves the excessive energy – in addition to the required final energy in order to maintain the processes at the property – and transfer the surplus to third parties in the close environment.

4.3 Outlook

The objective of the "ecoHub" case study is to raise the level of ecological optimisation potential in the interplay between buildings, their building services engineering equipment and intralogistics facilities by means of a comprehensive approach. As such, the next work steps involve creating the bases for the life cycle assessment of the individual segments, in particular of the intralogistics processes on the basis of real consumption values. To this end, electricity consumption measurements were conducted in a variety of logistics operations business premises.

In addition, relevant scenarios for logistics real estate will be deduced in which technologies for increasing resource conservation and eco-efficiency are examined more closely and their effects in the interplay with the entire logistics system are assessed.

Within the scope of this case study the coherencies are represented as well as the results of the individual areas "building and resource extraction", "intralogistics" as well as "processes and process control" are combined. The objective is the development of a tool (modular construction system) that offers a decision-making basis for the reasonable implementation of technology considering the stated basic conditions. At the same time, the associated economic and ecological effects shall be made transparent by that tool.

5 Conclusions

Suitable measures could already simultaneously reduce costs, improve process sequences and reduce the effects on the environment today. The increasing political and public pressure on the logistics industry indicates that in the near future more statements regarding the effects on the environment and successful optimisation measures will be demanded. With the optimisation approaches presented herein, the "Green Logistics" partners demonstrate the practicability and potential of environmentally-friendly logistics services. The action recommendations and guidelines derived from this support other logistics industry participants in applying the "Green Logistics" successes to their own business processes.

References

1. McKinnon, A.C. (ed.): Green logistics. Improving the environmental sustainability of logistics. Kogan Page, London (2010)
2. Green Logistics: `http://www.green-logistics-network.de/`
3. Seemann, A.: Grüne Bilanzen unter der Lupe. DVZ Deutsche Verkehrs-Zeitung (6), 30–33
4. Clausen, U., Herden, J.: Was ist Ökoeffizienz in der Logistik? Internationales Verkehrswesen (2(63)), 16–17 (2011)
5. Kraftfahrt-Bundesamt (ed.): Verkehr deutscher Lastkraftfahrzeuge. Inlandsverkehr, Eigenschaften der Ladung. Jahr 2010, p. 3 (2011), `http://www.kbashop.de/wcsstore/KBA/Attachment/Kostenlose_producte/vd3_inland_ld_2010.pdf` (checked on February 17, 2012)
6. Eglese, R., Black, D.: Optimizing the routing of vehicles. In: McKinnon, A.C. (ed.) Green Logistics. Improving the Environmental Sustainability of Logistics. Kogan Page, London (2010)
7. Woodburn, A., Whiteing, A.: Transferring freight to "greener" transport modes. In: McKinnon, A.C. (ed.) Green Logistics. Improving the Environmental Sustainability of Logistics, Kogan Page, London (2010)
8. Bundesamt für Güterverkehr (ed.): Marktbeobachtung Güterverkehr. Bericht Herbst 2011, p. 7 (2011)
9. European Union: EU transport in figures. Statistical Pocketbook 2011, p. 19. Publications Office of the European Union, Luxembourg (2011)
10. Statistisches Bundesamt (ed.): Verkehr. Kombinierter Verkehr, Wiesbaden (Fachserie 8 Reihe 1.3), p. 145f (2012)
11. Czotscher, E., Preußer, J.: Branchenkompass 2010 Transport. Aktuelle Entscheiderbefragung, Grüne Logistik in der Konsumgüterindustrie und im Einzelhandel. FAZ-Institut, Frankfurt am Main (2010)
12. Carbon Disclosure Project (ed.): CDP supply chain Report 2012. A New Era: Supplier Management in Low-Carbon Economy. Accenture (2012), `http://www.cdproject.net`
13. World Economic Forum: Supply Chain Decarbonization, The Role of Logistics and Transport in Reducing Supply Chain Carbon Emissions, p. 7 (2009), `http://www.weforum.org/pdf/ip/SupplyChainDecarbonization.pdf` (checked on February 20, 2012)
14. Logistikimmobilien – Markt und Standorte 201; Studie der Fraunhofer Arbeitsgruppe für Supply Chain Services SCS; Nürnberg (September 2011)
15. VDI 2698 Typenblätter für Flurförderfahrzeuge (August 2002)
16. Jungheinrich: Das Jungheinrich Umweltprädikat. Eine Untersuchung zur Ermittlung der Ökobilanz der Jungheinrich-Flurförderzeugflotte auf Basis von ISO 14040 (2011)
17. Norm DIN EN ISO 14040: Umweltmanagement - Ökobilanz - Grundsätze und Rahmenbedingungen (October 2006)
18. Norm DIN EN ISO 14044: Umweltmanagement - Ökobilanz - Anforderungen und Anleitungen (October 2006)
19. Informationsportal Nachhaltiges Bauen des BMVBS (Bundesministerium für Verkehr, Bau und Stadtentwicklung)

Upstream Carbon Dioxide Assessment at the Product Level

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Abstract. Carbon dioxide emissions are a major driver of the greenhouse gas effect and must hence be significantly reduced. Wherever choices between multiple alternatives have to be made, quantification of the amount of associated emissions is a necessity. Since a major part of carbon dioxide emissions stems from processes upstream in the supply chain, algorithms are required which facilitate upstream carbon dioxide assessment in absence of supplier data. Furthermore, for the purchasing of goods and services, this assessment has to be undertaken at the product level, rather than at the firm level. We facilitate the development of such an algorithm by reviewing data quality and system boundary requirements of existing standards, and by analyzing extant and conceiving further possible calculation methods. Based on this research, an algorithm can be developed.

Keywords: Sustainability, sustainable supply chain management, carbon footprint, IOA.

1 Introduction

One of the most pressing environmental concerns is the greenhouse gas (GHG) effect (Lashof and Ahuja, 1990). Global warming will be difficult to stop, even if GHG emissions are decreased drastically. Without radical emission abatement, the consequences are expected to be devastating for the natural environment, economy and mankind. While the basic need for emission reduction has been understood (e.g. Weinhofer and Hoffmann, 2010) and related levers have been identified (e.g. Walker *et al.,* 2008), implementing it is a huge challenge due to high volume of data processing, methodological complexities and lack of common guidelines (Plassmann *et al.*, forthcoming).

Firms which are willing to decrease their emissions or feel obliged to do so find that, due to vertical disintegration, a large fraction of the emissions of their products is created outside their own operational boundaries. With the ongoing trends towards global and multi-channel sourcing, and towards longer supply chains, procurement decisions have gained more responsibility for the emissions of the final product the company sells. Hence, the emissions that accompany the supply chain play a crucial

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 163–174.
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role for a company that tries to reduce its GHG emissions (Sundarakani et al. 2010). The concept of the Product Carbon Footprint (PCF) is able to address this issue, if all relevant data is available. The PCF is "a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product." (Wiedmann and Minx, 2008, p. 4). However, in cases where suppliers do not want to or cannot provide PCF information, tools and algorithms for the estimation of upstream carbon dioxide assessment at the level of the product are still lacking. This research gap is clearly relevant, because without the knowledge about those emissions, purchasing cannot take informed decisions. From a procurement perspective, there are different challenges for calculating a PCF then from the perspective of the supplier. This paper[1] aims to make a contribution by identifying, describing and comparing multiple procedures that companies could apply in their purchasing decisions to estimate a Product Carbon Footprint (PCF) for goods to be bought, in absence of required supplier data. The research takes existing standards into account. Therefore, we seek to address the following research questions: (1) *Which standards for GHG emission estimation exist or are in the process of being created that a new algorithm has to take into account?* (2) *Which algorithm outlines are imaginable, and what are their respective advantages and disadvantages?*

In the following section we present a methodological framework that interlinks relevant supply chain and GHG terms and further elaborates the research gap. The subsequent chapter comprises the analysis of standards. In the penultimate chapter, possible algorithm variants are identified and analyzed. We close with a discussion of implications.

2 Methodological Framework

The GHG protocol initiative serves as an instrument for differentiation between direct and indirect emission sources and for improving transparency. It defines so-called "scopes" (scope 1, scope 2 and scope 3) in order to avoid double counting of emissions by neighbouring companies in the supply chain (WRI & WBCSD, 2004). Scope 1 refers to GHG emissions that stem from sources owned or controlled by the company that is doing the assessment. Scope 2 relates to GHG emissions from purchased electricity consumed by the company itself, and Scope 3 is an optional reporting category for all other indirect emissions, such as (non-electricity) emissions in the upstream supply chain ("value chain") or downstream emissions that occur, for example, during product usage. If we look at emissions from a temporal perspective, then the perspective of the company that is focused on – or that is doing the assessment – can be equated with the present, its upstream supply chain with the past and its downstream supply chain with the future. All scope 2 emissions are emissions in the upstream supply chain because electricity is generated before it is consumed. Those scope 3 that occur at direct (tier-1) or indirect (tier-2 to tier-n) suppliers are

[1] This article is a scientific excerpt from an ongoing research project. We gratefully acknowledge that this project is funded by the German Federal Ministry of Education and Research, grant no. 01IC10L14A.

related to the past. Scope 3 emissions in the downstream supply chain, i.e. all emissions that occur at direct or indirect customers or end consumers, on the other hand are related to the future.

In life cycle assessment terminology, emissions in a company's upstream supply chain can also be referred to as "cradle-to-gate" emissions of its *suppliers* (ISO 14044; WRI & WBCSD, 2011): According to the GHG Protocol (WRI & WBCSD, 2011, p. 37) "cradle-to-gate is a partial life cycle inventory, which includes all emissions and removals from material acquisition through to when the intermediate product leaves the reporting company's gate (typically immediately following its production) and excluding final product use and end-of-life." "Cradle-to-grave" emissions on the other hand also include downstream production emissions, as well as emissions caused by the use of the product and end-of-life related emissions (WRI & WBCSD, 2011). Figure 1 depicts the interrelations between supply chain management, and GHG life-cycle terminology.

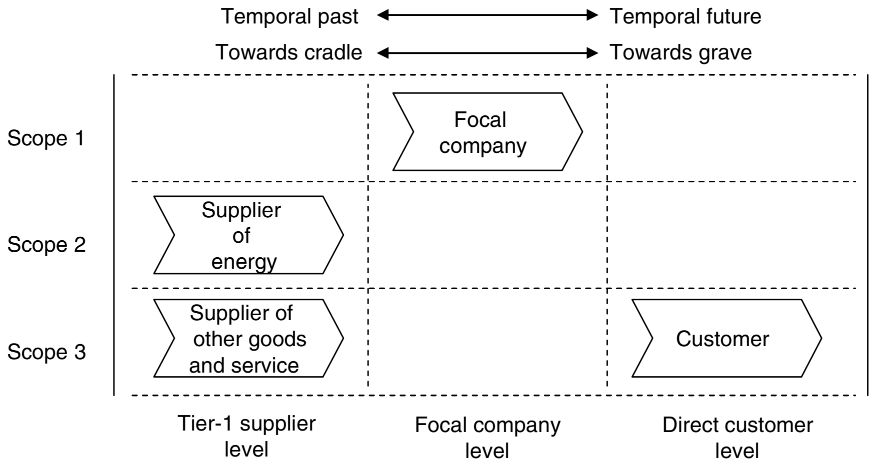

Fig. 1. Terminology interrelation overview

Previous research has focused on adequate measurement of scope 1 and 2 emissions, and a lot of effort is currently invested to calculate PCFs. However, PCFs are not yet fully available. Hence, a company which is willing to undertake ecologically responsible purchasing decisions and to include their suppliers' PCFs in their decision-making frequently cannot do so. Only if a working algorithm for the assessment of unknown PCFs, i.e. especially for unknown scope 3 emissions, existed, could firms take this information into account in their purchasing decisions. As long as such an algorithm and some PCFs are lacking, good-willing individuals and firms are actually prevented from acting in the least environmentally damaging way.

For most of the products produced and bought, it is impossible to calculate a cradle-to-grave PCF, as they are semi-finished products that will become an integral part of another, possibly unknown, final product. Furthermore, future product usage and end-of-life are difficult to predict, so that cradle-to-gate PCFs are not only easier to calculate than cradle-to-grave PCFs, but likely also more reliable. However, if the decision for a certain (semi-finished) product had a systematic impact on downstream scope 3 emissions, i.e. if decision alternatives varied in terms of carbon dioxide emissions in the future part of the life cycle, then these emissions would also have to be taken into account by an environmentally oriented purchasing decision. We focus on cradle-to-gate PCFs and thereby assume that there is no systematic difference of that kind. This assumption even seems realistic for all those cases where technical details of the semi-finished products to be bought are very similar.

3 Analysis of Existing Standards

In this chapter, we present an overview of current international standards and those under revision. Most of them are early prototypes or later derivatives from three basic standards: PAS 2050, GHG Protocol and ISO 14000 series. Standards relate to three different levels of application: product, corporate and national levels. The national level also covers sectoral figures. There are also a lot of carbon calculators for individual household emissions, but they are not of our interest.

Carbon accounting guidelines and standards include requirements for the design, development, management, reporting, quantification and verification of a product's or organization's GHG inventory. We begin our overview with the disclosure of the Kyoto Protocol in 1997 which set national emission targets to counter the global warming problem. The Kyoto protocol (which is not a standard in itself) triggered a relatively rapid development of GHG related standards at all three application levels (cp. Figure 2).

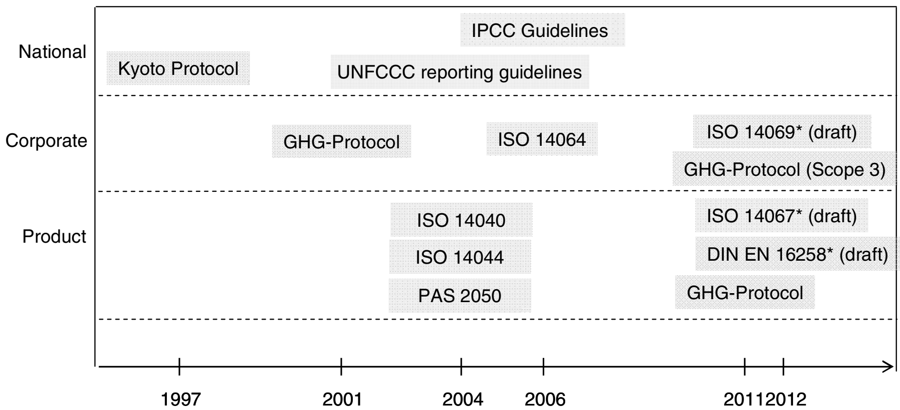

Fig. 2. History of carbon accounting standards development

Standards were evaluated by boundary setting rules, scopes, allocation methods, GHG included, as well as by distinct features. While the standards offer clear guidance regarding data quality and system boundaries, they leave the decision which method should be used for the calculation of the PCF open (cp. Plassmann *et al.*, forthcoming). We address this decision in the subsequent chapter.

At the product level, one of the first available standards was *PAS 2050*, developed by the British Standards Institution in 2006. In transportation related emissions, PAS 2050 includes not only the actual product transportation, but also emissions associated with return journeys of a vehicle (to be applied in cases of airplane travelling or product delivery by truck to the final customer). Besides taking into account the six GHGs included in the Kyoto protocol, *PAS 2050* also deals with other carbon-included substances controlled by the Montreal protocol (a protocol dedicated to emissions that harm the depleting ozone layer). Each GHG is converted into a CO_2 equivalent value. Emissions induced by human energy inputs, by customer travelling and by employees commuting to and from work are excluded from the PCF calculation (Plassmann *et al.*, forthcoming), although in some companies like IKEA such emissions account for up to 66% of all corporate emissions (WBCSD & WRI, 2004). Defining allocation scopes and boundaries is therefore important for the PCF. Further methodological complexities of *PAS 2050* were identified by Plassmann *et al.* (forthcoming). Additional product level standards are *ISO 14040* and *ISO 14044* on life-cycle assessment. They are compatible with our methodological framework, but too general to facilitate specific conclusion with respect to system boundaries etc. The latest extant standard at the product level is the *GHG Protocol Product Life Cycle Accounting and Reporting Standard*, recently released in 2011 (WBCSD & WRI, 2011). It is built on the framework and requirements established in the *ISO 14040/14044 Life Cycle Assessment* standards and *PAS 2050*. It enables product comparisons, beyond comparing product performance over time, although additional specifications to ensure consistent application of this standard for a product or product category are needed (WBCSD & WRI, 2011). According to *GHG Protocol Product Life Cycle Accounting and Reporting Standard*, companies shall collect data for all processes included in the inventory boundary and are required to disclose any exclusion of attributable processes under an insignificance threshold of up to one percent. Such regulations set high requirements on data collection and quality, which might eventually result in complications (Huang et al., 2009). For more detailed comparisons with other standards, please see BSI (2011). Finally, *ISO 14067* is a standard that is currently being developed, aiming at requirements and guidelines for quantification and communication of PCFs.

At the corporate level, the pioneer standard was the *GHG Protocol Corporate Accounting and Reporting Standard* (WBCSD & WRI, 2004), first published in 2001 and revised in 2004. For the definition of the corporate level, it introduces the previously discussed scope concept that sets organisational boundaries for emission accounting. To establish emission allocation, similar to financial accounting, it employs equity share or control approaches. As this Corporate Standard was permitting some discretion regarding which emissions have to be taken into account, WRI & WBCSD created a new supplement to the GHG-Protocol in 2011. This *GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard* refers specifically to indirect emissions from upstream supply chain activities, providing more transparency and guidance for how companies can account and report their emissions. Next, the *ISO 14064* standard that is based on the GHG protocol also applies the concepts of financial and operational control to establish an organisation's operational boundaries. Following the Kyoto protocol example, six GHG are considered in the form of carbon dioxide equivalents, which are calculated using the mass of a given GHG multiplied by its global warming potential. *ISO 14064* also takes CO_2 emissions from combustion of biomass into account and quantifies them separately. The standard represents a very good example of a well-structured tool for GHG reporting at the corporate level. A new standard that is currently being generated is *ISO 14069*, aimed at organizational carbon footprinting.

According to Plassmann *et al.* (forthcoming), existing standards based on Life Cycle Assessment leave too much discretion to practitioners who may have particular aims in their analysis, so that the comparability of carbon footprints may be limited. Gogolin *et al.* (2011) points out that none of the standards mentioned above take emissions associated with transportation specifically into account, since they provide only general guidelines for product and corporate emission accounting. It means that logistics details are blurred and evened out in the specific product carbon footprint. To increase comparability and transparency between different supply chains, a new European standard, developed by the European Community for energy consumption and GHG accounting in the transportation sector (*DIN EN 16258)*, is currently being planned. It is supposed to establish clear guidelines on carbon allocation for service products within the transportation sector.

Last, at the national level, the reporting guidelines *UNFCC* and *IPCC* exist. Those can be used as secondary data sources for carbon footprint calculation, where primary data are not available. They are however out of the scope of this paper.

4 Analysis of Algorithm Alternatives

As the described standards do not predetermine the means of PCF calculation, it is possible to apply several methods. For example, the GHG protocol mentions direct measurement of GHG emissions ("not common"), calculation based on a mass balance or stoichiometric basis and calculation through emission factors ("most common approach") and offers several tools for emission calculation in specific industrial sectors (WRI & WBCSD, 2004, pp. 40ff.). PAS 2050 explicitly mentions the use of secondary data, in cases "where primary activity data is not required." (BSI, 2008, p. 18).

PAS 2050 requires data collection only for sources which account for at least 1% of the overall GHG emissions (so-called "material contributions", BSI, 2008, p. 4). The GHG protocol sets a similar materiality threshold at 5% (WRI & WBCSD, 2004, p. 72). Furthermore, PAS 2050 demands a capture rate of at least 95% of all emissions, meaning that the inventory of PCF emissions must cover at least this fraction of the total amount (BSI 2008, p. 13). Huang *et al.* (2009) point out that the application of the materiality threshold only leads to high variance of capture rates across different sectors. On the other hand, the capture rate threshold necessitates the collection of such vast numbers of data points that it is supposedly unaccomplishable in corporate practice. Apparently, the use of secondary data is generally inevitable, even from the perspective of a company that tries to estimate its own PCF.

The difficulty with collecting data for suppliers with only small contributions to the PCF and an origin multiple tier-levels upstream of the focal company has led to the development of additional, indirect methods for calculating GHG emissions. All these calculation methods can be classified and characterized as depicted in Table 1 (cp. Wiedmann, 2009; Minx *et al.*, 2008; Huang *et al.,* 2009).

Beside these well-known approaches, we identified two alternatives. First, the production process and the materials used for the production of a product could be assessed from the outside and in a theoretical manner, basically by creating a virtual factory for the product. We tentatively call this concept the Production Technology Approach (PTA). As input for the PCF, a database containing a list of materials and production technologies, as well as their average CO_2 emissions are required. To estimate the PCF of the product, its raw materials and production processes would have to be theoretically determined first. Second, the respective CO_2 emissions would have to be extracted from a database. Last, the PCF could be calculated. Especially for transportation services, solutions have been issued that calculate GHG emissions in a theoretical manner and can therefore be classified as PTA. Examples are provided by Kranke et al. (2011). The advantages of PTA appear to be that the PCF assessment is possible for all products and services and that the approach reflects differences in CO_2 efficiencies for different production technologies. On the downside, different energy mixes and varying energy intensities of different production outlets cannot be reflected by PTA. Furthermore, the more complex a product is the more complex the assessment would have to be. Databases would have to comprise vast information on production technologies and raw materials. Last, the longer a supply chain is, the less certain the PCF will be. PTA is a theoretic approach to estimate a PCF; it should not be confounded with Process Analysis, which is an approach for analysing the actual production processes of a company.

Table 1. Comparison of the most established approaches for PCF assessment

Approach	**Process Analysis** (PA), incl. Process Life-Cycle Assessment	**Input-Output-Analysis** (IOA), incl. Input-Output Life-Cycle Assessment	**Hybrid Life Cycle Assessment** (Hybrid LCA)
Target	– to understand the ecological impacts of individual products across their product life cycle	– to assess GHG emissions of large entities, such as product groups, companies or countries	– to combine the advantages of IOA and PA to get a full picture of the PCF at reasonable costs
Features	– calculation of emissions by analysing product creation and usage (“bottom-up approach”). – use of primary data and process-specific secondary data	– calculation of emissions by using available emissions data related to nations, industrial sectors or supply chain structures – use of national account input-output tables	– different forms (cp. Suh and Huppes, 2009) – all forms use PA for more and IOA for less important processes – IOA is also used in absence of primary data

Table 1. (*continued*)

Advantages	– results for defined products supposed to be of high precision – analysis performed directly at the process level – primary data helps to identify improvement potentials	– system completeness (inclusion of Scope 3 emissions) – avoidance of cut-off thresholds – efficiency – robustness – ability to fill data gaps – can be used for almost any economic activity and for many different life-cycle stages – facilitates calculation of emissions for fast growing assortments	– combines advantages of PA and IOA by starting with the complete system and adding process specific data – no system boundary or threshold problems – includes emissions related to services, over-head and capital goods – potentially good balance between data collection needs and data quality – robust and comparable GHG estimates
Disadvantages	– needs to define a system boundary, i.e. exclusion of certain production steps and emission sources – estimation errors of unknown size – costliness – restriction to small entities	– homogeneity of prices, outputs and CO_2 emissions at the sector level assumed – complex initialization process – not intuitive, acceptance and expertise by practitioners missing – perceived uncertainty – misses use and end-of-life phase – possibly outdated data (input-output-tables)	– in some cases, emissions associated with feedback loops in downstream processes can be missed – robustness depends on data quality of the PA and IOA used – little expertise among practitioners
References	– product life cycle accounting and reporting standard of the GHG protocol (WRI & WBCSD, 2011) – ISO 14067 – Lee and Cheong (2011)	– Huang et al. (2009) – Suh and Huppes (2009)	– “state of the art […] in academia” (Wiedmann, 2009, p. 178) – “most robust and comparable estimates” (Minx et al,. 2008, p. 21)

One of the major drawbacks of established PCF calculation methods is that they do not take product and supply chain complexity into account. Products assembled with many sub-products that contain other sub-products can only be handled by IOA with its specific limits since PA will give only a small piece of the picture, as long as supplier PCFs are not widely available. For instance, a modelling approach by Sundarakani et al. (2010) that provided a footprint for a whole supply chain by integrating emissions along the supply chain with a set of equations also relied on the knowledge of emission rates of the supply chain members. Furthermore, to date, product variants cannot be taken into account, at all. For a model series of cars, over the whole product life cycle, the ratio between numbers of cars produced and different configuration produced is supposed to be only between 1 and 2.5 (Stich 2007). Hence, in this case, PA or IOA would have to be calculated far too often to be efficient. We propose a Database-aided Analysis (DaA) as the alternative: For every part that can be assembled to the final product, the PCF should be laid down in the database, together with possible assembling processes and their associated emissions. Some kind of "overhead emission" factor would also have to be incorporated. The same tool that is used for deriving the final bill of material for a certain car could be applied to this aim. DaA can be seen as a model of PCF calculation at a higher product (variant) level. At the ordinary product level, another method like PA or IOA could still be employed to calculate the PCF for the assembly parts. The following Table 2 sums up relevant idealized features of all five PCF calculation approaches that we discussed.

Table 2. Idealized characteristics of different calculation approaches of cradle-to-gate PCF's

Approach	**Input**	**Per-spective**	**Direction of analysis**	**Most suitable length of supply chain**	**Most suitable object of analysis**
Process Analysis (PA)	Real information on production processes	Inside	Bottom up	Short	Simple products
Input-Output-Analysis (IOA)	Aggregated information on emissions and economic relationships	Outside	Top down	Long	Product groups
Hybrid Life Cycle Analysis (Hybrid)	As with PA and IOA	Inside /outside	Bottom up / top down	Long	Advanced products
Production Technology Approach (PTA)	Possible production layouts, emission factors	Outside	Bottom up	Very short	Simple products
Database-aided Analysis (DaA)	Cradle-to-gate PCFs of primary products	Inside /outside	Bottom up / top down	Long	Multi-variant products

5 Discussion

From our procurement perspective on upstream scope 3 CO_2 emissions, we opt for a cradle-to-gate PCF, which includes CO_2 emissions occurring up to and including the point when the product arrives at the new organisation. The calculation requires two decisions: (1) to choose a specific standard according to which data quality and system boundary shall be determined, and (2) to select a specific calculation approach.

Regarding the first choice, it seems advisable to follow latest product standard, the *GHG Protocol Product Life Cycle Accounting and Reporting Standard* (WRI & WBCSD, 2011). It provides guidelines for cradle-to-gate PCF and represents the state-of-the-art in emission accounting at the product level.

Regarding the calculation approaches, the procurement perspective requires a cradle-to-gate PCF of the supplier of the product and, in addition, a PCF of the distribution service, as the cradle-to-gate supplier PCF only covers the emission until the product leaves the supplier's factory gate. Hence, the algorithm to be developed should be split into two parts: assessment of the carbon footprint of the *product* to be purchased and assessment of the carbon footprint of the *distribution* of the product to the buyer.

Our methodological framework made it clear that the product related PCF has to be assessed from the outside perspective. This limits the calculation approaches to be taken to IOA and PTA. We suggest that the choice between IOA and PTA should be taken depending on the specific application context. For long and interwoven supply chains and aggregated product group levels, IOA appears to be the better choice, whereas PTA seems best suited in cases of rather short supply chains and relatively simple products.

In the case of IOA, we expect particular methodological challenges to relate to emission overhead allocation (e.g., those at the corporate or factory level). Certain business metrics such as turnover, number of units produced or value added may be used (Hoffmann and Busch, 2008). The selection of the metric will be crucial for the validity of the results the algorithm will produce. The major challenge in the case of PTA is expected to stem from prediction accuracy within the virtual factory.

The distribution part of the algorithm, which will be mainly transportation, can be solved with PTA. It can presumably capitalize on the forthcoming DIN EN 16258 as a calculation framework, as well as on secondary data sources that provide average values for parameters like fuel consumption, electricity consumption (e.g. Dobers, 2012), capacity usage, or modal split. Related software to calculate PCFs of logistical (especially transportation) services is already available. However, as methodologies and results differ noticeably, another major task will be to select the most suitable tool.

There have been many initiatives during recent years to set up accounting systems for GHG emissions, but there is still a long way to go. While calculation of national emissions has become a standard and estimation of corporate emissions has become a usual task, the estimation of product level data is still in a very early stage of development. The development of the proposed procurement algorithm will close an existing gap in the field of GHG accounting at the product level and will therefore help to achieve the overall goal of excellence in sustainable sourcing.

References

BSI. PAS 2050:2008 Specification for the assessment of the life cycle greenhouse gas emissions of goods and services. British Standards, UK (2008)

BSI. PAS 2050 research report. British Standards, UK (2011)

Dobers, K.: Green Logistics - Efficiency Cluster Logistics Ruhr. Presentation held at the 1st Fraunhofer Innovation and Technology Platform (FIT), New Delhi, India (March 6, 2012)

Gogolin, M., Klaas-Wissing, T., Stölzle, W.: Carbon accounting – A challenging task for logistics service providers. Internationales Verkehrswesen 63(6), 38–43 (2011)

Hegge, H.M.H., Wortmann, J.C.: Generic bill of material: A new product model. International Journal of Production Economics 23(1-3), 117–123 (1991)

Hoffmann, V.H., Busch, T.: Corporate carbon performance indicators. Journal of Industrial Ecology 12(4), 505–520 (2008)

Huang, Y.A., Lenzen, M., Weber, C.L., Murray, J., Matthews, H.S.: The role of input–output analysis for the screening of corporate carbon footprints. Economic Systems Research 21(3), 217–242 (2009)

ISO 14040. Environmental management – Life cycle assessment – Principles and Framework. International Organisation for Standardization, Geneva, Switzerland

ISO 14044. International standard, environmental management – Life cycle assessment – Requirements and guidelines. International Organisation for Standardization, Geneva, Switzerland

ISO 14064. Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals. International Organisation for Standardization, Geneva, Switzerland

ISO/CD 14067-1 [draft]. Carbon footprint of products – Part 1: Quantification, http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=59521

ISO/CD 14069-1 [draft]. Greenhouse gases (GHG) – Quantification and reporting of GHG emissions for organizations, http://www.iso.org/iso/iso_catalogue/catalogue_tc/~catalogue_detail.htm?csnumber=43280

IPCC. Climate Change 2007: Synthesis report. Contribution of working groups I, II and III to the fourth assessment report of the intergovernmental panel on climate change. IPCC, Geneva, Switzerland (2007)

Kranke, A., Schmied, M., Schön, A.D.: CO_2-Berechnung in der Logistik – Datenquellen, Formeln, Standards. Heinrich Vogel, Munich (2011) ISBN 978-3-574-26095-7

Lashof, D.A., Ahuja, D.R.: Relative contributions of greenhouse gas emissions to global warming. Nature 344(6266), 529–531 (1990)

Lee, K.-H., Cheong, I.-M.: Measuring a carbon footprint and environmental practice: The case of Hyundai Motors Co (HMC). Industrial Management & Data Systems 111(6), 961–978 (2011)

Mattila, T., Kujanpää, M., Dahlbo, H., Soukka, R., Myllymaa, T.: Uncertainty and sensitivity in the carbon footprint of shopping bags. Journal of Industrial Ecology 15(2), 217–227 (2011)

Minx, J., Wiedmann, T., Barrett, J., Suh, S.: Methods review to support the PAS process for the calculation of the greenhouse gas emissions embodied in goods and services (2008), http://randd.defra.gov.uk/Document.aspx?Document=EV02074_7071_FRP.pdf

Plassmann, K., Norton, A., Attarzadeh, N., Jensen, M.P., Brenton, P., Edwards-Jones, G.: Methodological complexities of product carbon footprinting: A sensitivity analysis of key variables in a developing country context. Environmental Science & Policy (forthcoming), doi:10.1016/j.envsci.2010.03.013

Stich, C.: Produktionsplanung in der Automobilindustrie. Kölner Wissenschaftsverlag. Cologne, Germany (2007)

Suh, S., Huppes, G.: Methods in the Life Cycle Inventory of a Product. In: Suh, S. (ed.) Handbook of Input-Output Economics in Industrial Ecology, pp. 263–282. Springer, Heidelberg (2009)

Suh, S., Lenzen, M., Treloar, G.J., Hondo, H., Horvath, A., Huppes, G., Jolliet, O., Klann, U., Krewitt, W., Moriguchi, Y., Munksgaard, J., Norris, G.: System boundary selection in life-cycle inventories using hybrid approaches. Environmental Science & Technology 38(3), 657–664 (2003)

Sundarakani, B., de Souza, R., Goh, M., Wagner, S., Manikandan, S.: Modelling carbon footprints across the supply chain. International Journal of Production Economics 128, 43–50

Tiefenthaler, H.: Der Product Carbon Footprint. Ends Report 01, 10–11 (2009)

UNFCCC. UNFCCC reporting guidelines, `http://unfccc.int/resource/docs/2006/sbsta/~eng/09.pdf`

Walker, H., Di Sisto, L., McBain, D.: Drivers and barriers to environmental supply chain management practices: lessons from the public and private sectors. Journal of Purchasing & Supply Management 14(1), 69–85 (2008)

Weinhofer, G., Hoffmann, V.H.: Mitigating climate change – How do corporate strategies differ? Business Strategy & the Environment 19(2), 77–89 (2010)

Wiedmann, T.: Editorial: Carbon footprint and input-output analysis – An introduction. Economic Systems Research 21(3), 175–186 (2009)

Wiedmann, T., Minx, J.: A Definition of 'Carbon Footprint'. In: Pertsova, C.C. (ed.) Ecological Economics Research Trends, ch. 1, pp. 1–11. Nova Science Publishers, Hauppauge (2008)

WRI & WBCSD, The Greenhouse Gas Protocol: A corporate accounting and reporting standard (revised edition). World Resource Institute & World Business Council for Sustainable Development (2004)

WRI & WBCSD, Corporate value chain (scope 3) accounting and reporting standard. World Resource Institute & World Business Council for Sustainable Development (2011)

WRI & WBCSD, Product life cycle accounting and reporting standard. World Resource Institute & World Business Council for Sustainable Development (2011)

Environmental and Sustainable Performance from a Supply Chain Management Perspective

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Abstract. Environmental performance assessment is growing strongly in importance due to environmental problems, stakeholder interests and a prevailing shortage of resources. Because of outsourcing and specialization, corporate environmental performance is largely imprinted by environmental performance along supply chains. Out of the plurality of research problems that exist in this area, we choose two which we analyze here. First, we treat the fundamental issue of green overhead allocation in the challenging case of logistics warehouses. To this aim, we draw on an analogy with activity-based costing. This offers the opportunity to distinguish between direct and indirect environmental effects, allocate these effects to process activities and assess suppliers' logistic processes as carried out for customer firms. Second, we analyze barriers to sustainable supplier selection. Supplier selection that takes social and ecologic aspects into account is not yet established in corporate practice. We frame this problem from the perspective of information processing theory and depict an interim result regarding drivers of information processing requirements and of related information processing capacities.

Keywords: Sustainable supply chain management, environmental performance, activity-based analysis, supplier selection.

1 Introduction

In consequence of environmental problems and growing stakeholder demands, consensus has been achieved that firms must take both environmental and social aspects of their business activities into account (Kleindorfer et al., 2005). The World Commission on Environment and Development 1987, better known as the Brundtland Commission, defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission On Environment And Development, 1987). Nowadays, sustainable management follows the concept of the triple bottom line that consists of the three dimensions: economy, ecology and society (Elkington, 1994). Sustainable corporate strategies can lower environmental impacts, enhance corporate financial performance (Klassen and McLaughlin, 1996; Campbell, 2007) and even

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generate competitive advantage (Hart, 1995). Supply chain management in particular can improve a firm's corporate sustainable performance (Zhu and Sarkis, 2004), and focal firms can influence their suppliers' behaviour (Carter and Jennings, 2004).

To facilitate the incorporation of environmental performance in decision-making, this performance must first be assessed appropriately. Environmental performance measurement is therefore growing strongly in importance (Noci, 1997). Due to the outsourcing wave in recent decades, a large fraction of environmental performance is predetermined by the upstream supply chain (Handfield et al., 2002). Hence, instruments and procedures are required that allow the assessment of upstream environmental performance. Out of the plurality of research problems that exist in this area, we choose two[1] which we depict here.

First, we seek to lay the groundwork for linking the corporate and the product level within Environmental Performance Measurement. Both have been studied before (Xie and Hayase, 2007), but to link them, the problem of overheads within various environmental performances must be solved. We target this fundamental issue in the particularly challenging case of warehouses. To this aim, we draw on an analogy with activity-based costing. Our data base consists of workshops with five firms. As a result, we depict a draft of a methodology which may in the future be applied. If the two levels were better interlinked, logistics service providers would be capacitated to more accurately attach environmental labels to their logistics services. Hence, selection of more environmentally friendly service would be made possible.

Second, we analyze barriers to sustainable supplier selection, which is not yet established in corporate practice. We frame this problem from the perspective of information processing theory, which suggests that there may be a mismatch between information processing requirements and available information processing capacities. Based on a conceptual literature analysis, as well as on interviews, we identify numerous requirements and capacity drivers. Thus, our research facilitates the design of policies and measures to decrease requirements and to increase capacity. Both will facilitate sustainable supplier selection and hence increase sustainability performance.

2 The Case of Environmental Performance within Logistic Processes

2.1 Research Problem

The logistics and transportation industry is responsible for 15 percent of global carbon dioxide emissions and has numerous other detrimental environmental impacts (Bretzke, 2011). Therefore, the logistics and transportation industry is highly interested in environmental performance measurement. Since focusing on core competencies has become necessary for many firms, a large fraction of companies have outsourced their logistics processes to third parties (Bolumole, 2001; Lieb, 2005), so that multiple supply chain echelons are involved in the generation of environmental effects. Consequently, outsourcing logistic services to third parties can

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not only increase the difficulty to measure performance along the supply chain, but also the difficulty to measure environmental effects in general (Ellram et al., 2008).

In warehouses – which we focus on here – multiple logistics activities are provided, such as receipt of goods, unpacking, storage, preserving, picking etc. Logistics service providers frequently bundle the demand of multiple customers within the same warehouse; they create multi-user warehouses. Beyond the need to assess the environmental performance of the warehouse as a whole, logistics service providers' customers also have to know which environmental performance is associated with the specific services that are provided to them. This kind of allocation problem is much complicated by the existence of environmental performance overheads which cannot immediately be assigned to individual services. Our research focuses on this challenge. We develop an instrument for logistics service providers as well as buying companies to assess environmental effects along their logistic processes. To facilitate the allocation of environmental effects to their respective causes, the processes within a warehouse are structured into chains of activities. This separation offers the opportunity for a detailed analysis and the identification of the causes of environmental effects. In a next step, the environmental overhead is allocated to the identified causes. Comparability between logistics processes as well as between organizations is ensured.

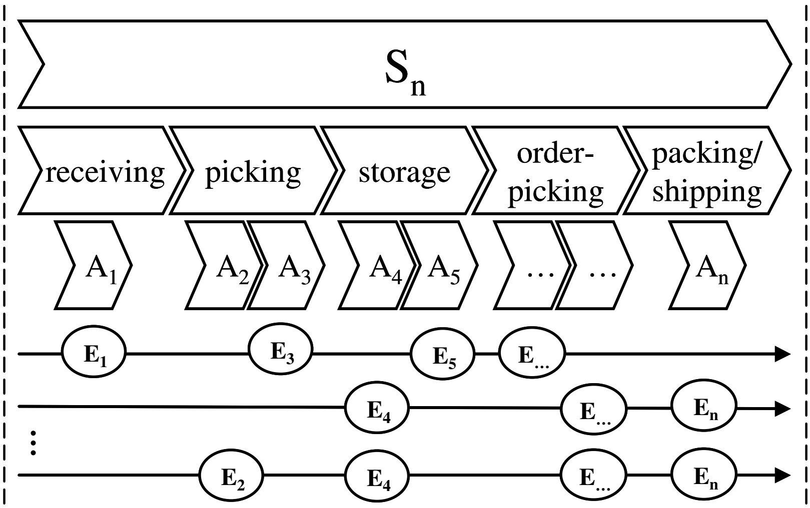
2.2 Methodology

The investigation builds on the activity-based analyses developed by Cooper and Kaplan (Cooper and Kaplan, 1992; Cooper and Kaplan, 1988). Their procedural framework was originally designed to analyze costs per activity and to assist by revealing the links between performing activities and the caused costs from performing each activity (Pohlen and La Londe, 1994). Here, the framework is applied to environmental performances and extended to include numerous dimensions, at once. Based on a procedural analysis of multiple warehouses, environmental performances are allocated to archetypical logistics activities. Using the advantage of the same or at least similar structure of logistic processes, at the activity level, cross-organizational comparability is assured.

The activity segmentation, performance dimensions and KPI identification activities build on previous literature, as well as on conceptual considerations, but they also necessitate collaboration with corporate practice. To this aim, five organizations that perform or buy complex logistics processes (three customer firms and two logistics service providers) are engaged in this research. All participating firms and individuals are particularly interested in sustainable logistics operations. The data base consists mainly of internal firm documents (e.g. workflow models), as well as of semi-structures interviews and workshops.

2.3 Results

The research has not yet been finished, but preliminary results indicate that the developed instrument constitutes a substantial contribution to academic research, as well as corporate practice. Previously, most research attention was given to analyzing transportation processes and their environmental impacts (Marchant, 2010). Paying attention to warehousing and evaluating the environmental effects of their processes leads to a new research perspective within sustainable supply chain management (Marchant, 2010). Most importantly, the instrument that is developed and empirically tested here facilitates systematic analyses of environmental performances in logistics services, particularly in warehouse processes. The instrument can presumably be adapted to other product and service landscapes. For this research, warehouse processes are divided into archetypical logistics sub-processes and activities as shown in Figure 1 (Rouwenhorst et al., 2000).



S: Supplier's Warehouse Process
A: Logistic Process Activites
E: Environmental Effects
--: Scope

Fig. 1. Example of archetypical logistics activities within warehouse processes

Furthermore, this instrument distinguishes between direct and indirect environmental effects in analogy to activity based costing. A systematic approach is offered to handle typical overheads like lightning electricity within warehouses. This approach offers the opportunity to allocate overhead environmental effects to process activities and assess environmental effects at the level of the logistic activity. At the level of logistical activities, distinct important performance dimensions and KPIs are identified. Cross-organizational transferability and cross-organizational analysis are ensured. Last, corporate practice is provided with an instrument that can readily be applied and support logistics service provider selection, based on the environmental performances of the services they provide.

3 The Case of Sustainable Supplier Selection for Physical Goods

3.1 Research Problem

As a result of increasing specialization and outsourcing over recent decades, the sustainability performance of supply chains is largely imprinted by the sustainability performance of upstream suppliers (Handfield et al., 2002) and therefore of great significance for the buying firm. While sustainable supplier selection has been addressed before, (Handfield et al., 2002; Noci, 1997) genuine sustainable supplier selection taking into account the entire upstream supply chain is apparently not widely established in corporate practice (Carter and Rogers, 2008). Contributions concerning the exact barriers for genuine sustainable supplier selection are limited to notable exceptions (Walker et al., 2008). If barriers to sustainable supplier selection were understood in greater detail, then remedies such as managerial instruments like sustainable supplier evaluation and selection systems could be developed. Therefore, we build on the contribution of Walker et al. (2008) and extend it by analyzing the requirements for genuine sustainable supplier selection along the upstream supply chain.

We apply an information processing perspective, based on the Information Processing Theory (IPT). The IPT states that organizations face information processing requirements (IPR) and therefore need a certain degree of information processing capacity (IPC) in order to perform effectively. In the original context of organizational design, IPR on the one hand rise as a consequence of uncertainty towards the task (Tushman and Nadler, 1978) and IPC on the other hand is determined by vertical information systems (Galbraith, 1974). Thus, a buying firm must obtain information and transparency concerning the sustainable measures the supplier enforces with its sub-suppliers in order to make informed decisions. In line with extant literature we conclude that obtaining full transparency and information on the true sustainability of suppliers and their products is highly complex and resource consuming.

3.2 Methodology

Conceptual and empirical methods are employed. A first process and barrier model is developed conceptually, based on an in-depth literature review of the sustainable supplier selection and the information processing literature. Thereafter, interviews at five purposefully chosen German firms, which strive to apply sustainable sourcing practices, are conducted. To control for context specificity of the environmental criteria, the analysis is limited to a specific purchasing product group, namely office desks. Low to medium product complexity, functional homogeneity of decision alternatives and high symbolic visibility were selection criteria of this exemplary product. At each firm, three interviews are conducted to collect all available data on supplier environmental performance assessment, evaluation and supplier selection. Key informants are middle and top managers in the purchasing department, as well as staff from other departments such as staff in the facility management department.

3.3 Results

Our research has not yet been finalized, but preliminary results indicate that more barriers exist than were listed in previous literature, especially when the supply base beyond the first-tier level is also taken into account. Besides motivational barriers like high costs (Porter and van der Linde, 1995) or poor supplier commitment (Wycherley, 1999) due to lack of relational trust (Cheng et al., 2008) we identified so called capacity barriers.

We found that product and supply chain complexity, overhead allocation problems and multidimensionality of environmental performance measures affect the IPR of the buying firm (cp. Figure 2). On the other hand, the lack of resource quality and scale, as well as the lack of environmental standards hinder buying firms from building up the required IPC, which is needed to obtain full and comparable information to select the most sustainable supplier (cp. Figure 3).

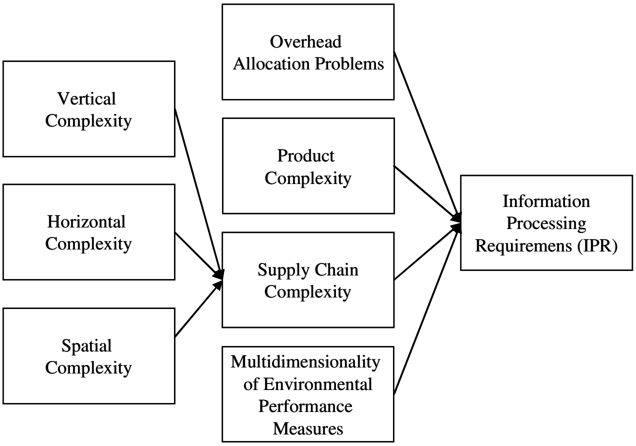


Fig. 2. Drivers of information processing requirements

Based on the effective drivers of IPR and the prevailing barriers for the build up of IPC, there seems to be a mismatch between the existing IPR and the actual IPC. For this reason, buying firms struggle with obtaining full information about the sustainability of their suppliers. Thus, the genuine incorporation of the green and the social dimension along with the traditional economic supplier selection criteria is hindered at this stage.

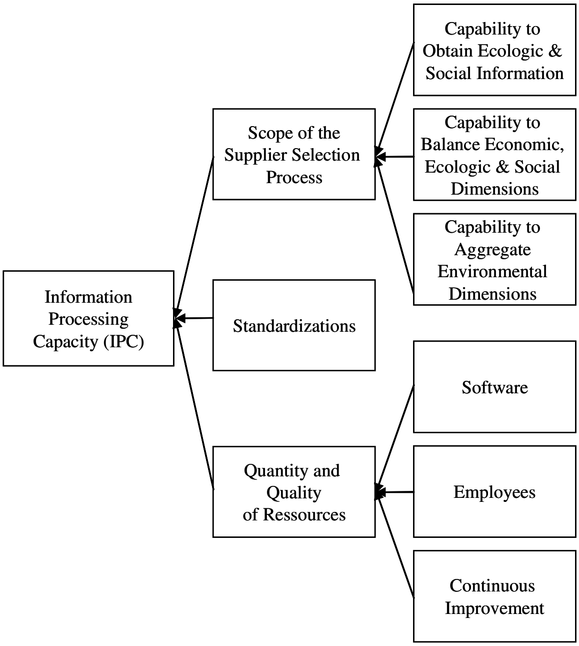


Fig. 3. Drivers of information processing capacity

4 Conclusion

Climate changes and other environmental problems initiate the ongoing research within sustainable supply chain management. Especially the logistics industry offers numerous opportunities to decrease environmental impacts. This research paper focuses on environmental impacts in warehousing as well as on the existing barriers for buying firms to fully assess suppliers' sustainable performance and to take it into account in supplier selection decisions.

Regarding the first case of environmental performance within logistic processes, an instrument is developed which facilitates identifying environmental effects and allocating overheads to process activities within outsourced logistic processes. This standardized instrument can ensure transferability based on an activity based approach and therefore pursues one of the most significant challenges regarding environmental performance measurement. Conducting the research in close partnership with practitioners, the outcomes do not just have a substantial contribution to academic research, but also to corporate practice.

It is necessary to understand the prevailing barriers to sustainable supplier evaluation and selection in depth, to facilitate the development of remedies, such as managerial instruments like evaluation systems and sustainable sourcing strategies. To this aim, we developed a model grounded in IPT that takes IPR and IPC into account. We found that a mismatch between high levels or IPR and low levels of IPR hinders and disincentives buying firms from selecting a supplier while taking all environmental impacts into account. This article make a major conceptual contribution, since it creates transparency concerning the amount and quality of resources that need to be devoted in order to make an informed and genuine supplier selection decision. Besides, it facilitates ample highly relevant future research and depicts some possible avenues to follow for governmental policy makers, non-governmental organizations, as well as buying and supplying firms.

References

Bolumole, Y.A.: The Supply Chain Role of Third-Party Logistics Providers. International Journal of Logistics Management 12(2), 87–102 (2001)

Bretzke, W.-R.: Sustainable logistics: In search of solutions for a challenging new problem. Logistics Research 3(4), 179–189 (2011)

Campbell, J.L.: Why would corporations behave in socially responsible ways? An institutional theory of corporate social responsibility. The Academy of Management Review 32(3), 946–967 (2007)

Carter, C.R., Jennings, M.M.: The role of purchasing in corporate social responsibility: a structural equation analysis. Journal of Business Logistics 25(1), 145–186 (2004)

Carter, C.R., Rogers, D.S.: A framework of sustainable supply chain management: Moving toward new theory. International Journal of Physical Distribution & Logistics Management 38(5), 360–387 (2008)

Cheng, J.H., Yeh, C.H., Tu, C.W.: Trust and knowledge sharing in green supply chains. Supply Chain Management: An International Journal 13(4), 283–295 (2008)

Cooper, R., Kaplan, R.S.: Measure Costs Right: Make the Right Decisions. Harvard Business Review 66, 96–103 (1988)

Cooper, R., Kaplan, R.S.: Activity-Based Systems: Measuring the Costs of Resource Usage. Accounting Horizons 6(3), 1–13 (1992)

Elkington, J.: Towards the sustainable corporation: Win-win-win business strategies for sustainable development. California Management Review 36(2), 90 (1994)

Ellram, L.M., Tate, W.L., Billington, C.: Offshore outsourcing of professional services: A transaction cost economics perspective. Journal of Operations Management 26(2), 148–163 (2008)

Galbraith, J.R.: Organization design: An information processing view. Interfaces 4(3), 28–36 (1974)

Handfield, R., Walton, S.V., Sroufe, R., Melnyk, S.A.: Applying environmental criteria to supplier assessment: A study in the application of the Analytical Hierarchy Process. European Journal of Operational Research 141(1), 70–87 (2002)

Hart, S.L.: A Natural-Resource-Based View of the Firm. The Academy of Management Review 20(4), 986–1014 (1995)

Klassen, R.D., McLaughlin, C.P.: The impact of environmental management on firm performance. Management Science, 1199–1214 (1996)

Kleindorfer, P.R., Singhal, K., Wassenhove, L.N.: Sustainable operations management. Production and Operations Management 14(4), 482–492 (2005)

Lieb, R.: The 3PL Industry. Where It's Been, Where It's Going. Supply Chain Management Review 9(6), 20–27 (2005)

Marchant, C.: Reducing the Environmental Impact of Warehousing. In: Mckinnon, A., Cullinane, S., Browne, M., Whiteing, A. (eds.) Green Logistics: Improving the Environmental Sustainability of Logistics. Kogan Page, distributed by Ingram Publisher Services, London, Chambersburg (2010)

Noci, G.: Designing green vendor rating systems for the assessment of a supplier's environmental performance. European Journal of Purchasing & Supply Management 3(2), 103–114 (1997)

Pohlen, T.L., La Londe, B.J.: Implementing Activity-Based Costing (ABC) in Logistics. Journal of Business Logistics 15(2), 1–23 (1994)

Porter, M.E., van der Linde, C.: Green and Competitive: Ending the Stalemate. Harvard Business Review 73(5), 120–134 (1995)

Rouwenhorst, B., Reuter, B., Stockrahm, V., van Houtum, G.J., Mantel, R.J., Zijm, W.H.M.: Warehouse design and control: Framework and literature review. European Journal of Operational Research 122(3), 515–533 (2000)

Tushman, M.L., Nadler, D.A.: Information processing as an integrating concept in organizational design. Academy of Management Review, 613–624 (1978)

Walker, H., Di Sisto, L., McBain, D.: Drivers and barriers to environmental supply chain management practices: Lessons from the public and private sectors. Journal of Purchasing and Supply Management 14(1), 69–85 (2008)

World Commission on Environment and Development, Our Common Future. Oxford University Press, New York (1987)

Wycherley, I.: Greening supply chains: The case of the Body Shop International. Business Strategy and the Environment 8(2), 120–127 (1999)

Xie, S., Hayase, K.: Corporate environmental performance evaluation: A measurement model and a new concept. Business Strategy and the Environment B 16(2), 148–168 (2007)

Zhu, Q., Sarkis, J.: Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. Journal of Operations Management 22(3), 265–289 (2004)

A Foundation of Sustainability Related Supply Chain Risks in Stakeholder Theory

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Abstract. Based on an in-depth literature review of supply chain risk management and drawing on stakeholder theory, we develop a conceptualization of sustainability-related supply chain risks. Our accompanying conceptual analysis reveals that damage caused by sustainability-related supply chain risks evolves qualitatively differently than the traditionally established mechanism. Instead of supply chain disruptions, stakeholder reactions are effective as triggers of damage to focal firms. Therefore, a novel sustainability-related supply chain risk management is required.

Keywords: Sustainable supply chain management, supply chain risk, stakeholder theory, legitimacy.

1 Introduction

Over the course of the last decades, sustainability matured from an abstract concept to an important source of corporate legitimacy (Brønn and Vidaver-Cohen, 2009). Recent research even suggests a positive link between sustainable corporate behavior and corporate performance (Campbell, 2007; Vogel, 2005). Supply chain management plays an important role in shaping and framing sustainability, due to the high level of external value added in many industries (Meehan and Bryde, 2011; Carter and Rogers 2008). Through product design decisions and contractual arrangements with their suppliers, firms can influence their suppliers' action with respect to social and environmental outcomes (Klaasen and Vereecke, forthcoming). Increasingly, firms are therefore being held responsible for their suppliers' behavior with respect to sustainability-related issues such as child labor or extortion within the social dimension, or toxic emissions and environmental degradation within the ecological sphere (Amaeshi *et al.*, 2008; Seuring and Mueller, 2008). These issues can cause adverse publicity, reputational losses, and litigation for focal firms (Carter and Jennings, 2004).

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To date, sustainability-related risks are mostly not part of the supply chain risk management discussion (Harwood and Humby, 2008; Chopra and Sodhi, 2004). In consequence, established classifications tend to neglect social and ecological issues (e.g., Deleris and Erhun, 2011; Cousins *et al.*, 2004). Recently, some first works have begun to address sustainability-related risks (e.g., Spekman and Davis, 2004; Johnson, 2001). Although notions like environmental, social or sustainability risks do exist, they tend to amalgamate causes and effects. For example, Anderson and Anderson (2009) and Anderson (2006) name chemical harmful substances and decreasing ecosystem services together with boycott risks and social justice risks as sustainability risks. To our understanding, boycotts are actions by stakeholders with which they respond to practices that are perceived to be inacceptable. The usage of harmful substances, on the other hand, relates to practices within suppliers' (or even focal firms') operations which may yet be assessed by stakeholders. Thus, more research is needed to clarify the integration of sustainability into supply chain risk management (Carter and Rogers, 2008). Therefore, the present research set out to address the following research question: *How is a sustainability-related supply chain risk to be conceptualized?*

In this article, we derive a definition, based on an in-depth literature review on sustainable supply chain management and supply chain risks and drawing on stakeholder theory. Our conceptualization facilitates important conceptual insights into the nature of sustainability-related supply chain risks and into the possible responses of stakeholders. In consequence, this research also lays the groundwork for sustainability oriented supply chain risk management, aiming at risk prevention, damage mitigation and vulnerability reduction.[1]

2 Literature Review

2.1 Sustainable Supply Chain Management

The origins of corporate sustainability date back to the World Commission on Environment and Development publication *Our Common Future* which defined sustainable development as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987, p.8). This normative guideline has been widely accepted by governments and firms worldwide and numerous alternative conceptualizations of sustainable development have emerged. However, the guideline is criticized to be fuzzy, elusive and contestable (Gladwin *et al.*, 1995). Particularly, the macro-economic definitions of sustainability provide little guidance for firms on how to identify present and future needs, develop the technologies and resources required to meet those needs and how to balance organizational responsibilities to stakeholders (Hart 1995; Starik and Rands, 1995). Further problems like lack of training, poor supplier commitment or financial constraints (Faisal, 2010; Walker *et al.*, 2008)

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appear when firms seek to develop strategies and implement processes to meet the goals of corporate sustainability (Garriga and Melé, 2004).

The ambiguity inherent in the sustainable development guideline led to a segmented and mostly unidimensional understanding of sustainability within supply chain management. Recent reviews of the literature on sustainable supply chain management (Carter and Easton, 2011; Seuring and Müller, 2008; Linton *et al.*, 2007) show that mostly, only environmental issues (e.g., Guide and Van Wassenhove, 2009; Vachon, 2007) or social issues (e.g., Ehrgott *et al.*, 2011; Carter and Jennings, 2004) are addressed. Few works refer to both types of issues (Seuring and Müller, 2008), as we do.

At the microeconomic level, an integrative understanding of sustainability as the umbrella concept around equally weighted economic, ecologic and social evaluation criteria was promoted by the famous triple bottom line concept of Elkington (1999). Although highly debated in academic circles (e.g., Hubbard, 2009; Norman and MacDonald, 2004), the triple bottom line is nowadays widely accepted in corporate practice and the term is frequently used synonymously with the term sustainability (Carter and Easton, 2011; Kleindorfer *et al.*, 2005). Based on the triple bottom line concept, Carter and Rogers (2008) propose a framework for sustainable supply chain management (SSCM) which they define as "the strategic, transparent integration and achievement of an organization's social, environmental and economic goals in the systemic coordination of key interorganizational business processes for improving the long-term economic performance of the individual company and its suppliers" (p.368).

2.2 Supply Chain Risks

Supply chain risks arise from the interconnected flows of materials, information, and funds in inter-organizational networks (supply chains). Already in the 1980s, Kraljic (1983) and Treleven and Schweikhart (1988) stressed that global supply chains are inherently susceptible to risky events. However, it was not until recently that the interest in this phenomenon, both from scholars and practitioners, has grown (Sodhi *et al.*, 2012; Bode *et al.*, 2011; Narasimhan and Talluri, 2009). A large body of literature published in the past years has depicted examples and case studies of events that disrupted supply chain and transportation operations and of the serious impact on the involved firms (e.g., Sheffi 2005). Arguably, there are at least two factors that fueled the recent interest: (1) the current business environment is characterized by discontinuity, high velocity of change, and permanent risk for unexpected adverse events, and (2) many modern supply chains have become relatively sensitive to exogenous shocks. Hamel and Välikangas (2003) conjectured that "the world is becoming turbulent faster than organizations are becoming resilient" (p. 52). Several recent publications have attempted to advance the conceptual clarity of the terms used in the domain of supply chain risk management (e.g., Rao and Goldsby, 2009; Manuj and Mentzer, 2008a; Manuj and Mentzer, 2008b; Ritchie and Brindley, 2007; Craighead *et al.*, 2007). In essence, the phenomenon under investigation in this stream of literature is the negative outcome resulting from adverse events that occur in supply chain operations, but usually two interrelated terms are distinguished: Supply chain risk and supply chain disruptions.

Supply chain risk is the predominant theme in the literature and often applied as a catchall concept for a wide range of events, situations, potential threats, or uncertainties. One can identify two major perceptions of risk: (1) risk as both danger and opportunity and (2) risk as purely danger (Mitchell 1995). The former is dominant in the field of finance, but the latter is more consistent with the human perception of risk (March and Shapira, 1987; MacCrimmon and Wehrung, 1986) so that we apply it here. Risk is thus conceived as the (negative) deviation from the expected value of a (or more) performance measure(s), resulting in negative consequences for the focal firm.

In contrast to risk, a *supply chain disruption* is a manifested circumstance. It can be viewed as the combination of (1) an unintended and unexpected triggering event that occurs somewhere in the supply chain, or the supply chain environment, and (2) a consequential situation which significantly threatens the normal course of business operations of the focal firms. In attempting to differentiate supply chain disruptions from other adverse events in business (e.g., shocks on the financial markets), many scholars have proposed classifications of supply chain disruption in the form of typologies and/or taxonomies (e.g., Cavinato, 2004; Chopra and Sodhi, 2004; Christopher and Peck, 2004; Norrman and Lindroth, 2004; Svensson, 2000). The derived categories of supply chain disruptions are usually labeled supply chain risk sources, in terms of being a known source from which supply chain disruptions emerge with a certain probability. Understanding the various supply chain risk sources and their nature is very important because different risk sources demand different sets of risk management activities. In summary, our review of the sustainable supply chain management and supply chain risk management literatures highlights that the sustainability concept and the risk concept have both found their way into supply chain management research. Both streams of research have generated very valuable insights, yet, despite the large body of literature, we know remarkably little about sustainability-related supply chain risks and their management.

3 A Stakeholder-Theory Perspective

Stakeholder theory views the firm as an enterprise from which numerous participants with different interests obtain benefits (Donaldson and Preston, 1995; Freeman 1984). It does not assume any hierarchy of interests or benefits. Stakeholder theory is used in positive (empirical), instrumental or normative manners (Donaldson and Preston, 1995). In the following, we use stakeholder theory as a positive theory which describes the interaction between the firm as an organizational entity and its multiple stakeholders.

If stakeholders of the firm do not accept corporate behavior, this will erode organizational legitimacy (Mueller *et al.*, 2009; Driscoll and Crombie, 2001; Grolin, 1998; Suchman, 1995). We understand legitimacy as a "generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed systems of norms, values, beliefs, and definitions" (Suchmann, 1995, p.574). Legitimacy is therefore a crucial asset since neglecting central stakeholders' expectations may leave firms short of central inputs: customers may stop buying products, shareholders may sell their stock, employees withhold loyalty and best efforts, government imposes fines or regulates, and environmental advocates sue (Wood, 1991). The concept of legitimacy provides a linkage between the organizational and societal level of analysis: organizational behavior is constrained by legitimacy, i.e. social norms and values (Dowling and Pfeffer, 1975). However, societal expectations and norms alone would leave the analysis incomplete, as stakeholders have specific interests and benefit expectations. In order to organize and evaluate those instruments we also need to have an idea about the stakeholders of the firm.

There are several varyingly broad perceptions towards identifying stakeholders of the firm: Adopting a narrow view, legitimate stakeholders are identified by the existence of a contract, expressed or implied, between them and the firm. This conception does however not include, e.g., environmental interests of communities, or potential employees (Donaldson and Preston, 1995). Mitchell *et al.* (1997) proposed a wider and more structured approach, according to which stakeholders can be identified by "their possession or attributed possession of one ore more of the following attributes: (1) the stakeholder's *power* to influence the firm, (2) the *legitimacy* of the stakeholder's relationship with the firm, and (3) the *urgency* of the stakeholder's claim on the firm" (p. 854). Based on those attributes, a theory of stakeholder salience is developed with important implications for stakeholder management.

Although the importance of stakeholders varies over time and depends on issues and interests (Buysse and Verbeke, 2003; Jawahar and McLaughlin, 2001), Mitchell *et al.*'s (1997) frequently cited framework offers definite criteria to identify stakeholders. Following Freeman *et al.* (2010), we can therefore deduce an archetypical list of relevant third party actors to guide our research (cp. Table 1).

Although top management is technically considered as a stakeholder among others, they constitute a distinct group (Jones, 1995): Managers are the only group of stakeholders with direct control over the decision making resources of the firm (Donaldson and Preston, 1995; Hill and Jones, 1992). Despite their quasi agent-of-all-stakeholders role, we argue that managers as individuals do hold values and expectations against corporate behavior in social and economic spheres, respectively. Furthermore, we argue that managers' individual values and expectations influence their decisions and behaviors. Therefore, we treat management as an equal group of stakeholders in our research context.

Table 1. Relevant stakeholders to the firm

Competitors	(Local) Communities
(Business) Customers/Consumers	Management
Employees/Potential Employees	Media
Government/State	NGOs and special interest groups
Investors	Owners/Shareholders
(Labor) Unions	Suppliers

4 Conceptualization of Sustainability-Related Supply Chain Risks

We now use stakeholder theory as a theoretical lens through which sustainability-related supply chain risks can be conceptualized. Stakeholders observe corporate behavior and act upon triggers (Fombrun *et al.*, 2000) that appear e.g. on the supply side of the firm. Among those triggers are social and ecological issues such as melamine-tainted dairy products (Tybout and Roehm, 2009; DeLaurrentis, 2009) or violation of labor conditions (Duhigg *et al.*, 2012; Teevs, 2012).

We begin with the action of focal firms. If focal firms within supply chains can influence suppliers' behavior with respect to the natural environment and social issues, then they also position themselves towards these issues through their supplier selection, supplier monitoring, supplier development, and purchasing decisions. Consequentially, stakeholders may hold focal firms responsible for whatever takes place in their upstream supply chains.

The mere presence of a sustainability issue within a supply chain does however not necessarily provoke stakeholder action. If stakeholders for example do not become aware of working conditions which they would assess as problematic, then they will show no reaction. Given awareness, an additional ingredient for stakeholder action is their perception and judgment of corporate behavior. The interrelation of stakeholders' perception of corporate action and check against their individual values is best described by the concept of legitimacy (Zimmerman and Zeitz, 2002; Suchman 1995). A firm is granted legitimacy if its perceived behavior is "desirable, proper and appropriate" (Suchman, 1995, p. 574). Thus, if stakeholders to a focal firm become aware of the behavior of its suppliers, e.g. of the applied production processes and the resulting impacts on the natural environment, then they will hold their individual values and expectations against these issues and assess if they regard (1) the situation as per se acceptable and (2) focal firms as responsible. If the situation is deemed unacceptable and the firm is found responsible, then stakeholders will regard focal firms' behavior as illegitimate.

Illegitimate behavior will typically elicit some stakeholder reaction. For example, customers may stop recommending the firm, they may decrease their share-of-wallet or they may entirely switch to another firm. Employees may become less motivated, may require higher salary to stick to the firm or may even leave the firm. Investors may withdraw funds, NGOs may start campaigning etc.

All of the aforementioned sustainability-related issues can thus cause damage to the focal firm in the supply chain, so that they should be characterized as risks. However, damage is not immediate, but depends on stakeholder reactions. Although a certain event can trigger a shareholder reaction, e.g. an extreme abuse of supervisory power on subordinate workers in an Asian factory, it is also possible that a permanent work condition, such as extreme overtime, is made public by the media and then assessed as illegitimate by stakeholders. Therefore, we define a sustainability-related risk (in short: sustainability risk) as follows: *A sustainability risk is an issue or a potentially occurring issue that stakeholders might assess as socially or ecologically illegitimate.* Furthermore, we define a sustainability-related supply chain risk (in short: supply chain sustainability risk) as *a sustainability risk within a focal firm's supply chain.*

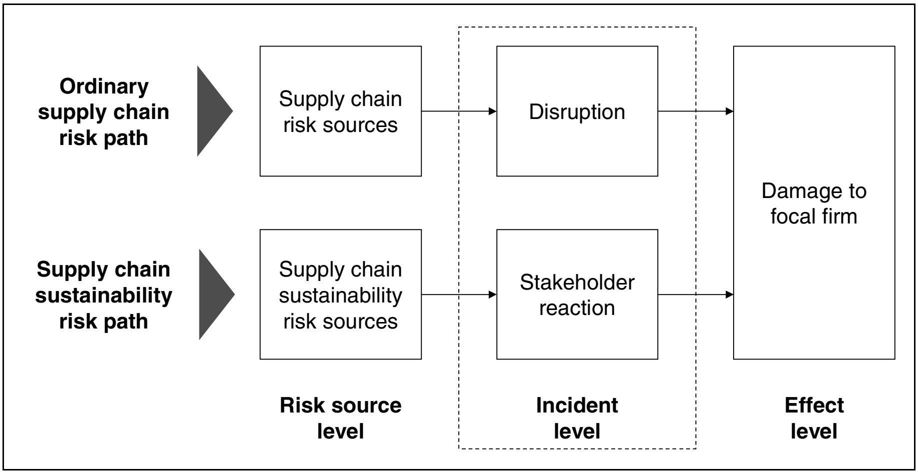

Fig. 1. A comparison of ordinary and sustainability-related supply chain risks

In structural equivalence to ordinary supply chain risks, supply chain sustainability risks evolve from certain risk sources and have the potential to cause damage to a focal firm if certain incident is triggered. However, the specific risk sources and the damage triggering incident differ between ordinary and supply chain sustainability risks. A sustainability-related supply chain risk source is an issue which is considered inacceptable by one of the focal firm's stakeholders. If the respective stakeholder becomes aware of the issue, assesses it as unacceptable and regards the focal firm as responsible for it, then the stakeholder may change his legitimacy assessment of the focal firm's action and react by withdrawing some or all of his inputs to the firm. The consequential loss of important resource provisions then causes damage to the focal firm.

The stakeholder reaction may in turn be related to a permanently present and – from a purely operations management point of view – perfectly workable state. To put this very bluntly: If 500 sewers in a factory work 75 hours a week, then from an operations management point of view, their disposability and output will likely be perfectly calculable and therefore be operationally free of risk. From a supply chain sustainability risk (or an ethical) point of view, the situation is highly risky (unacceptable), as harmful stakeholder reactions are always possible. Hence, when firms screen their supply chains with "ordinary" supply chain risk management concepts, sustainability issues may go unnoticed. It is therefore a core managerial implication of our analysis that a new sustainability-related supply chain risk management must use novel risk identification and assessment criteria which are derived from the criteria held by the multitude of stakeholders. Sustainability-related supply chain risks differ qualitatively from those risks which are traditionally regarded as supply chain risks (cp. Figure 1). Beside pure operational and pure sustainability risks, there are operational risks that at the same time contain potential for sustainability risks. A chemical agents-accident at a supplier's site, for example, may lead to a disruption and provoke third party action, as well.

5 Conclusion

Due to increases in global sourcing, vertical disintegration, information availability and stakeholder convictions in the ideal of sustainable development, sustainability issues become ever more important in supply chain risk management. Drawing on stakeholder theory, we show how stakeholders evaluate the legitimacy of focal firms' behavior and potentially react in ways harmful to focal firms. Once they have become aware of an ecological or social issue in a supply chain, stakeholders assess the issue against their values, norms and interests. Furthermore, they assess focal firms' responsibility in the matter and come to an overall conclusion regarding their behavioral legitimacy. Illegitimate behavior may lead to reactions which vary from stakeholder to stakeholder, but always have the potential to harm the focal firm.

Our conceptual analysis yields important managerial recommendations. Most importantly, we identify a danger that classical supply chain risk management practices directed at risk reduction and mitigation may fail to identify sustainability issues. As a remedy, we show how sustainable supply chain risk management has to derive its risk identification criteria from stakeholders. Hence, this article lays the groundwork for successful sustainability-oriented supply chain risk management.

The limitation of this work is that it is based on conceptual analysis only. Field work should hence be amended. Given the novelty of the object of study and the consequential lack of firmly established corporate practices, a merely observatory approach may not be adequate. A new management concept for sustainability-oriented supply chain risk management may rather be developed by means of a design science approach. It should particularly develop a procedural mechanism (1) how stakeholder expectations can be understood and categorized, (2) how they can be translated into risk identification and assessment criteria, (3) how supplier behavior can be controlled and managed to fulfill stakeholder expectations and (4) how stakeholders can be managed so as to accept the inherent global and intercultural difficulties in supplier development. Thus, important open research questions relate not only to sustainability issues within supply chains, i.e. to risk reduction and avoidance, but also to vulnerability reduction by means of proactive stakeholder management.

References

Amaeshi, K.M., Osuji, O.K., Nnodim, P.: Corporate Social Responsibility in Supply Chains of Global Brands: A Boundaryless Responsibility? Clarifications, Exceptions and Implications. Journal of Business Ethics 81(1), 223–234 (2008)

Anderson, D.R.: The Critical Importance of Sustainability Risk Management. Risk Management 53(4), 66–74 (2006)

Anderson, D.R., Anderson, K.E.: Sustainability Risk Management. Risk Management & Insurance Review 12(1), 25–38 (2009)

Bode, C., Wagner, S.M., Petersen, K.J., Ellram, L.M.: Understanding Responses to Supply Chain Disruptions: Insights from Information Processing and Resource Dependence Perspectives. Academy of Management Journal 54(4), 833–856 (2011)

Brønn, P., Vidaver-Cohen, D.: Corporate Motives for Social Initiative: Legitimacy, Sustainability, or the Bottom Line? Journal of Business Ethics 87(suppl. 1), 91–109 (2009)

Buysse, K., Verbeke, A.: Proactive Environmental Strategies: A Stakeholder Management Perspective. Strategic Management Journal 24(5), 453–470 (2003)

Campbell, J.L.: Why Would Corporations Behave in Socially Responsible Ways? An Institutional Theory of Corporate Social Responsibility. Academy of Management Review 32(3), 946–967 (2007)

Carter, C.R., Easton, P.L.: Sustainable Supply Chain Management: Evolution and Future Directions. International Journal of Physical Distribution & Logistics Management 41(1), 46–62 (2011)

Carter, C.R., Jennings, M.M.: The Role of Purchasing in Corporate Social Responsibility: A Structural Equation Analysis. Journal of Business Logistics 25(1), 145–186 (2004)

Carter, C.R., Rogers, D.S.: A Framework of Sustainable Supply Chain Management: Moving toward New Theory. International Journal of Physical Distribution & Logistics Management 38(5), 360–387 (2008)

Cavinato, J.L.: Supply Chain Logistics Risks: From the Back Room to the Board Room. International Journal of Physical Distribution & Logistics Management 34(5), 383–387 (2004)

Chopra, S., Sodhi, M.S.: Managing Risk to Avoid Supply-Chain Breakdown. MIT Sloan Management Review 46(1), 53–62 (2004)

Christopher, M., Peck, H.: Building the Resilient Supply Chain. International Journal of Logistics Management 15(2), 1–13 (2004)

Cousins, P.D., Lamming, R.C., Bowen, F.: The Role of Risk in Environment-Related Supplier Initiatives. International Journal of Operations & Production Management 24(6), 554–565 (2004)

Craighead, C.W., Blackhurst, J., Rungtusanatham, M.J., Handfield, R.B.: The Severity of Supply Chain Disruptions: Design Characteristics and Mitigation Capabilities. Decision Sciences 38(1), 131–156 (2007)

DeLaurentis, T.: Ethical Supply Chain Management. China Business Review 36(3), 38–41 (2009)

Deleris, L.A., Erhun, F.: Quantitative Risk Assessment in Supply Chains: A Case Study Based on Engineering Risk Analysis Concepts. In: Kempf, K.G., Keskinocak, P., Uzsoy, R. (eds.) Planning Production and Inventories in the Extended Enterprise. Springer, New York (2011)

Driscoll, C., Crombie, A.: Stakeholder Legitimacy Management and the Qualified Good Neighbor: The Case of Nova Nada and Jidi. Business & Society 40(4), 442 (2001)

World Commission on Environment and Development (WCOEAD), Our Common Future. Oxford University Press, Oxford (1987)

Donaldson, T., Preston, L.E.: The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications. Academy of Management Review 20(1), 65–91 (1995)

Dowling, J., Pfeffer, J.: Organizational Legitimacy: Social Value and Organizational Behavior. Pacific Sociological Review 18(1), 122–136 (1975)

Duhigg, C., Barboza, D.: How U.S. Lost out on Iphone Work. New York Times (2012), http://www.nytimes.com/2012/01/22/business/apple-america-and-a-squeezed-middle-class.html?pagewanted=all

Ehrgott, M., Reimann, F., Kaufmann, L., Carter, C.: Social Sustainability in Selecting Emerging Economy Suppliers. Journal of Business Ethics 98(1), 99–119 (2011)

Elkington, J.: Cannibals with Forks. The Triple Bottom Line of 21st Century Business. Capstone, Oxford (1999)

Faisal, M.N.: Analysing the Barriers to Corporate Social Responsibility in Supply Chains: An Interpretive Structural Modelling Approach. International Journal of Logistics: Research & Applications 13(3), 179–195 (2010)

Fombrun, C.J., Gardberg, N.A.: Opportunity Platforms and Safety Nets: Corporate Citizenship and Reputational Risk. Business & Society Review (00453609) 105(1), 85 (2000)

Freeman, R.E.: Strategic Management: A Stakeholder Approach. Cambridge Univ. Press, Cambridge (1984)

Freeman, R.E., Harrison, J.S., Wicks, A.C., Parmar, B.L., De Colle, S.: Stakeholder Theory. The State of the Art. Cambridge Univ. Press, Cambridge (2010)

Garriga, E., Melé, D.: Corporate Social Responsibility Theories: Mapping the Territory. Journal of Business Ethics 53(1/2), 51–71 (2004)

Gladwin, T.N., Kennelly, J.J., Krause, T.-S.: Shifting Paradigms for Sustainable Development: Implications for Management Theory and Research. Academy of Management Review 20(4), 874–907 (1995)

Grolin, J.: Corporate Legitimacy in Risk Society: The Case of Brent Spar. Business Strategy & the Environment 7(4), 213–222 (1998)

Guide Jr., V.D.R., Van Wassenhove, L.N.: The Evolution of Closed-Loop Supply Chain Research. Operations Research 57(1), 10–18 (2009)

Hamel, G., Välikangas, L.: The Quest for Resilience (Cover Story). Harvard Business Review 81(9), 52–63 (2003)

Hart, S.L.: A Natural-Resource-Based View of the Firm. Academy of Management Review 20(4), 986–1014 (1995)

Harwood, I., Humby, S.: Embedding Corporate Responsibility into Supply: A Snapshot of Progress. European Management Journal 26(3), 166–174 (2008)

Hill, C.W.L., Jones, T.M.: Stakeholder-Agency Theory. Journal of Management Studies 29(2), 131–154 (1992)

Hubbard, G.: Measuring Organizational Performance: Beyond the Triple Bottom Line. Business Strategy & the Environment 18(3), 177–191 (2009)

Jawahar, I.M., McLaughlin, G.L.: Toward a Descriptive Stakeholder Theory: An Organizational Life Cycle Approach. Academy of Management Review 26(3), 397–414 (2001)

Johnson, M.E.: Learning from Toys: Lessons in Managing Supply Chain Risk from the Toy Industry. California Management Review 43(3), 106–124 (2001)

Jones, T.M.: Instrumental Stakeholder Theory: A Synthesis of Ethics and Economics. Academy of Management Review 20(2), 404–437 (1995)

Jüttner, U.: Supply Chain Risk Management: Understanding the Business Requirements from a Practitioner Perspective. International Journal of Logistics Management 16(1), 120–141 (2005)

Klassen, R.D., Vereecke, A.: Social Issues in Supply Chains: Capabilities Link Responsibility, Risk (Opportunity) and Performance. International Journal of Production Economics (forthcoming)

Kleindorfer, P.R., Singhal, K., Van Wassenhove, L.N.: Sustainable Operations Management. Production & Operations Management 14(4), 482–492 (2005)

Kraljic, P.: Purchasing Must Become Supply Management. Harvard Business Review 61(5), 109–117 (1983)

Linton, J.D., Klassen, R., Jayaraman, V.: Sustainable Supply Chains: An Introduction. Journal of Operations Management 25(6), 1075–1082 (2007)

MacCrimmon, K.R., Wehrung, D.A., Stanbury, W.T.: Taking Risks. The Management of Uncertainty. Free Press, New York (1986)

Manuj, I., Mentzer, J.T.: Global Supply Chain Risk Management. Journal of Business Logistics 29(1), 133–155 (2008a)

Manuj, I., Mentzer, J.T.: Global Supply Chain Risk Management Strategies. International Journal of Physical Distribution & Logistics Management 38(3), 192–223 (2008b)

March, J.G., Shapira, Z.: Managerial Perspectives on Risk and Risk Taking. Management Science 33(11), 1404–1418 (1987)

Meehan, J., Bryde, D.: Sustainable Procurement Practice. Business Strategy & the Environment 20(2), 94–106 (2011)

Mitchell, R.K., Agle, B.R., Wood, D.J.: Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts. Academy of Management Review 22(4), 853–886 (1997)

Mitchell, V.-W.: Organizational Risk Perception and Reduction: A Literature Review. British Journal of Management 6(2), 115–133 (1995)

Mueller, M., Dos Santos, V., Seuring, S.: The Contribution of Environmental and Social Standards Towards Ensuring Legitimacy in Supply Chain Governance. Journal of Business Ethics 89(4), 509–523 (2009)

Narasimhan, R., Talluri, S.: Perspectives on Risk Management in Supply Chains. Journal of Operations Management 27(2), 114–118 (2009)

Norman, W., Macdonald, C.: Getting to the Bottom of "Triple Bottom Line". Business Ethics Quarterly 14(2), 243–262 (2004)

Norrman, A., Lindroth, R.: Categorization of Supply Chain Risk and Risk Management. Supply Chain Risk. Ashgate, Aldershot (2004)

Rao, S., Goldsby, T.J.: Supply Chain Risks: A Review and Typology. International Journal of Logistics Management 20(1), 97–123 (2009)

Ritchie, B., Brindley, C.: Supply Chain Risk Management and Performance: A Guiding Framework for Future Development. International Journal of Operations & Production Management 27(3), 303–322 (2007)

Seuring, S., Müller, M.: From a Literature Review to a Conceptual Framework for Sustainable Supply Chain Management. Journal of Cleaner Production 16(15), 1699–1710 (2008)

Sheffi, Y.: The Resilient Enterprise. MIT Press, Cambridge (2005)

Sodhi, M.S., Son, B.-G., Tang, C.S.: Researchers' Perspectives on Supply Chain Risk Management. Production & Operations Management 21(1), 1–13 (2012)

Spekman, R.E., Davis, E.W.: Risky Business: Expanding the Discussion on Risk and the Extended Enterprise. International Journal of Physical Distribution & Logistics Management 34(5), 414–433 (2004)

Starik, M., Rands, G.P.: Weaving an Integrated Web: Multilevel and Multisystem Perspectives of Ecologically Sustainable Organizations. Academy of Management Review 20(4), 908–935 (1995)

Suchman, M.C.: Managing Legitimacy: Strategic and Institutional Approaches. Academy of Management Review 20(3), 571–610 (1995)

Svensson, G.: A Conceptual Framework for the Analysis of Vulnerability in Supply Chains. International Journal of Physical Distribution & Logistics Management 30(9), 731–750 (2000)

Teevs, C.: Billig-Kleidung Von Lidl und Co. Spiegel Online (2012), `http://www.spiegel.de/wirtschaft/service/0,1518,808288,00.html`

Treleven, M., Schweikhart, S.B.: A Risk/Benefit Analysis of Sourcing Strategies: Single vs. Multiple Sourcing. Journal of Operations Management 7(4), 93–114 (1988)

Tybout, A.M., Roehm, M.: Let the Response Fit the Scandal. Harvard Business Review 87(12), 82–88 (2009)

Vachon, S.: Green Supply Chain Practices and the Selection of Environmental Technologies. International Journal of Production Research 45(18/19), 4357–4379 (2007)

Vogel, D.: The Market for Virtue: The Potential and Limits of Corporate Social Responsibility. Brookings Inst. Press, Washington, DC (2005)

Walker, H., Di Sisto, L., McBain, D.: Drivers and Barriers to Environmental Supply Chain Management Practices: Lessons from the Public and Private Sectors. Journal of Purchasing & Supply Management 14(1), 69–85 (2008)

Wood, D.J.: Corporate Social Performance Revisited. Academy of Management Review 16(4), 691–718 (1991)

Zimmerman, M.A., Zeitz, G.J.: Beyond Survival: Achieving New Venture Growth by Building Legitimacy. Academy of Management Review 27(3), 414–431 (2002)

Towards a Standardized Supplier Code of Conduct – Requirements from a Literature-Based Analysis

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Abstract. Firms are increasingly held responsible for their suppliers' sustainability related performance. Supplier codes of conduct (SCoC) are therefore an important instrument to govern multiple supplier relationships simultaneously. If there was a unanimously accepted SCoC standard, it could increase stakeholders' trust in sustainability oriented supplier governance and also help firms to save costs. To facilitate its development, we analyze the literature on codes of conduct, aiming at the identification of requirements for such a standard. We sum up the requirements in form of eight theses.

Keywords: Code of conduct, sustainable supply chain management, literature review.

1 Introduction

Over the last quarter of a century, concepts such as sustainability and corporate social responsibility have gained tremendous attention worldwide and have evolved into a pivotal source of legitimacy for business activities. The basic idea behind all of them is to reconcile economical goals with social and ecological ones, which is also expressed explicitly by the triple bottom line approach (Elkington, 1998). Nowadays, firms are therefore expected to respect their environment, to uphold human rights and to guarantee socially acceptable working conditions instead of just focusing on profit maximization. However, it is also in firms' own interest to prevent sustainability related wrongdoings, since such disclosures are potentially negatively effecting their reputation and subsequently their financial performance (McGuire *et al.*, 1988).

Supply chain management plays a major role for achieving sustainable development (Carter and Jennings, 2004), since focal firms can influence their suppliers' behavior through supplier selection and supplier development decisions. Focal firms can therefore directly influence the sustainability performance of supply chains. Consequentially, firms are not only held responsible for their own operations, but increasingly also for their upstream supply chains, and misconduct at suppliers' sites has turned into a very serious potential problem for focal firms (Amaeshi *et al.*, 2008). Already out of self-interest, firms must therefore ensure that major social or environmental problems do not arise in their supply chains. However, while stakeholders nowadays tend to make focal companies in supply chains responsible for

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their suppliers' misconduct, and while misconduct information is more easily available than it used to be, structural supply chain complexity makes the fulfillment of stakeholder requests extraordinarily difficult. Modern supply chains are characterized by horizontal, vertical and spatial complexity (cp. Choi and Hong, 2002). Due to global sourcing, many supply chains have become geographically dispersed (spatial complexity), so that triple bottom line standards diverge to a great extent among regions, countries, and companies (Ehrgott *et al.*, 2011). While focal firms in developed economies are nowadays held responsible for supplier misconduct, supply chain governance for sustainability is an extremely difficult mission: Specialization which results in large numbers of suppliers per tier level (horizontal complexity), as well as outsourcing which leads to vertical disintegration (vertical complexity) are responsible for this challenge.

The key question in sustainability-oriented supply chain governance is how to effectively control and manage multiple or even numerous dyadic relationships with suppliers in order to prevent the aforementioned sustainability related wrongdoings and consequential reputational damages. As one of the main instruments to achieve this, firms have begun to apply codes of conduct not only to their own employees (corporate codes of conduct) but also to their suppliers; so-called supplier codes of conduct (SCoC). These SCoC usually prescribe norms and principles which suppliers have to agree to and comply with if they want to successfully uphold the business relationship with their customers (Colwell *et al.*, 2011). For this reason, a cascade of codes (Preuss, 2010) with different purposes and initiators has emerged. While the need for corporate code and SCoC usage is obvious from a positive point of view of firms' self-interest, as well as from the normative perspective of the sustainable development ideal, the plurality of existing codes poses multiple problems of its own accord, such as lack of unanimously accepted content, misfits between multiple codes, high procedural costs, fear of greenwashing etc.

A standardized and globally accepted code to govern firms' own operations and their upstream supply chain with respect to sustainability – which we henceforth refer to as a Global Sourcing Governance Code (GSGC) – on the other hand might offer many advantages for firms, shareholders, and other stakeholders: First, firms are facing sustainability-related challenges almost everywhere in their organization and supply chain. Besides national and international mandatory regulations, the existence of a multitude of self-regulatory codes and standards aiming at very similar goals is confusing and often intransparent, leading into a dilemma: Firms are either trying to embrace and join numerous of these initiatives or they attempt to select particular ones. While the first option bears a lot of costs, the second involves the danger of opting for non-efficient ones or even to select an ineffective option. An effective standardized code, accompanied by enforcement means and a compliance system, might conjoin the best initiatives and make most of them redundant. As a result, a GSGC should not only increase transparency and consequentially stakeholders' trust in the focal firm's sustainability performance, but also decrease costs.

Second, shareholders increasingly show interest in investing their money not only in terms of financial benefits but also with regard to sustainability criteria. In addition to diverse ratings and indices, a global label or certification could increase transparency and prevent free-riding and greenwashing so that shareholders could allocate their money more fittingly.

Third, other stakeholders such as employees, customers, media or NGOs are expecting firms to act in a sustainable and responsible manner. A GSGC could serve as evidence that sustainability efforts are more than merely lip service, because firms' commitments would be visibly documented in writing and could be compared with their actual behavior. Moreover the code could promote sustainability performance on the global sphere by fostering sustainability-related competitive mechanisms between firms and supply chains.

These arguments confirm that a unanimously acceptable GSGC would be a useful tool for the governance of firms' operations and their upstream supply chains, as well as for their shareholders and other stakeholders. From the normative sustainable development perspective, it would also be desirable. However, such a standard does not yet exist. Thus, in this article[1], we present a review of relevant literature on codes of conduct in order to analyze the requirements on a GSGC. We express these requirements in the form of eight theses. Our research facilitates an open-ended high-level discourse in the field of sustainability theorists and practitioners about this topic.

2 Literature Review

2.1 Concept and Emergence of Codes of Conduct

According to Kaptein and Schwartz (2008, p. 113) a corporate code of conduct is "a distinct and formal document containing a set of prescriptions developed by and for a company to guide present and future behavior on multiple issues of at least its managers and employees toward one another, the company, external stakeholders and/or society in general."

The idea of implementing codes of conduct in order to control and manage behavior is not new. It was at the beginning of the 19th century, when companies and business associations first established guidelines and credos, which defined a corporation's responsibility to customers, employees, the community and shareholders (Heermance, 1924). Nevertheless, first major rise of the concept did only occur in the 1970s, when international guidelines were developed for the first time. Drivers of these initiatives were International Organizations and Non-Governmental Organizations along with governments of developing countries, which strove for controlling the behavior of multi-national companies (ILO, 1999). Trigger to these processes were negative social and environmental impacts of large foreign investments and of further activities such as low-cost country sourcing, offshoring, and outsourcing of multi-national companies to countries with low environmental and social standards (Kolk and van Tulder, 2010). Over the 1980s, initial motivation and enthusiasm flattened and the discourse about codes of conduct took almost exclusively place in the U.S. During the 1990s, the concept of codes of conduct regained widespread attention within multi-national companies (Kolk *et al.*, 1999) Some of the most widely accepted codes like e.g. the Caux Roundtable Principles for Responsible Business (1994), the SA8000 (1997) and the United Nations Global

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Compact (1999) emerged in that decade. Thus, to date, codes of conduct are the most prevalent measures to achieve sustainable development beside national and international mandatory regulations. Latest studies report that 86% of the Fortune 200 companies have a business code in place with the number of code adopting firms doubled in the last decade (KPMG, 2008).

Beside corporate codes, there is a plurality of codes issued by other organizations. Kaptein and Schwartz (2008), as well as Preuss (2010), categorize codes of conduct according to their issuing unit, e.g. professional, regional and national codes, codes developed by industry associations, and global or transnational organizations. Corporate SCoC are a special form of codes, as they are issued by a single firm, but address multiple other firms. For the analysis of requirements on a GSGC, we therefore review research on corporate codes, as well as research on codes that transcend the sphere of single firms.

2.2 Previous Research on Corporate Codes of Conduct

Previous research on codes of conduct has particularly focused on three main topics: code content and comparisons of codes, code implementation, as well as code effectiveness. We discuss each stream in turn.

Content Analysis and Comparisons

Several studies have compared the content of different codes of conduct with the aim of generating a general overview of code inventories. In a review of these, we find that all of these studies are organized by sustainability-related issues, however at a rather abstract level. For instance, there is relative agreement that the most important topics are *labor standards* and *human resources* issues (ILO, 1999; OECD, 2001; KPMG, 2008; Lugli *et al.*, 2009) as well as environmental topics (van Tulder and Kolk, 2001; O'Dwyer and Madden, 2006; KPMG, 2008; Oehmen *et al.*, 2010). In the first category, *forced labor* (ILO, 1999; World Bank, 2003), *child labor* (ILO, 1999; World Bank, 2003; Kolk and Van Tulder, 2002), *non-discrimination* (Oehmen *et al.*, 2010), *safety and health* (Kaptein, 2004; O'Dwyer and Madden, 2006), *working hours* and *wages* (van Tulder and Kolk, 2001; Oehmen *et al.*, 2010) as well as *freedom of association and collective bargaining* (ILO, 1999; World Bank, 2003) are mentioned very often. In the environmental sphere, most codes state *obedience with laws and regulations* (OECD, 2001; Oehmen *et al.*, 2010), *control of emissions, waste and pollution* (OECD, 2001; World Bank, 2003; Kaptein, 2004) and the use of *environmental management systems* (van Tulder and Kolk, 2001; Oehmen *et al.*, 2010) and include more general statements concerning *resource efficiency* and *responsibility towards the environment* (Kaptein, 2004; O'Dwyer and Madden, 2006; Singh, 2006; KPMG, 2008). Moreover, topics like *anti-corruption* and *bribery* (Gordon and Myake, 2001; Singh, 2006), *fair competition* (Lugli *et al.*, 2009; Oehmen *et al.*, 2010) as well as *production or service quality* (Kaptein, 2004) are mentioned quite often.

However, before an inventory of topics for the GSGC can be created, international codes should also be taken into account. As a GSGC is supposed to address a wide range of firms on a global level, the contents of corporate codes might be only partially applicable. Furthermore, results of content-comparing research are not entirely consistent: Whereas Forster *et al.* (2009) found much overlap in the codes of S&P 500 companies, OECD (2001) states that the 233 codes they examined differ considerably. They ascribe these results to the differences of organizations with regard to their size, industry and regional context. More recently, Stohl *et al.* (2010) compared codes of 157 corporations on the Global 500 and/or Fortune 500 lists. For them, a "pressure to 'think globally'" with regard to aspects of sustainability and corporate social responsibility among companies exist (Stohl *et al.*, 2010, p. 618). Thus, a trend towards globally unified and accepted content can be posited, due to already existing and wide-spread initiatives, regulations and certificates, first and foremost in the field of environmental and social topics. In the field of human rights and labor standards, the United Nations Universal Declaration of Human Rights (1948) and the many conventions of the International Labour Organization, especially the Declaration on Fundamental Principles and Rights at Work (1998) have gained global recognition and thus serve as a benchmark. The same applies in the environmental sphere to ISO 14001 (1996), which is an internationally accepted environmental standard.

As our review revealed, there are some sustainability-related issues which clearly must be addressed in a GSGC, because they are typical content of established codes and appear virtually undisputed, such as e.g. child labor, forced labor and so on. Other issues are mentioned which may be difficult to enforce globally and interculturally, such as animal protection or sexual non-discrimination. However, an in-depth review of international codes should back these topics. We hence formulate our first thesis regarding code content as follows:

T_1: A GSGC needs to (i) be organized by high-level sustainability issues, (ii) cover all topics and principles in the area of sustainability that are undisputed, (iii) cover those topics and principles that are not related to sustainability, but are also typically included in corporate codes of conduct and SCoC.

Implementation

The second research stream refers to firms' implementation of codes. For instance, Adam and Rachman-Moore (2004) investigate the role of formal, informal as well as personal factors in enabling a successful implementation of codes. They find out that rather informal methods like social norms of the organization or the positive managerial role model have the biggest impact on implementing a code of conduct. Similarly, Verbos *et al.* (2007, p. 28) highlight the importance to "enact a living code (…) by focusing on the multiplicative interaction of internal authentic leadership, aligned processes, and ethical organizational culture." Hanson and Rothlin (2010) also focus on culture and investigate how to apply Western codes in China. In their view, many firms fail, since they ignore to adapt their codes to cultural and national characteristics. Logsdon and Wood (2005) point to difficulties of firms in following universal ethical principles, while concurrently respecting cultural and national differences. They see this problem as a particular problem for the sphere of codes of conduct, as these express core values. Despite this challenge, they advocate a solution in which codes state global standards and universal principles. Existing initiatives and codes like e.g. the United Nations Universal Declaration of Human Rights (1948), the OECD Guidelines for Multinational Enterprises (1976) and others clearly point into this direction, as well.

Müller *et al.* (2009) analyze how global standards can gain legitimacy so that they are widely acceptable and thus adoptable. In the course of their research they postulate five legitimacy criteria combining input and output legitimacy which have to be met: 1. *inclusivity*, which is the integration of relevant stakeholders, 2. *discourse* that is developing potential criteria of the standards in a processed of discourse, 3. c*ontrol* achieved by certification and accreditation, 4. *supply chain* that means to integrate all participants along the supply chain, and 5. *transparency* of the results and processes towards the stakeholders. In order to increase the legitimacy of codes, it is necessary to improve their transparency with regard to certification processes. (Müller *et al.*, 2009). Firms supposedly will not be willing to comply with self-regulatory means if they are not clear on its processes and results. Moreover, Müller *et al.* (2009) ascribe supply chains a multiplication effect regarding the diffusion of environmental and social standards, as long as relevant members of the supply chain are involved in the process of generating these. Therefore, we suggest:

$T_{2:}$ An efficient GSGC has to balance universal principles with local adjustments without losing its ability of being globally applicable.

T_3: Relevant stakeholders and firms upstream and downstream the supply chain have to be involved in the discourse of developing a GSGC. Code design has to be assessed against a plurality of cultural and regional norms.

T_4: Processes and results concerned with the application of the GSGC have to be made transparent and to be controllable by internal and external bodies.

Effectiveness

Since codes of conduct are widely seen as instruments to achieve a better corporate social or ethical performance, studies primarily center on the effectiveness of codes. However, effectiveness related results differ, and the role codes play in preventing unethical malpractice is not obvious (Kaptein and Schwartz, 2008). Bondy *et al.* (2008) even doubt the overall effectiveness of codes for governing corporate social responsibility. They hold that voluntary initiatives of self-regulation should be recognized as a necessary but insufficient supplement to regulatory means in achieving their intended aims. The work of Kaptein (2011) is a good example of ambivalent findings regarding the effectiveness of codes: Results suggest that the mere existence of a code does not significantly affect absence of unethical behavior at the workplace. Rather, commitment to the code by senior and local management is the most important factor in reducing ethical wrongdoings (similarly: Weaver *et al.*, 1999; Pedersen and Andersen, 2006). Moreover, Kaptein (2011) points out that the quality of communication activities associated with the code moderates the effectiveness of the latter. These finings are backed up by Sims (1992), Weaver *et al.* (1999) and Rottig *et al.* (2011).

Further measures in increasing the effectiveness of codes of conduct frequently highlighted by scholars are trainings, as well as sanctions and surveillance systems (Sims, 1992; Singh, 2011). Trainings are considered as “a way of institutionalizing ethics in the organization“ (Singh, 2011, p. 388) which provide people with patterns of guidance in cases of ethical dilemmas or situations in which they have to make decisions with regard to code topics. Furthermore, sanctions and surveillance systems play an important role as drivers for code success (Rottig *et al.*, 2011). To prevent non-compliance, the balance of potential costs and benefits should lead to deterrence by making the individuals aware of the sanctions (costs) they will have to bear in case of non-compliant behavior (cp. Lee and Lee, 2002). Conversely, opposite measures like rewards can lead to the fostering of compliance (Treviño, 1992). Pedersen and Andersen (2006) analyze how firms manage to impose their codes of conduct on their suppliers from a principal-agent perspective and highlight the role of safeguards in preventing supplier opportunism. They argue that direct sanctions, trust, goal congruence, third party monitoring and enforcement, as well as reputational effects trigger the effectiveness of codes. Concerning trust and goal congruence, one might think of continuous communication and coordination between all relevant code parties. Jiang (2009), as well as Egels-Zandén and Hyllman (2007) highlight the importance of building closer relationships with suppliers to increase their SCoC compliance and thus points into the same direction. Therefore, we postulate:

T_5: A GSGC needs both senior and local management commitment.
T_6: The effectiveness of a GSGC is dependent not only on the mere existence of the code itself but also on a set of other accompanying measures.
T_{6a}: Frequent communication of a GSGC and its contents increases code awareness and thus its effectiveness.
T_{6b}: Regular trainings of employees and management in code issues increase the awareness for a GSGC and its topics and thus increase its effectiveness.
T_{6c}: GSGC effectiveness is fostered by the existence of a sophisticated enforcement system, consisting of a deviance detection mechanism, clearly defined sanctions and an incentives scheme.
T_{6d}: Coordination between firms and their suppliers with regard to goals and requirements of the GSGC alleviates the implementation and effectiveness of the code.

Codes Transcending the Sphere of Single Firms

Although the majority of studies concerning codes of conduct investigate corporate codes, other codes have been examined as well. For instance, Emmelhainz and Adams (1999) find that an efficient SCoC has to comprise the following features: workability, transparency, monitorability, and enforceability. In line with our aforementioned theses, it is these features which might improve most existent codes that are “lax in the area of monitoring and enforcement” (Emmelhainz and Adams, 1999, p. 56). Furthermore, they find most SCoC to “still lack substantial detail” on the content side (Emmelhainz and Adams, 1999, p. 56). Therewith they endorse Kolk *et al.* (1999) who regard *content specificity* as well as *means of compliance* as SCoC quality criteria. *Content specificity* relates to the degree, to which contents issued in the code are concretized and measurable. Thus, we add:

T_7: A GSGC needs a sufficient degree in content specificity in order to facilitate the measurement of compliance with the code.

Pedersen and Andersen (2006) see reputational benefits as a major reason for code adoption. Firms that are sufficiently successful at ensuring their sustainability performance might in consequence finally benefit from increased market shares and potential shareholder invests (Kolk and Perego, 2010) as they are dissociating themselves of potential greenwashing firms. Each firm that is supposed to participate in a GSGC also has to become aware of substantial advantages for doing so. Without clearly visible benefits, also in comparison to established initiatives, such a tool is unlikely to gain enough participants. The adoption of multiple codes leads to transaction and complexity costs and is quite time intensive (Pedersen and Andersen, 2006). Sullivan (2005) also highlights the multitude of existing international initiatives which more or less aim at the same topics. He finds that the integration of multiple voluntary approaches can lead to reduced transaction costs, improved data quality and both improved enforcement as well as participatory processes.

Colwell *et al.* (2011) undertake an inquiry concerning the impact of suppliers' code enforcement in dyadic relationships. They find that buyers commit themselves to continue the dyadic relationship with code compliant suppliers, rather than with non-compliant ones. Therefore, both suppliers and buyers have a high interest in code compliance as relational rents result from it.

Three kinds of benefits of code implementation and compliance thus might occur: reputational benefits with regard to stakeholders, relational rents in dyadic relationships – upstream and downstream the supply chain, and intra-organizational benefits, resulting from reduced transaction and complexity costs. Thus, we posit:

T_8: A GSGC has to offer firms a set of benefits and incentives e.g. through decreased complexity costs, decreased transaction costs as well as reputational effects for code adopters.

3 Conclusion and Outlook

The development of a GSGC is found to be a worthwhile undertaking. By increasing transparency over sustainability issues in supply chains, it facilitates sustainability oriented competition. Furthermore, it offers potential advantages for firms, shareholders and stakeholder. A GSGC will only come to existence, if it proves to be an advantageous tool for firms. As long as firms do not see their benefits associated with the implementation, they cannot be expected to participate in the GSGC initiative.

The mere existence of a code of conduct does however not suffice for the prevention of ethical and sustainability related misconduct. Any code has to be designed with regard to content coverage, content specificity, the degree of universality and transparency. Moreover, a code has to be supported by top and local management of implementing firms. These general findings also apply to the GSGC.

Specific requirements for the creation of a GSGC are that relevant stakeholders and supply chain members are included in the development process, as only such an approach guarantees a sufficient level of legitimacy for the code. The GSGC should also be entangled in a whole management system of activities concerning the enhancement of sustainable behavior. Such activities include strong additional methods of implementation, and enforcement (sanctions and incentives).

It is also apparent that no single firm can develop such a code on its own accord. A universally applicable and enforceable GSGC requires combined efforts, coordination and support of many companies from different industries. Therefore, when it comes down to the generation of a GSGC, we recommend the usage of a supra-organizational design science approach. Design science is a problem-driven methodology which aims at the artificial creation of a "means to an end" for ill-structured and complex problems (Holmström *et al.*, 2009, p. 69). Means-ends analysis lies at its core (Simon, 1996; Holmström *et al.*, 2009). The GSGC requirements which we present here serve as a first specification of the "ends" (Holmström *et al.*, 2009), which should be further refined within empirical research. The "means" (Holmström *et al.*, 2009) would have to be developed through close interaction with corporate practice across multiple industries, states of economic development and cultures. Empirical involvement of stakeholders in different regions of the world, such as in-depth qualitative interviews, additional workshops and roundtable discussions must hence be included.

In the end, if a GSGC was to fulfill the above requirement on transparency, standardization, controllability and acceptance, it ought to contribute to raising ecological and social standards across the globe.

References

Adam, A.M., Rachman-Moore, D.: The methods used to implement an ethical code of conduct and employee attitudes. Journal of Business Ethics 54(3), 223–242 (2004)

Amaeshi, K.M., Osuji, O.K., Nnodim, P.: Corporate social responsibility in supply chains of global brands: A boundaryless responsibility? Clarifications, exceptions and implications. Journal of Business Ethics 81(1), 223–234 (2008)

Bondy, K., Matten, D., Moon, J.: Multinational corporation codes of conduct: Governance tools for corporate social responsibility? Corporate Governance: An International Review 16(4), 294–311 (2008)

Carter, C.R., Jennings, M.M.: The role of purchasing in corporate social responsibility: A structural equation analysis. Journal of Business Logistics 25(1), 145–186 (2004)

Choi, T.Y., Yunsook, H.: Unveiling the structure of supply networks: Case studies in Honda, Acura, and Daimler Chrysler. Journal of Operations Management 20(5), 469–493 (2002)

Colwell, S., Zyphur, M., Schminke, M.: When does ethical code enforcement matter in the inter-organizational context? The moderating role of switching costs. Journal of Business Ethics 104(1), 47–58 (2011)

Egels-Zandén, N., Wahlqvist, E.: Post-partnership strategies for defining corporate responsibility: The business social compliance initiative. Journal of Business Ethics 70(2), 175–189 (2007)

Ehrgott, M., Reimann, F., Kaufmann, L., Carter, C.R.: Social sustainability in selecting emerging economy suppliers. Journal of Business Ethics 98(1), 99–119 (2011)

Elkington, J.: Cannibals with forks: The triple bottom line of the 21st century. New Society Publishers, Stoney Creek (1998)

Emmelhainz, M.A., Adams, R.J.: The apparel industry response to "sweatshop" concerns: A review and analysis of codes of conduct. Journal of Supply Chain Management 35(3), 51–57 (1999)

Forster, M., Loughran, T., McDonald, B.: Commonality in codes of ethics. Journal of Business Ethics 90, 129–139 (2009)

Gordon, K., Miyake, M.: Business approaches to combating bribery: A study of codes of conduct. Journal of Business Ethics 34(3), 161–173 (2001)

Hanson, K.O., Rothlin, S.: Taking your code to China. Journal of International Business Ethics 3(1), 69–80 (2010)

Heermance, E.L.: Codes of Ethics: A handbook. Free Press Printing Co., Burlington (1924)

Holmström, J., Ketokivi, M., Hameri, A.P.: Bridging practice and theory: A design science approach. Decision Sciences 40(1), 65–87 (2009)

ILO. A social conscience in the global market place: Labor dimensions of codes of conduct, social labeling and investor initiatives. International Labour Organization, Geneva (1999)

Jiang, B.: The effects of interorganizational governance on supplier's compliance with SCC: An empirical examination of compliant and non-compliant suppliers. Journal of Operations Management 27(4), 267–280 (2009)

Kaptein, M.: Business codes of multinational firms: What do they say? Journal of Business Ethics 50(1), 13–31 (2004)

Kaptein, M.: Toward effective codes: Testing the relationship with unethical behavior. Journal of Business Ethics 99(2), 233–255 (2011)

Kaptein, M., Schwartz, M.S.: The effectiveness of business codes: A critical examination of existing studies and the development of an integrated research model. Journal of Business Ethics 77(2), 111–127 (2008)

Kolk, A., Perego, P.: Determinants of the adoption of sustainability assurance statements: an international investigation. Business Strategy and the Environment 19(3), 182–198 (2010)

Kolk, A., van Tulder, R.: Child labor and multinational conduct: A comparison of international business and stakeholder codes. Journal of Business Ethics 36(3), 291–301 (2002)

Kolk, A., van Tulder, R.: International business, corporate social responsibility and sustainable development. International Business Review 19(2), 119–125 (2010)

Kolk, A., van Tulder, R., Welters, C.: International codes of conduct and corporate social responsibility: Can transnational corporations regulate themselves? Transnational Corporations 8(1), 143–180 (1999)

KPMG. Business codes of the global 200: Their prevalence, content, and embedding. KPMG Special Services B.V., Netherlands (2008)

Lee, J., Lee, Y.: A holistic model of computer abuse within organizations. Information Management & Computer Security 10(2), 57–63 (2002)

Logsdon, J.M., Wood, D.J.: Global business citizenship and voluntary codes of ethical conduct. Journal of Business Ethics 59(1), 55–67 (2005)

Lugli, E., Kocollari, U., Nigrisoli, C.: The codes of ethics of S&P/MIB Italian companies: An investigation of their contents and the main factors that influence their adoption. Journal of Business Ethics 84(1), 33–45 (2009)

McGuire, J.B., Sundgren, A., Schneeweis, T.: Corporate social responsibility and firm financial performance. Academy of Management Journal 31(4), 854–872 (1988)

Müller, M.V., dos Santos, V.G., Seuring, S.: The contribution of environmental and social standards towards ensuring legitimacy in supply chain governance. Journal of Business Ethics 89(4), 509–523 (2009)

O'Dwyer, B., Madden, G.: Ethical codes of conduct in Irish companies: A survey of code content and enforcement procedures. Journal of Business Ethics 63(3), 217–236 (2006)

OECD, Corporate codes of conduct: Expanded review of their contents, Working Papers on International Investment Number 2001/6. Directorate for Financial, Fiscal and Enterprise Affairs, Paris (2001)

Oehmen, J., De Nardo, M., Schönsleben, P., Boutellier, R.: Supplier code of conduct - State-of-the-art and customisation in the electronics industry. Production Planning & Control 21(7), 664–679 (2010)

Pedersen, E.R., Andersen, M.: Safeguarding corporate social responsibility (CSR) in global supply chains: How codes of conduct are managed in buyer-supplier relationships. Journal of Public Affairs 6(3/4), 228–240 (2006)

Preuss, L.: Codes of conduct in organisational context: From cascade to latticework of codes. Journal of Business Ethics 94(4), 471–487 (2010)

Rottig, D., Koufteros, X., Umphress, E.: Formal infrastructure and ethical decision making: An empirical investigation and implications for supply management. Decision Sciences 42(1), 163–204 (2011)

Simon, H.: The sciences of the artificial, 3rd edn. The MIT Press, Cambridge (1996)

Sims, R.R.: The challenge of ethical behavior in organizations. Journal of Business Ethics 11(7), 505–513 (1992)

Singh, J.B.: A comparison of the contents of the codes of ethics of Canada's largest corporations in 1992 and 2003. Journal of Business Ethics 64(1), 17–29 (2006)

Singh, J.B.: Determinants of the effectiveness of corporate codes of ethics: An empirical study. Journal of Business Ethics 101(3), 385–395 (2011)

Stohl, C., Stohl, M., Popova, L.: A new generation of corporate codes of ethics. Journal of Business Ethics 90(4), 607–622 (2009)

Sullivan, R.: Code integration: alignment or conflict? Journal of Business Ethics 59(1), 9–25 (2005)

Treviño, L.: The social effects of punishment in organizations: A justice perspective. Academy of Management Review 17(4), 647–676 (1992)

van Tulder, R., Kolk, A.: Multinationality and corporate ethics: Codes of conduct in the sporting goods industry. Journal of International Business Studies 32(2), 267–283 (2001)

Verbos, A.K., Gerard, J.A., Forshey, P.R., Harding, C.S., Miller, J.S.: The positive ethical organization: Enacting a living code of ethics and ethical organizational identity. Journal of Business Ethics 76(1), 17–33 (2007)

Weaver, G.R., Treviño, L.K., Cochran, P.L.: Integrated and decoupled corporate social performance: Management commitments, external pressures, and corporate ethics practices. Academy of Management Journal 42(1), 539–552 (1999)

World Bank. Company codes of conduct and international standards: An analytical comparison. Apparel, Footwear and Light Manufacturing, Agribusiness, Tourism, vol. 1. World Bank, Washington (2003)

An Introduction to Logistics as a Service

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Abstract. In order to handle the increasing need for supply chain flexibility and changeability and, thus, to manage complexity and dynamics, the deficits of traditional IT systems need to be addressed with new approaches. "Logistics as a service" is dedicated to the development of principles, concepts and prototypes of flexible and modular logistics IT services and infrastructures. These services are designed for individual combinability in a cloud marketplace and will offer comprehensive support from design and planning to operational management of supply chains. This paper introduces the respective main concepts and guiding thoughts which are picked up by several projects of the EffizienzCluster LogistikRuhr.

Keywords: Logistics as a Service, Logistics Assistance Systems, Service-oriented Architecture, Supply Chain Design, Supply Chain Planning, Supply Chain Execution.

1 Introduction

A permanent change of influencing factors on supply networks may be perceived. Drivers for dynamism are market- and competition-driven changes in the supply chain strategy as well as technological innovations. All of these are appearing with an increasing frequency within product life cycles; thus, resulting in a short- to mid-term need for adaptation of supply chain processes and resources. Moreover, also supply chain structures are subject to continuously growing dynamics caused by the exit of existing partners and the need for integration of new partners.

In addition, customised and individualised products require extending the cooperation in the supply chain from customers and dealers to suppliers. Companies are increasingly pursuing collaborative strategies to improve the performance and the efficiency of their production and logistics processes [1]. Consequently, the scope and complexity of the processes to design, plan and manage is growing dramatically [2].

Furthermore, the design of environmentally friendly and sustainable supply networks assumes a whole new importance in the system of supply chain objectives, which traditionally comprise cost, performance and quality targets [3].

Concluding, the complexity of design and operational decisions in production and logistics continues to rise for all players, and results in an ever-increasing uncertainty regarding the resulting requirement profiles on the respective supply chain systems in both the near and distant future [4]. Especially small and medium suppliers are challenged as often the necessary competences as well as resources are lacking [5], [6].

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It is common knowledge that only IT systems empower logistics managers and planners to deal with this complexity, both with regard to the strategic network design ("Supply Chain Design") as well as in the subsequent planning and operations of supply chain processes ("Supply Chain Planning & Execution"). Nevertheless, available IT systems are just as diverse as the respective tasks in the design, planning and control of a complex supply chain [7].

Against this background, adaptive systems are increasingly called for since a few years. When it comes to this issue, the concepts of flexibility, changeability and robustness dominate discussions in science and industry (see for example [8], [9], [10], [11]).

In context of logistics, robustness is generally defined as the degree in which a logistics system is able to fulfil its objectives despite internal and external influences, i.e. disruptions, market dynamics, etc. [12]. Even under dynamics and uncertainties, robustly designed supply chain systems hold the ability to remain within a specified cost and performance range [13]. Nevertheless, these competitive advantages of a supply chain system cannot be obtained solely by increasing flexibility. Consequently, these systems should be able to compensate the need for change to a defined degree and, moreover, shall allow for a quick and cost-effective adaptation to more radical changing conditions. This implementation of an appropriate degree of changeability can be identified as a key factor to the robustness of the system, i.e. to establish a successful market position (see also [14], [15]).

In order to achieve this level of changeability in the supply chain, three elements are necessary [16]: First, drivers for change in a given supply chain system need to be continuously monitored in real-time and triggers for change have to be identified. Second, measures of change need to be planned and impacts to be analysed quickly based on the system's immanent flexibility. Third, the supply chain needs to be empowered so as to actively and collaboratively implement the necessary measures of change. A systemisation of this event-oriented planning process has been given by Kuhn et al. [12] as well as by Bertsch and Nyhuis [17].

In this context, this paper will introduce the prospects that information and communication technology is providing with new technologies. After discussion of requirements and deficits of IT systems in chapter 2, a generic IT-service framework for supply chain management is presented in chapter 3, which has been applied in the respective projects of the EffizienzCluster LogistikRuhr. Chapter 4 concludes with a summary and a promising outlook on the already realised and further expected deliverables.

2 State of the Art in SCM IT

Commonly, supply chain management systems provide diverse functionalities for design tasks (Supply Chain Design), planning tasks (Supply Chain Planning) and/or operational tasks (Supply Chain Execution) (see for example [7]). In order to handle the need for changeability and, thus, to manage complexity and dynamics, the following deficits of these IT systems need to be addressed with new approaches (see for example [18], [19]):

1. **Configurability:** The extensive individualisation of today's monolithic information technology typically leads to inflexible individual solutions which would not be able to keep pace with changes in the supply chain.
2. **Interoperability in collaboration:** Both horizontal and vertical networking requires collaborative and coordinated IT functionalities. Past experiences show that the centralistic approach is conflict-laden and a lack of trust between different actors of the supply chain may restrain successful collaboration significantly.
3. **Exploitation of technological innovation:** Mobile devices and sensors already allow monitoring supply chain processes precisely. Nevertheless, the information overload is seldom incorporated into IT functionalities in an advantageous way.
4. **Availability on demand:** For certain tasks, particularly in the strategic design of supply chain networks, IT support is not required permanently, but ad-hoc. Yet, in contradiction, the current decision support tools require long implementation and configuration lead times.
5. **Comprehensiveness and consistency:** Comprehensive and consistent decision support from strategic to operational decisions in the supply chain has not yet been achieved [7]. Logistical targets such as cost, performance and quality are indeed covered by most IT systems. However, continuity and consistency of criteria over individual functions and hierarchy levels is given only infrequently. Even more so, the limits are clearly maxed out if costs and benefits of supply chain decisions need to be regarded from the perspective of different partners.

New concepts like autonomous systems, service-oriented architectures (SOA) and cloud computing are on the rise and allow for a new generation of decentralised and interoperable IT systems. Holistic logistics and IT design based on these three technologies is understood as one of the most promising paradigms for the realisation of on-demand, changeable, individualised and collaborative supply chain processes. This concerns particularly the concept of cloud computing, which represents an extension of the concept of content access via the internet: the capabilities of business applications are exposed as sophisticated services that can be accessed freely over a network [20]. However, these services need to be designed in an interoperable and configurable way, in order to achieve short implementation and ramp-up lead times of logistics IT systems; and thus allow for synchronisation with dynamics in life cycles of supply chain structures, processes and resources. The following chapter presents a respective framework for this concept named "Logistics as a Service".

3 A Framework for Logistics as a Service

The aim of the Effizienzcluster LogistikRuhr is to develop methods and instruments for the management of supply chain tasks which provide flexible decision support through appropriate IT functionalities. The projects clustered under the guiding topic "Logistics as a Service" are dedicated to the development of a flexible and modular kit of logistics IT services complemented by infrastructural elements. A framework comprising four types of services has been developed (see also [16]):

1. **Services for data integration and interchange:** IT-support is required to link processes to dependent processes, e.g. inventory planning to processes such as demand planning, production planning and transport planning (see for example [21]). There is a need to integrate respective information and data from a variety of sources, e.g. demand scenarios, resource capacities and service level targets from ERP systems as well as online supply chain information from tracking and tracing software or inventory levels from warehouse management systems.
2. **Services for supply chain transparency:** Heterogeneous data needs to be consistently integrated and analysed, so that situations requiring intervention and replanning can be identified. The necessary services have to incorporate a variety of reporting functionalities ranging from common business intelligence approaches to innovative visual management concepts. For example these services have to provide an analysis of the impacts of new demand scenarios on stocking points and inventory levels and the effects of changes in production programs on product fill rates.
3. **Services for robust logistics planning:** It is imperative to consider logistics planning activities from a network perspective rather than treating each stage as a single isolated player. This requires innovative planning models for robust and collaborative planning, whose service-oriented realisations merge into instances of individualised, collaborative and decentralised planning systems.
4. **Services for on-demand collaboration:** Supply chains are characterised by dynamic structures, i.e. companies enter and exit the supply chain frequently. Even so, these organisations need to coordinate and harmonise their planning activities. Hence, it is necessary that negotiation is treated as an important part of the required service functionalities.

All services in these four categories need to be designed for individual combinability on an integrated platform and shall offer comprehensive support from design and planning to the operational management of supply chains. Within the Effizienzcluster LogistikRuhr, these developments are divided into three project sections:

- **Supply Chain Design:** Comprises methodological enhancement of existing planning tools for supply chain design under consideration of ecology and sustainability. Covered is the integration of partially-acting planning tools into holistic, on-demand, applicable and modular design instruments for supply chains (Design Services).
- **Supply Chain Planning, Supply Chain Execution:** Encompasses the development of a modular system consisting of easily transferable and configurable planning and control instruments for selected, especially challenging tasks in supply chains (Planning Services, Execution Services), which shall lead to a radical reduction of effort in development, implementation and deployment.
- **Service Infrastructure** (Service Design Studio, Logistics Mall): Includes the development of a web-based infrastructure platform for logistics, enabling technologies for cloud-oriented service marketplaces and

infrastructural principles and standards for logistics; thus empowering the development and configuration of services, their integration into individual logistics systems and their runtime deployment to the marketplaces.

The development of all components is based on the principle of service-oriented architectures (SOA). SOA describes a concept in which infrastructures are aligned with the desired businesses and can be adapted quickly to changing demands in the business environment [22]. This presupposes a flexible system architecture, which loosely couples professional services and functionalities in the form of autonomous services (service chaining). Open interfaces of all services allow docking single functionalities to comprehensive logistics assistance systems (LAS) [23], as well as these LAS to other internal IT systems (e.g. Manufacturing Execution Systems or Enterprise Resource Planning Systems) or those of external network partners. The interoperability of these systems is facilitated by the development of the appropriate data structures in the form of semantic models, known as business objects (BO, e.g. order, forecast but also fill rate, resource capacity). The thorough application of these common data structures enables processes to be networked IT-wise with each other quickly and easily.

The infrastructural developments of the projects "Service Design Studio" and Fraunhofer-Innovationscluster "Cloud Computing für Logistik"[5] allow for the single IT functionalities to be configured and combined into individualised IT systems: As part of the Fraunhofer-Innovationscluster, a standardised web platform (Logistics Mall) is being designed and developed, which will offer logistics services, allow orchestrating these services into processes and provide a runtime environment for logistics assistant systems. For the transfer of the developed functional applications and services into integrated systems with individual functionalities and perspectives, specific technical requirements need to be fulfilled, so as to guarantee a smooth and rapid configuration and deployment of such logistical assistance systems. Hence, in addition to the methodological functionality of these services, a number of technical properties are to be provided, e.g. criteria catalogues of software quality, semantic descriptions of functional and non-functional properties, monitoring services for resource consumption, and resource management, billing services and a central service repository. The Service Design Studio is this web-based, standardized service infrastructure, which will provide the necessary enabling technologies to offer the services on cloud-oriented service-marketplaces like the Logistics Mall. It contains instruments for the configuration and integration of services as a component of an individual logistics assistance system.

4 Conclusions and Outlook

The paradigms of service-oriented architectures and cloud computing provide a solid foundation for the development of a new generation of decentralised and interoperable IT-services for logistics. As a result of the research in the guiding topic "Logistics as a Service", principles, concepts and prototypes of a new generation of IT systems will be developed that will support design, planning and operational tasks in supply chains.

These systems may be configured and deployed within short implementation and ramp-up lead times in the form of logistics assistance systems. Interoperability is guaranteed by open interfaces and a common logistics data model. By orchestration and configuration of modular logistics services, an individually customized IT solution can be achieved. Thus, on-demand adaptation as well as advancements is finally realized. An issue which for today's integrated, monolithic IT solutions is neither cost-efficiently possible nor feasible. Thus, IT can pick up the pace of dynamics in processes and product life cycles and no longer vice versa. By the interaction of its deliverables, the guiding topic "Logistics as a Service" will establish a quasi-standard for future, sustainable logistics information technology.

The guiding topic "Logistics as a Service" is constituted on the idea of an open platform. Based on industrial use cases, an initial set of services is being developed within the respective projects. Business processes and scenarios from industry partners are used to deduce those logistical problems which, in the next step, will specify the requirements for the largely universally applicable services yet to be developed.

Therefore, on the one side, research within the projects is focused on methodological innovation, i.e. the advancement and integration of existing methods and algorithms for the specified design, planning and operational problems. On the other side, in the context of technological development, the underlying basic principles and architectures are being developed and, thus, serve to translate the innovative methods into specific logistics IT services. Upon completion of the research and development work, the industrial use cases are to be used for demonstration and validation of the developed solutions.

Following the idea of an open platform, other services shall be supplemented by other projects within the cluster, by cluster members. Moreover, with their application the developed services will be further advanced in the course of time. Here, the project "Service Design Studio" in cooperation with the Fraunhofer-Innovationscluster "Cloud Computing für Logistik" generates the necessary architectural framework to allow for the orchestration and deployment of services in the form of individualised Logistics Assistance Systems (LAS).

In result, the research deliverables of "Logistics as a Service" contribute significantly to the cluster strategy. With the advanced design instruments (Design Services), structures, processes, resources and strategies in supply chains can be designed efficiently and sustainable. Thus, supply chains are beeing qualified for changeability thus securing logistcis efficiency in dynamic environmens. Logistics assistance systems, which are based on the developed planning and execution services, will help to effectively and efficiently manage and operate the customised value added. The design of individual logistics IT systems to support enterprise-specific logistics tasks will be simplified, so as to become quicker and more efficient in implementation and deployment. Furthermore, resources can be preserved by outsourcing of IT services in energy-efficient cloud computing centres in the sense of Green IT.

"Logistics as a Service" also provides the infrastructure and methods for process and IT collaboration of different partners. This enables, thus, to implement joint strategies for sustainable urban development through the collaborative use of infrastructures, increased bundling of flows of goods, and improved networking of manufacturers, distributors and service providers.

In reference to the service-oriented principle and thus to the ability to be integrated in today's heterogeneous IT landscapes, innovative IT companies may offer niche functionalities on the market, which exceed the available standard solutions of traditional ERP, SCM, WMS or MES systems. The provision of infrastructure components and the configurability and, thus, reusability of all services will allow for competitive prices and terms on side of IT providers. In return, the concept of adaptable, modularised services systems circumvents high investments (pay-per-use) on user side. Hence, tailored and collaborative solutions reduce the barriers for entry and exit of firms in supply chains. This holds especially true for small and medium enterprises (SME).

References

1. Kolodziej, M., Mostberger, P., Sternbeck, M.: Gemeinsam statt einsam – Kooperationsmanagement als Erfolgsfaktor. In: Baumgarten, H. (ed.) Das Beste der Logistik, Innovationen, Strategien, Umsetzungen, pp. 197–206. Springer, Berlin (2008)
2. Lechner, A., Wagenitz, A.: Antizipative Logistikplanung in der variantenreichen Serienfertigung der Automobilindustrie durch Bewertung dynamischer Logistikkomplexität. In: Sucky, E., Asdecker, B., Dobhan, A., Haas, S., Wiese, J. (eds.) Logistikmanagement, Herausforderungen, Chancen und Lösungen, Band III, pp. 251–270. University of Bamberg Press, Bamberg (2011)
3. Cirullies, J., Klingebiel, K., Scavarda, L.-F.: Integration of Ecological Criteria into the Dynamic Assessment of Order Penetration Points in Logistics Network. In: Burczynski, T., Kolodziej, J., Byrski, A., Carvalho, M. (eds.) Proceedings of the 25th European Conference on Modelling and Simulation, pp. 608–615. European Council for Modelling and Simulation (ECMS), Krakow (2011)
4. Baumgarten, H.: Das Beste in der Logistik – Auf dem Weg zu logistischer Exzellenz. In: Baumgarten, H. (ed.) Das Beste der Logistik, Innovationen, Strategien, Umsetzungen, pp. 11–19. Springer, Berlin (2008)
5. Ten Hompel, M., Meinhard, M.-B., Lippmann, T.: Cloud Computing für Logistik. Fraunhofer Verlag, Stuttgart (2011)
6. Holtkamp, B., Steinbuss, S., Gsell, H., Loeffeler, T., Springer, U.: Towards a Logistics Cloud. In: 2010 Sixth International Conference on Semantics Knowledge and Grid (SKG), pp. 305–308. IEEE Computer Society Conference Publishing Services, Los Alamitos (2010)
7. Ten Hompel, M.: IT in der Logistik. DVV Media Group, Hamburg (2012)
8. Pibernik, R., Isermann, H.: Flexibilitätsplanung in Wertschöpfungsnetzwerken. Deutscher Universitäts-Verlag, Wiesbaden (2001)
9. Hernández, R., Wiendahl, H.-P.: Die wandlungsfähige Fabrik – Grundlagen und Planungsansätze. In: Kaluza, B., Blecker, T. (eds.) Erfolgsfaktor Flexibilität – Strategien und Konzepte für wandlungsfähige Unternehme, pp. 203–227. Schmidt, Berlin (2005)
10. Möller, N.: 212 Bestimmung der Wirtschaftlichkeit wandlungsfähiger Produktionssysteme. Herbert Utz Verlag, Munich (2008)

11. Blumenau, J.-C., Kotz, T.: Wandlungsfähigkeit auf Abruf – Bedarfsgerechte Gestaltung und Bewertung stückzahlflexibler Produktionssysteme für die Massenfertigung von Hochleistungserzeugnissen. ZWF Zeitschrift für wirtschaftlichen Fabrikbetrieb 1-2, 42–45 (2005)
12. Klingebiel, K., Winkler, M., Klaas, A., Laroque, C.: A Cross-Level Approach to Planning Changeability in Distribution Systems. Article Accepted for Publication. In: Spring Simulation Multi-Conference (SpringSim), Orlando (2012)
13. Kuhn, A., Klingebiel, K., Schmidt, A., Luft, N.: Modellgestütztes Planen und kollaboratives Experimentieren für robuste Distributionssysteme. In: Spath, D. (ed.) Wissensarbeit, Schriftenreihe der Hochschulgruppe für Arbeits- und Betriebsorganisation e.V. (HAB), pp. 177–198. GITO-Verlag, Berlin (2011)
14. Berkholz, D.: Wandlungsfähige Produktionssysteme – der Zukunft einen Schritt voraus. In: Nyhuis, P., Reinhart, G., Abele, E. (eds.) Wandlungsfähige Produktionssysteme, pp. 13–18. Impressum Verlag, Hamburg (2008)
15. Schuh, G., Berlak, J., Gottschalk, S., Kampker, A.: Design for Changeability (DFC) – Das richtige Maß an Wandlungsfähigkeit finden. wt Werkstattstechnik online 94(4), 100–106 (2004)
16. Klingebiel, K., Kuhn, A.: Planning Changeability in Distribution Systems. Article Accepted for Publication. In: 6th International Scientific Symposium on Logistics, Hamburg (2012)
17. Bertsch, S., Nyhuis, P.: Wandlungsfähige Produktionslogistik. ZWF Zeitschrift für wirtschaftlichen Fabrikbetrieb 9, 630–634 (2011)
18. Klingebiel, K., Toth, M., Wagenitz, A.: Logistische Assistenzsysteme. In: Pradel, W.H., Süssenguth, W., Piontek, J., Schwolgin, A. (eds.) Praxishandbuch Logistik, Section 2.2.10, Fachverlag Deutscher Wirtschaftsdienst, Cologne (2010)
19. Barret, M.: Understanding the Meaning of Collaboration in the Supply Chain. Supply Chain Management – An International Journal 9(1), 30–42 (2004)
20. Buyya, R.: Cloud Computing and Emerging IT Platforms Platforms: Vision, Hype, and Reality for Delivering Computing as the 5th Utility. Future Generation Computer Systems 25(6), 599–616 (2009)
21. Fleischmann, B.: Distribution and Transport Planning. In: Stadtler, H., Kilger, C. (eds.) Supply Chain Management and Advanced Planning, pp. 231–246. Springer, Berlin (2008)
22. Dostal, W., Jeckle, M., Melzer, I., Zengler, B.: Service-orientierte Architekturen mit Web Services. Spektrum Akademischer, Munich (2009)
23. Toth, M., Wagenitz, A.: Logistical Assistant Systems for Effective Supply Chain Planning. ASOR Bulletin 29(2), 3–14 (2010)

Supply Chain Execution Supported by Logistics IT Services

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Abstract. The ever increasing dynamic nature of logistic networks has strengthened the demand for versatile IT systems that can be adapted to constantly changing environments. The planning and control systems currently in the market are usually very rigid and time consuming to customize. This paper presents how customizable IT services for the capture and near real-time order management of logistics processes are identified and developed. Using the Plug & Control Center, services can be run on a cloud platform making it possible especially for small and medium-sized enterprises to have access to these service-oriented services. The development, IT implementation, and validation of the Plug & Control Center are within the scope of the joint project Supply Chain Execution of the EffizienzCluster LogistikRuhr, which includes two use cases from the furniture industry.

Keywords: Supply Chain Execution, Order Management, IT Services, Logistic Assistance System, Premium Service, Decision Support Systems, RFID, Sensors.

1 The Challenges in Managing Supply Chains

Logistics has become more and more dynamic in recent years. Companies are now focussing on their core competencies and the added value that they can bring to upstream and downstream supply chain partners, all of which strengthen the importance of collaboration. Moreover, the need to address individual and growing customer requirements through improved material and information flows is greater than ever. To ensure that added value processes are focussed on the needs of the end customer, companies have to restructure their existing processes in such a way that the entire supply chain is taken into consideration. The abundance and complexity of information that results from this integrated approach can only be managed using suitable IT decision support tools that can be adapted to constantly changing environments [1, 2].

The goal of the joint project Supply Chain Execution of the EffizienzCluster LogistikRuhr (Leading-Edge Cluster) is to develop a cross-company logistics

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solution, for the challenges described above, that facilitates the control of order processing and material flows. The primary research objective is to develop customizable, adaptive control systems that enable interoperability in cross-company collaboration. The communication between the IT systems across the entire supply chain should facilitate an integrated, complete, and continuous evaluation of operational decisions. Furthermore, the potential for using Auto ID technology [3] with mobile output devices at the control levels needs to be fully exhausted. The focus of the research work is on the Logistic Assistance System (LAS) as a computer-aided decision support for order management [4, 5]. This should be available on a service-oriented platform (cloud ready) and enable especially small and medium-sized enterprises to create networks within supply chains [6].

This paper describes the design and development of an IT services toolkit that can be configured for customizable LAS for the management of supply chains.

2 Requirements for an IT Toolkit for Managing Supply Chains

A module with universally applicable components for the operational capture (Premium Services) and control (LAS Services) of materials flows is being developed within the scope of the joint project Supply Chain Execution. This toolkit is available through the "Plug & Control Center" (see fig. 1) and follows the control philosophy of the Internets of Things. The services are web-based and can be used by mobile devices or other systems on the network.

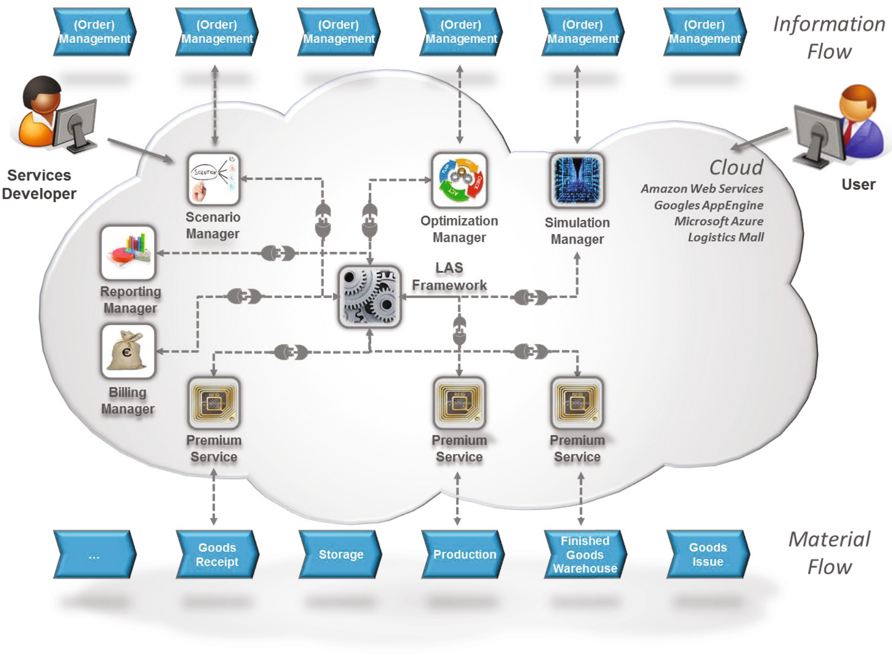

Fig. 1. Plug & Control Center

This chapter describes the steps necessary to develop and implement the Plug & Control Center. These steps involved the identification of points in logistics processes for effective control, the determination of components for the near real-time control of supply chains, as well as the formulation of technical requirements for the interfaces of the services and the infrastructure required to run the services.

2.1 Control Points

The control points in the supply chain are the branches in the flows of material that control the events. Measurement data is captured at these selected points in the supply chain and analyzed to determine the condition or quality of the product or step in the process.

In order to identify the control points in a production chain, the processes first have to be divided into subprocesses from which measurement data will be captured. It is important to ensure that the data capture services (Premium Services) are integrated properly throughout the production flow. Once all of the control points have been identified, all of the processes at those points are evaluated.

2.2 Requirements for Data Capture Services (Premium Services)

In general, data capture services locate, identify, and analyze the status of the components, which are geared towards physical material flows.

Different sensors can be used to capture the required measurement data. RFID technology [3], cameras, or laser measurement systems can be used to identify the components. The benefit of using cameras is that they can also show the quality of the product such as the colour scheme or other optical features.

To be able to assign a specific quality criterion to sensor data, it must be possible to assign a sensor. For this reason, each sensor that is used to capture data must have an ID. After all of the information about a subprocess step has been captured, it has to be consolidated into a Key Performance Indicator and the criteria calculated in this manner has to be transmitted to the primary decision support system along with the identification of the component. The type of component condition, which can be monitored, can be clearly distinguished for each use case. One possibility might be to calculate a quality score that can be used to identify a component or to monitor a certain feature.

2.3 Control Services Tasks

The decision-making process is used as the basis for the development of the control services. According to Kuhn [7] and Keßler [8], the decision-making process can be divided into three subprocesses. The requirements of these subprocesses form the basis for the necessary services [9]:

Subprocess I – Decision preparation:

- Provide transparency of the relevant data for the logistics processes
- Measure and analyse the conditions, system loads, performance, and costs
- Near real-time capturing of information

- Output decision-relevant Key Performance Indicators for the condition of the supply chain
- Determine and output deviations from specified performance and capacity margins

Subprocess II – Decision making:

- Identify potential measures that lead to the desired adaptation
- Prepare short-term control measures in the form of alternative decisions
- Perform dynamic analysis of the future development of the system to create transparency in production and logistic networks
- Determine the Key Performance Indicators that are relevant for decisions

Subprocess III – Implement and monitor the decisions:

- Create transparency for the traceability of decisions
- Implement the selected alternative decisions
- Generate a revision as feedback for the decisions that were made

This decision-making process describes above is used in Logistic Assistance Systems. Nevertheless, LAS do not aim replacing human beings. They rather constitute a decision support, providing a decision basis. Therefore, human strengths such as intuition, experience and creativity are still relevant factors during making a decision. [10]

2.4 Technical Requirements for the Service Interfaces and Infrastructure

The general requirements for the infrastructure of the Plug & Control Center are to facilitate the interoperability and configurability of the services and to ensure that the services are cloud ready and can be run on different platforms, such as the Logistics Mall.

The requirements for configurable control systems on the basis of the services aim at a service-based and loosely coupled infrastructure of the Plug & Control Center. The prerequisite for this and for the reusability of the services of the Plug & Control Center – especially the control services (LAS Services) – is specified in the description of the service interfaces, which have to support standard business objects for the management and exchange of data. Another requirement for the service-based infrastructure is the execution of the communication between the suppliers and customers, who are not usually operating in sync. To ensure interoperability and decentralized control, the systems also have to be cloud ready. The goal here is to implement the service-based, configurable Logistic Assistance System using services that are cloud ready.

3 Development and Usage of Services and the Plug & Control Center in the Furniture Industry

The furniture industry, with its high quality, custom products (for example, surface quality and gage), is a perfect example of the requirements for the new logistics paradigm: individuality, security of supply, sustainability, and resource efficiency. The resulting high demand for control support was used as motivation in the joint project Supply Chain Execution to use the furniture industry as an example and to develop the services and the Plug & Control Center together with two furniture manufacturers.

The use case taken from the project contract represents the quality control process in the manufacturing of pieces of furniture. Sensors were used to capture information about the quality of the boards used for cupboard doors. The captured data was provided in near real-time to the decision maker (for example, in production). If the actual quality deviated from the expected quality, the decision maker could use the control services as decision support to control and monitor the entire material flow.

This chapter will describe the steps used to identify the control points in the furniture production chain that led to this use case. It will also explain the design and development of the individual services used for the operational capture (Premium Services) and control (LAS Services) for quality control process use case. Lastly, the chapter will describe the infrastructure of the Plug & Control Center.

3.1 Identification of Control Points

The first step of the research project involved the analysis of the supply chain of the project partner from the furniture industry: starting from the lumber mill and going right up to the shipping department of the furniture store. The results of the analysis were used to identify those control processes with the biggest influence and cause and effect relationships. These were the control points for the quality control performed during production as well as the final assembly of the furniture. These process steps were chosen in order to show how to react to poor quality semi-finished or finished goods without large expenditures in time and money while still satisfying all customer demands.

A comparison was made between these control points and ones found in industries with similar high requirements for quality (for example, the automobile industry). One of the results of this comparison was the development of a generalized process concept that serves as a reference for defined control tasks in the supply chain.

3.2 Design and Development of Data Capture and Control Services

Several different services were identified that could be used to support the different tasks associated with the decision-making process described in chapter 2.3. Using the transparency provided by the Premium Service as a basis, decision support tools to help handle the occurrence of poor quality were made available through the LAS control services. By controlling the supply chain, the decision maker is given the opportunity to intervene in the manufacturing process to rework or exchange an inferior part. For example, a board that is meant to be used as a cupboard door can be used for the rear wall of a cupboard. The result is that the piece of furniture is still high quality and resources have been used efficiently. The following sections describe the design and prototypical implementation of the services and explain what control task they support.

1. Premium Service (Decision preparation):
   Premium Services are a collection of individual services, used for the identification and data capture of multiple sensors, that are aggregated by the Premium Service into, for example, a quality score. Premium Services are responsible for the platform-independent communication with the sensors and provide the LAS Services with a standardized interface using web services. The quality parameters can be easily modified in the Premium Service. The capture of sensor data is performed completely transparently for the LAS Service.

2. LAS Service “Monitoring Manager“ (Decision preparation):
   The Monitoring Manager performs the near real-time IT capture and monitoring of the quality information from the Premium Service. This information is transformed into business objects when it is retrieved by the control service and thereby linked with a specific item of wood or production order. Predefined plan values can be used to compare the captured and identified quality score of a board.

3. LAS Service “Scenario Manager” (Decision making):
   In the case of deviating quality in a test process, the Scenario Manager provides the decision maker with a list of all control options. Depending on the severity of the quality defect, it might be possible to forego any rework. It is also possible to rework the identified defect directly in the production line or, if it is a very severe quality deviation, take it out of production and rework it outside of the line. If rework is not possible, an alternative part can be allocated for use. The defective part can be assigned to another order and used in another spot. Once a scenario has been selected, a simulation of the selected control measure can be performed to see the future impact of the decision (see Simulation Manager).

4. LAS Service “Simulation Manager” (Decision making):
   The Simulation Manager uses historical data or proposed decision alternatives from the Scenario Manager to simulate decisions and visualize their impact. A new production schedule is generated based on the selected decision as well as the current existing and forecasted orders. The current and future requirements for parts are presented in the form of Bills of Materials or parts lists. These can be used to simulate the future conditions in the supply chain.

5. LAS Service “Optimization Manager” (Decision making):
   The Optimization Manager optimizes the restructuring of existing orders. In accordance with the plan sequence, predefined plan values for requested delivery dates or production runs can be adapted to and optimized for unforeseen changes (for example, a lengthy rework of a piece of furniture or a last-minute cancellation of an order that is already being processed).

6. LAS Service "Execution Manager" (Decision implementation):
   The Execution Manager facilitates the self-control of the supply chain by invoking one or more services in a specific sequence. Beginning with a quality test by the Premium Service, the Monitoring Manager determines if a quality defect is present. If this is the case, the Scenario Manager is automatically invoked and creates a list of all possible decisions based on predefined plan values. These control options are taken by the Simulation Manager and are simulated. The Reporting Manager checks the results of the simulations. The Execution Manager makes a decision from the generated results based on predefined and prioritized Key Performance Indicators and implements the selected control alternative through the connected management system. This service implements the self-control of the decision implementation.

7. LAS Service "Reporting Manager" (Decision implementation and monitoring):
   The Reporting Manager can be used to retrieve order-related reports. First the desired report type is selected (for example, throughput time of orders or stock overviews) and then other options can be specified such as item, orders, time period, and report display options. Restrictions and threshold values, for identifying areas, can be specified for some report types.

8. LAS Service "Decision History Manager" (Decision implementation and monitoring):
   This service documents the decisions that were made. All relevant information used to make a decision, including order-related data, is saved from the Scenario und Simulation Manager. The goal is to provide traceability for the decisions that were made because of defective quality for other instances. This information can also be used as a reference for future decisions. All decisions that represent an unscheduled intervention in the material flow can be documented. These documented interventions can be used as reference information and aid in future decision making.

9. LAS Service "Revision Manager" (Decision implementation and monitoring):
   The Revision Manager links decisions that were made and documented with the Decision History Manager with incoming complaints. This type of information from downstream supply chain stages allows for reflections on the impact as well as the monitoring of decisions that were made.

10. LAS Service "Quality Assurance" (Decision implementation and monitoring):
    The Service "Quality Assurance" is the quality-related equivalent of the Reporting Manager. This means that the retrievable reports focus on the quality defects that occurred. The type, number, and length of the rework carried out in the past in a specific process step serve as a reference for future decision making about the control of the material flow when the same or a similar quality defect occurs.

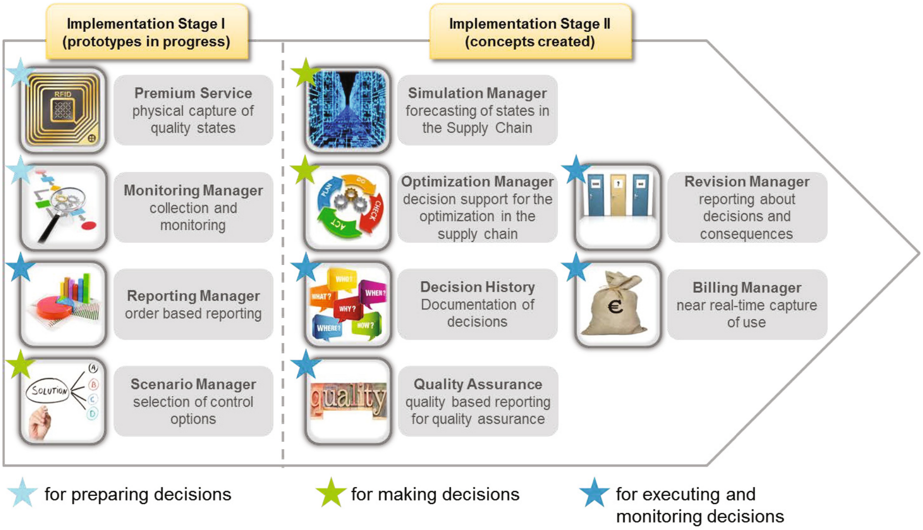

Fig. 2. Overview of Control Services

To enable the standardized exchange of data between the services and, thus, ensure that the targeted interoperability of the services was achieved, a uniform data standard was designed based on the Open Applications Group Integration Specification (OAGIS 9.4). The design and development of this standard was done in collaboration with associated projects such as the Logistics Mall and the LaaS joint projects. The goal of the working group is to define standard Business Objects (BOs) that can be used to standardize the exchange of data between the services and the interfaces and make them interoperable. The business objects defined by the working group appear in the input and output of the services. The current OAGIS standard is not really suitable for the existing tasks and does not meet all of the requirements for developing the services.

3.4 Infrastructure of the Plug & Control Center

The services of the Plug & Control Center can be divided into two categories: producing services (Premium Services) and consuming services (LAS Services). The Premium Services and LAS Services follow the supplier-consumer paradigm [11], in which the captured Premium Services data is made available for processing and analysis in remote LAS Services. The LAS Services need access to the captured data to process the operational data. The Service Registry (as a part of the LAS framework) was developed for this purpose and it provides a link between the two types of services without requiring identification or processing information. Premium Services register with the Service Registry as a supplier and the Logistic Assistance System registers as a consumer. The Service Registry establishes the link between the services so that the data requests from the consumer are automatically received by the Service Registry. The Service Registry can provide the requested data in two modes.

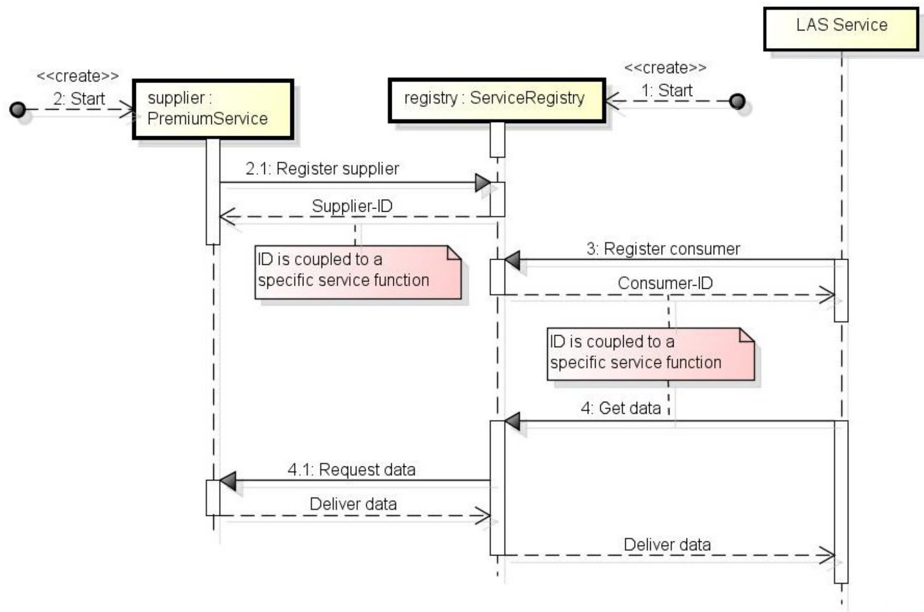

Fig. 3. UML Sequence Diagram of the Plug & Control Center Infrastructure

In the first variant, the data is pulled directly by the Producer Service (Pull Services) and in the second variant the Producer Services push the data to the Service Registry (Push Services) and it is immediately made available when requested.

The principle of Component Based Development was used to implement the configurable Logistic Assistance System Services of the control system. In this paradigm, the LAS Services are reusable components [12] and business objects are used to define their interfaces. The defined interfaces and the component-based approach make the LAS Services both individually configurable and orchestratable for specific customers. In adherence with Component Based Development, the communication between the control services of the Logistic Assistance System and the Service Registry was implemented through an interface component in the Logistic Assistance System.

The cloud computing model Software as a Service (SaaS) [13] was used to ensure that the Logistic Assistance System Services can be used by customers in the cloud. The minimal requirement for the Logistic Assistance System for the cloud (for example, in a cloud-based platform such as the Logistics Mall) is the description of the cloud services that the customers can use [14]. The description of the services can be done using a known standard such as the Web Services Description Language (WSDL). The Logistic Assistance System has to be run as a service in the corresponding application server. The operability in the cloud together with the described services for the customer provides the basis for the development of web applications that can be used by mobile devices. The Logistic Assistance System can run as a web application and use the services offered in the cloud.

4 Initial Conclusions on Prototypical Implementation and Validation

The use cases of the furniture industry provide practical requirements for solution development and real scenarios for testing and validating the results.

Premium Services are usually characterized by the consolidation of data from multiple sensors. One individual measurement criterion could be used to validate and analyse the Premium Services.

For this reason, disjointed Premium Services in the material flows of the participating project partners from the furniture industry were used for validation.

High-volume tests for identifying the individual components confirmed the practical use of RFID technology. RFID transponders were integrated into the production of edge-glued panels because these are used in the production of all furniture. Some of the transponders used in the high-volume tests reached an identification rate of > 99%.

Another decision point within the production process was in the surface quality of the furniture component. Sensors for identifying knotholes and colour schemes with the help of camera systems were tested in operation for measuring quality. The sensors were used during production to validate the evaluation algorithm of the Premium Service.

A distributed testing environment with a prototype of the Service Registry was used to validate the Service Registry, the Logistic Assistance System, and the Premium Service. The Premium Service made data available to the Service Registry. The Logistic Assistance System prototype was limited to the simple monitoring of the captured quality information from the Premium Service: it communicated with the Service Registry through an interface component in the Logistic Assistance System. The data pulled through this interface component was made available to the LAS Services (for example, the Monitoring Manager). The data was prepared for the interfaces of the LAS Services. The tests were supposed to provide the initial conclusions about the functionality of the Service Registry, the interface component of the Assistance System to the Service Registry, and the interaction of the components in a distributed environment.

The test results have shown that the fundamental functionality of the Service Registry (register and unregister the consumers and the producers as a Pull Service as well as receive data) was successful. The results of the tests were also positive for the communication of the Logistic Assistance System Services with the Service Registry and the interaction of all components in a distributed testing environment.

5 Outlook

The information presented in this paper represents the results from the first half of the project. The next step of the project involves the implementation of the LAS Services (for example, the Monitoring Manager) based on the described functionality and UML and design class diagrams as well as a component for generating business objects from data sources for the Logistic Assistance System. This step also involves the development of web front-ends for interaction with the LAS Services.

The functionality of the Service Registry will be expanded to include the use of Push Services. More work will be done on non-functional requirements such as increasing the robustness of the components so they can remain operational under unforeseen circumstances. Other services will be tested in the form of prototypes and validated using use cases in the furniture industry.

The software solution described in the previous chapters provides multiple benefits for both the vendor and the user. The interoperability and customizability of the services and the infrastructure mean that they can be used in other industries in the future and duplicated as often as desired. It is realistic to assume that it will be possible to implement the solution in industries that have a high standard for product quality. The standardization of data means that it can be implemented quickly in companies and it will be easy to communicate and work with other companies in the supply chain.

References

1. Buchholz, P., Clausen, U.: Große Netzte der Logistik. Springer, Heidelberg (2009)
2. Finlay, P.N.: Introducing Decision Support Systems, p. 274. Blackwell, Cambridge (1994)
3. Fleisch, E., Mattern, F.: Das Internet der Dinge: Ubiquitous computing und RFID in der Praxis Visionen, Technologien, Anwendungen, Handlungsanleitungen. Springer, Heidelberg (2005)
4. Klingebiel, K., Yüzgülec, G., Wagenitz, A.: Supply Chain Execution. Logistik Heute, 56–57 (June 2011)
5. Klingebiel, K., Toth, M., Wagenitz, A.: Logistische Assistenzsysteme. In: Pradel, W.H., Süssenguth, W., Piontek, J., Schwolgin, A. (eds.) Praxishandbuch Logistik, Fachverlag Deutscher Wirtschaftsdienst, Section 2.2.10, Cologne (2010)
6. Kuhn, A., Hellingrath, B., Hinrichs, J.: Logistische Assistenzsysteme. Software der Logistik (2008)
7. Kuhn, A.: Simulation großer Logistik-Netze. In: Fertigungstechnisches Kolloquium Stuttgart (2008)
8. Keßler, S., Schmidt, A., Wagenitz, A.: Intelligente Logistik in großen Netzen, LIFIS Online, `http://www.leibniz-institut.de/archiv/kessler_08_03_10.pdf`
9. Rudolph, S., Böhmann, T., Krcmar, H.: Struktur von IT-Servicekatalogen: Ein praxisorientierter Gestaltungsvorschlag für die Dokumentation des IT-Leistungsangebots. In: Multikonferenz Wirtschaftsinformatik, Munich (2008)
10. Schneider, M.: Assistenzsystem zur Strategiefestlegung in der Anlaufplanung. Verlag Praxiswissen, Dortmund (2006)
11. Vandal, P.J., Gokhale, S.S., Gokhale, A.S.: Performance Analysis of the Active Object Pattern in Middleware. In: 'SEKE', Knowledge Systems Institute Graduate School, pp. 730–735 (2007)
12. Szyperski, C.: Component Software: Beyond Object-Oriented Programming. Addison-Wesley Longman Publishing Co., Inc, Boston (2002)
13. Baun, C., Kunze, M., Nimis, J., Tai, S.: Cloud Computing - Web-Based Dynamic IT Services. Springer, Heidelberg (2011)
14. Buyya, R.: Cloud Computing and Emerging IT Platforms Vision, Hype, and Reality for Delivering Computing as the 5th Utility. Future Generation Computer Systems 25(6), 599–616 (2009)

Service Design Studio for SaaS

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Abstract. The aim of the Service Design Studio project is to provide methods and tools to enable the deployment of existing software in cloud environments based on the Software-as-a-Service (SaaS) model. As the project focuses on logistics IT services, the approach is contributing to a new 'Logistics-as-a-Service' offering. This article provides a description of the requirements analysis for enabling logistics IT services to be offered in cloud environments, the concepts for the necessary methods and tools, and the implementation of a proof of concept Service Design Studio environment.

Keywords: Cloud Services, Software-as-a-Service (SaaS), Logistics-as-a-Service (LaaS), Aspects, Security, Billing, Interceptors, USDL, EffizienzCluster, Cloud-oriented service-marketplace.

1 Introduction

The German logistics market consists of small and medium sized enterprises (SME) with an average size of 50 staff. Therefore thousands of logistics companies have little or no IT capacities and competences besides operating their own IT resources [1]. At the same time logistics is a cost factor for industry and trade which leads to logistics outsourcing to benefit from scale effects and synergies.

This way the market for logistics services has developed from classical transport – transhipment – warehousing services towards a growing market of more individual and more complex services. The annual study of the logistics outsourcing market shows a continuing opportunity for IT-based logistics services [2]. Today's logistics customers require individualized logistics services with a flexible and broad service spectrum, individual logistics processes and value-added services, transparency of costs and performance and short-term contracts.

The strict service-oriented design methodology of IT-systems targeted by Logistics-as-a-Service is the scaffolding for the provision of lean, cost-aware and fast operable solutions. In particular SME achieve transaction based, on demand access to professional software. These cloud based services can be individually integrated in the enterprise IT-landscape.

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 229–236.
springerlink.com

The Service Design Studio (SDS) project targets at the development of a web-based tool, which adds domain-specific capsules around existing services. These capsules add non-functional aspects like authentication, authorisation or pricing to services. An existing logistics-IT-service becomes a secured and billable product for cloud offerings, e.g. as Software-as-a-Service (SaaS). SDS copes with the cross-cutting concerns accounting, authentication and authorisation, which are essential for the Future Internet [3].

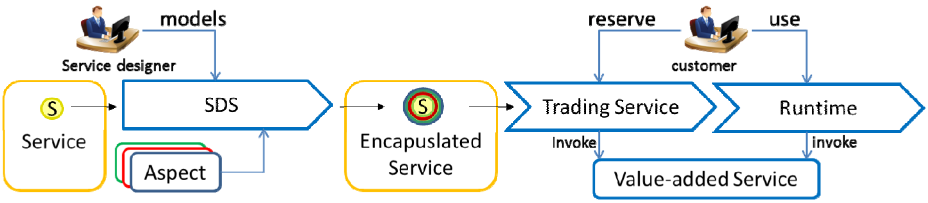

Fig. 1. Workflow to add aspect frames to an existing service using the Service Design Studio. The encapsulated service is exported to a cloud platform as a SaaS offering, invoking value-added services when being called by a customer.

While the functional description of a service is specified in a technical service description language, like WSDL, non-functional aspects must be delivered to a service platform and a service consumer in a different way. Both parts of a service description may be stored in a semantic service description (SSD) language. This semantic service description contains technical, operational and business components. The semantic service description must be interpretable by a service consumer, by the service platform of the service provider and by an enhanced service registry, a so-called trading service.

The semantic service description is designed to be exportable to different marketplaces. So a single service can be deployed to different platforms.

The rest of this paper is organized as follows. In the next section we discuss the state of the art in the research topics service description languages, pricing for services, security for SOA and cloud architectures and available tools for semantic service descriptions. The third section illustrates the specific approach of the Service Design Studio, followed by a section about first results achieved. The paper closes with the current state of this project and an outlook to future work.

2 State of the Art

This section provides a brief summary about the current state of research in the relevant topics for the Service Design Studio.

2.1 Service Description Languages

Nowadays service description languages focus on the technical part of a service without regarding the domain part. Languages like WSDL [4] or WADL [5] contain the required information about the service endpoint and the methods provided. Next to the WSDL specification exists a multitude of specifications like WS-Trust or WS-Policy, which replenish functionality to a service or a service endpoint. These standards are generally referred to as WS*-specifications. The Unified Service Description Language [6] (USDL) on the other hand combines technical, operational and business information about a service in a single service description [7] [8]. Therefore it is composed of different modules which handle the technical, operational and business part of a service. USDL is a W3C Recommendation [9].

2.2 Pricing for Services

Cost reduction is one of the main drivers to build up and offer cloud systems [10]. Different cloud layers (Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS)), deployment models (private, public, hybrid cloud), and roles (operator, provider, consumer) build a multi-dimensional space for building a vast number of combinations for successful business models. Cloud operators and service providers have to ensure that the revenues for their cloud services make up for the business value of the applications, service maintenance and required hardware to host the services (i.e., servers with processing power and storage) [11]. The number of relevant cost factors is large, making a thorough analysis of the resulting overall costs and determination of profitable, yet competitive pricing models a complex task [12].

On the other side, from the customer or consumer point of view, it is frequently demanded that SaaS pricing models are easy to understand and build a clear base of cost calculation [13]. It has to be mentioned that also psychological factors, such as overestimation of usage and avoidance of large bills, even when a fixed fee is more expensive than a usage-based fee over time, have been identified [13]. This has led to the two most frequently applied SaaS pricing models “pay-per-use” and “subscription”, both generally and specifically in the area of logistics services [14][15][16]: In the pay-per-use pricing model, consumers pay a fixed price per “service unit”, e.g., per session, per hour, per volume transferred or stored (e.g. MB), or per CPU-hour. In the subscription pricing model, consumers subscribe to a cloud application service for a fixed price and minimum timing period, e.g., one month or year. This fixed price, however, can be assembled based on different metrics (see below). Sometimes, a subscription is complemented by a limited free-of-charge trial period to overcome consumers' uncertainty about the use of a cloud application service.

From a provider point of view, it is common that a software business wants to offer already existing software also by means of the SaaS model. To do so, the company needs to define profitable, yet competitive pricing models for their software. Here, defining and offering different pricing models for a single application service in parallel, e.g. one subscription-based and one usage-based model, so that consumers can decide themselves which model is most suitable for them. This step also includes defining the metrics, i.e., the main service units and license conditions under which the software may be used.

A billing configuration should be defined once, whereas at deployment time this description is being automatically transformed for each cloud platform. Here, the previously mentioned USDL with its Payment module is highly relevant as a potential candidate for a platform-independent description of payment models [17].

2.3 Security for Clouds and SOA

Security in cloud environments faces some additional challenges compared to traditional hosting. SOA participants are not kept in a firewalled zone but may even be spread on different data centres what requires a better protection of the communication between these participants. There are different types and vendors of cloud services with different APIs, so security cannot be evaluated without in-depth knowledge of the inner workings of the cloud infrastructure. Especially in a PaaS type cloud you depend on the cloud service provider as in charge of most security aspects. New attack vectors in cloud environments are tenant isolation and, especially IaaS clouds, the hypervisor [18] [19]. A multi-tenant environment requires a strict isolation between different customers, so there is no unwanted sharing of data between them. The rise of virtualization technology enabled IaaS clouds. One server can host several virtual servers, where the hypervisor controls the virtual machine's access on system resources. Vulnerability in the hypervisor can allow an attacker to break out of the virtual machine and can take control over the cloud infrastructure.

2.4 Available Tools for Semantic Service Descriptions

Tools available today are basically developer tools for specific technologies, which realise the operational and business needs. Therefore a gap between the domain model and the technical implementation exists. A step to close this gap is USDL. The German THESEUS/TEXO project created an editor for USDL which is available as Open Source Software[1]. The editor provides basic support for the creation of USDL files but gives no support to reduce the vast complexity of USDL.

3 Specific Approach and Methods

The Service Design Studio targets at enabling technologies for cloud-oriented service-marketplaces (CSMP) [20]. A CSMP consists of a cloud-based execution environment, some value-added services, like a billing service, security services or helpdesk services and an enhanced service registry, a so called trading service (see Fig 2). The execution environment can be an IaaS or PaaS system [19]. With the trading service a human or a machine can lookup services by their functional description and by non-functional aspects, like a price model. It provides a shop-frontend like the SDS-Mall or the Logistics Mall [1] for human users and web service related methods for machines. A Cloud Operator is responsible for the provisioning of a service platform and other technical concerns. The Mall Operator on the other hand cares for business concerns and has a contractual relationship to service providers and service consumers. With SDS a Service Provider has the ability to place offerings on different CSMPs, with different customer groups or in different countries. The corresponding service implementation gets deployed to the marketplaces runtime. By

[1] `http://usdleditor.sourceforge.net/`

exporting a service description from the SDS tool to the target CSMP, the CSMP configures the runtime and creates an offering from the information stored in the service description. The service description created by the SDS can be potentially exported to different marketplaces. Therefor the SDS checks if description and target system are compliant.

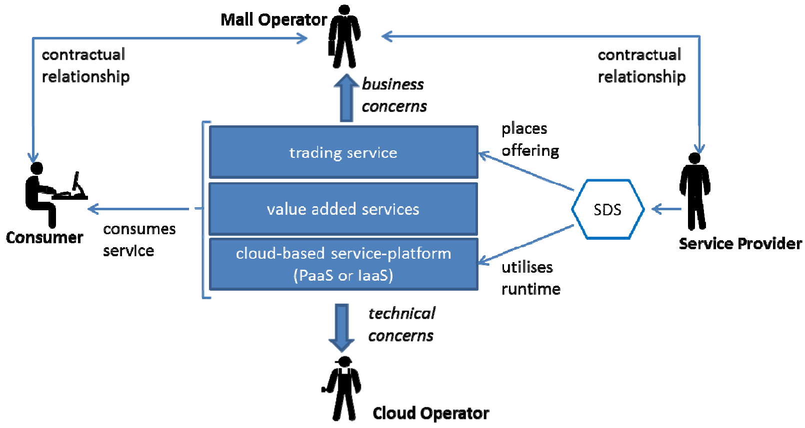

Fig. 2. Simple role model for a cloud-oriented service-marketplace

The SDS tool is a web application that can load a service description and attach the domain capsules to the service. Therefore it uses the sematic service description. The sematic service description contains the technical description of a service, e.g. the WSDL, and the domain description of the service. The domain description is presented to the consumer on the marketplace of the trading service while the technical description is used to establish the communication between consumer and provider. A domain capsule is bound to a service or to a service method as an aspect, which contains all necessary information to display a service on a trading service and to configure the runtime and the value-added-services. Additionally basic information about the target runtimes is stored in the sematic service description. The sematic service description is compliant to USDL and can be transformed to valid USDL.

With aspect templates, a service provider as a user of SDS is able to specify non-functional aspects for a given service, in particular, how the service is secured and billed.

With respect to billing, a dedicated set of billing templates is provided by SDS. When filling these templates, an SDS user is able to choose between different pricing models and methods. From a filled template, an aspect instance can be generated and transformed into a sematic service description supported by the target platform. One service description language supported by the SDS is USDL. Some of the terms used in the aspect templates for billing are in fact directly taken from USDL. For example, an instance of a billing aspect is called a price plan. Each price plan consists of a set of price components, revenue components, and tax components (see Fig. 3). Price components define the service costs, whereas revenue components define how the revenues obtained from the service usage are distributed among the service provider, mall operator, and cloud operator. Country-dependent taxes can be specified in tax components.

Note that several price plans can be attached to a single service. This allows users to select the most suitable price plan when booking a service.

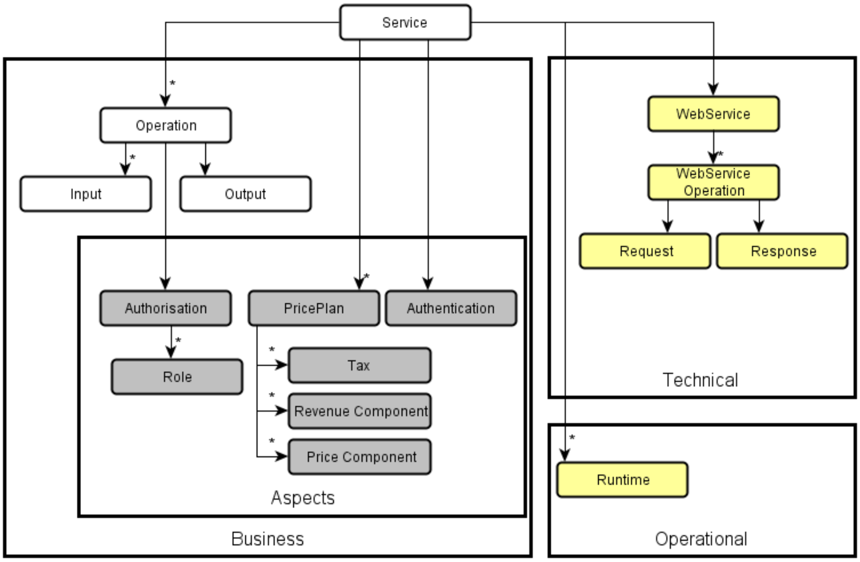

Fig. 3. Simplified structure of the semantic service description with aspects

On the other hand a security aspect predominantly consists of authentication and authorisation. While authentication indicates, that the service consumer must be identified by a security token, authorisation indicates that a user must have the necessary rights to gain access to specific method. Therefore the authorisation aspect must be bound to the service methods. In addition it is necessary to apply secrecy and integrity to the communication of the consumer and the provider. Secrecy and integrity are gained by encryption and digital signatures. All these aspects are reflected in the USDL.

4 First Results

Next to the conceptual results achieved within the project so far, a proof of concept of the SDS tool is already implemented and a reference implementation of a runtime environment is also available. The reference implementation consists of a simple trading service, the SDS Mall, and value added services for authorisation, authentication and billing. The SDS tool is able to load a service from a WSDL file, which can then be encapsulated by aspects. The SDS tool creates an sematic service description and a USDL description of the service. In an export process the service gets deployed to the SDS Mall and to a runtime. The current runtime is based on Apache CXF and Oracle Metro on Amazon EC2. All aspects are mapped to existing web service standards like WS Trust or WS Policy.

For the proof of concept we have not implemented every security aspect. Authentication is defined per service and affects all operations of the service. Method of authentication and token type are standardized so the only setting in the USDL is if authentication is enabled. Authorization is modelled by a role-based access control. Each service operation can have a list of roles defined. A user must be member in any of these roles to be allowed to access the operation. The operations and roles information can be transformed to an XACML-Standard conforming authorization request that is processed by an XACML policy decision point. Encryption and signatures are not in the scope of the proof of concept.

5 Conclusion

This article provides a brief overview over the current state and the methodology of the Service Design Studio. We have outlined the need for a holistic service description language and the relation to the Unified Service Description Language. A holistic service description language stores a technical, an operational and a business part for a service. In the proof of concept implementation we are able to map the holistic service description to a runtime which relies on WS* standards. Other approaches to provide secure and billable services over the Internet are developed in the THESEUS/TEXO project and in the Fraunhofer innovation cluster Cloud Computing for Logistics, the Logistics Mall. USDL is a result of the THESEUS/TEXO project [21]. The Service Delivery Framework, developed as a runtime for USDL in THESEUS/TEXO, is still unpublished [22]. The Logistics Mall project is associated with the Service Design Studio and is a target runtime environment for the Service Design Studio in the next months.

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References

1. Holtkamp, B., Steinbuss, S., Gsell, H., Loeffeler, T., Springer, U.: Towards a Logistics Cloud. In: 2010 Sixth International Conference on Semantics Knowledge and Grid (SKG), November 1-3, pp. 305–308 (2010), doi:10.1109/SKG.2010.46
2. Langley Jr., J.: 2012 Third-Party Logistics – The State of Logistics Outsourcing. In: 16th Annual Study (2012), http://www.3plstudy.com (last accessed May 15, 2012)
3. Wahlster, W., Raffler, H.: Forschen für die Internet-Gesellschaft: Trends, Technologien, Anwendungen, Technical report. Feldafinger Kreis (2008)
4. World Wide Web Consortium WSDL Specification, http://www.w3.org/TR/wsdl20/ (last accessed May 15, 2012)

5. Oracle WADL Specification, http://wadl.java.net/ (last accessed May 15, 2012)
6. SAP USDL, http://www.internet-of-services.com/index.php?id=264 (last accessed May 15, 2012)
7. Cardoso, J., Winkler, M., Voigt, K.: A Service Description Language for the Internet of Services. In: Alt, R., Fahnrich, K.-P., Franczyk, B. (eds.) First International Symposium on Services Science, ISSS 2009 (2009) ISBN 978-3-8325-2169-1
8. Cardoso, J., Barros, A., May, N., Kylau, U.: Towards a Unified Service Description Language for the Internet of Services: Requirements and First Developments. In: IEEE International Conference on Services Computing. IEEE Computer Society Press (2010)
9. W3C, Unified Service Description Language Incubator Group, http://www.w3.org/2005/Incubator/usdl (last accessed May 15, 2012)
10. Stadtler, A.: SaaS-Abrechnung per use, nicht per User, bringt Entwicklungsschub (March 2008), http://www.searchnetworking.de/themenbereiche/management/outsourcing/articles/111122/ (last accessed May 15, 2012)
11. CGI. Cloud billing: The missing link for cloud providers. White Paper, http://www.cgi.com/files/white-papers/cloud-billing-white-paper.pdf (last accessed May 15, 2012)
12. Weinhardt, C., Anandasivam, A., Blau, B., Borissov, N., Meinl, T., Michalk, W., Stößer, J.: Cloud Computing–A Classification, Business Models, and Research Directions. Business and Information Systems Engineering (BISE) 1(5), 391–399 (2009) ISSN: 1867-0202
13. Fishburn, P.C., Odlyzko, A.M.: Competitive Pricing of Information Goods: Subscription Pricing Versus Pay-Per-Use. Economic Theory 3, 447–470 (1999)
14. Michels, J.K.: Abrechnung mit Cloud. In: Information Management und Consulting, vol. (03), pp. 91–93 (2009)
15. Michels, J.K.: Die Abrechnung in der Wolke. In: IT Mittelstand, vol. (06), pp. 25–30 (2009)
16. Berg Insight: The Fleet Management and Wireless M2M, 5th edn. (March 2010)
17. Kiemes, T., Oberle, D.: Generic Modeling and Management of Price Plans in the Internet of Services. In: Informatik 2010: Service Science – Neue Perspektiven für die Informatik, Beiträge der 40. Jahrestagung der Gesellschaft für Informatik e.V (GI), Leipzig, Germany. LNI, vol. 175, pp. 533–538 (2010)
18. Mell, P., Grance, T.: The NIST Definition of Cloud Computing. Special Publication 800-145, http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf
19. Jensen, M., Schwenk, J., Gruschka, N., Iacono, L.L.: On Technical Security Issues in Cloud Computing. In: IEEE International Conference on Cloud Computing, CLOUD 2009, September 21-25, pp. 109–116 (2009), doi: 10.1109/CLOUD.2009.60
20. Stemmer, M., Holtkamp, B., Königsmann, T.: Cloud-orientierte Service-Marktplätze – Integrationsplattformen für moderne Dienstleistungsplattformen und IT-Dienste (Cloud-oriented Service-Marketplaces – Integrationplatforms for moden service platforms and IT services). White Paper (2012), http://www.isst.fraunhofer.de/Images/Fraunhofer-ISST_CSMP-Whitepaper_www_tcm81-98950.pdf (last accessed May 15, 2012)
21. Barros, A., Oberle, D.: Handbook of Service Description. Springer (2012)
22. TEXO – Infrastructure for Web-based services, http://theseus-programm.de/en/914.php (last accessed May 15, 2012)

Business Object Model for Realization of Individual Business Processes in the Logistics Domain

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Abstract. The present paper gives an introduction of a business object model being developed during research of the Fraunhofer innovation cluster "Logistics Mall – Cloud Computing for Logistics". Starting with an overview of the aimed benefits of the business objects model the requirements to this model as well as its architecture are described. Subsequent to this description, the development of the model itself according to a defined process model is presented. The paper closes with the presentation of a governance methodology for the business object model's evolutional extension.

Keywords: Process Modeling, Business Objects, Interoperability, Governance.

1 Introduction

The synergetic combination of logistics and IT has great potential to produce innovative and sustainable solutions for logistics [1]. In particular, the use of cloud computing allows the realization of new utilization forms of logistics software. Cloud computing is not a completely new technology, but by now, the expansion of the necessary technical infrastructure has reached such a good quality that the practical use of cloud computing especially in the field of logistics is practicable and feasible. The smart use of this technology has the potential to create IT solutions that make users benefit from shorter lead times, cost transparency and personalized IT service delivery.

Together with its industry partner Logata GmbH the two Fraunhofer-Institutes IML (Institute for Material Flow and Logistics) and ISST (Institute for Software and Systems Engineering) in Dortmund are working on new sales and provisioning forms of logistics software within the Fraunhofer innovation cluster "Logistics Mall – Cloud Computing for Logistics". The developments of the innovation cluster result in the "Logistics Mall" as a central marketplace providing individual logistics IT services to complete process chains that are offered as products. The concept of Logistics Mall (see Fig. 1) envisions that IT developers as one target group can offer applications and IT services in the cloud. Another target group are Logistics Process Designers.

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Logistics Process Designers are companies that act in the function of integrators and combine existing services in the cloud to a higher-quality offering in the form of business processes. This extends the existing XaaS (“Anything as a Service”) provisioning models to a new level, which can be described as BPaaS ("Business Process as a Service") [2]. The third target group are the logistics customers who can order and consume the Logistics Mall applications, IT services and business processes online. The utilization model behind the Logistics Mall allows the operation of the platform as public cloud or as private cloud [3].

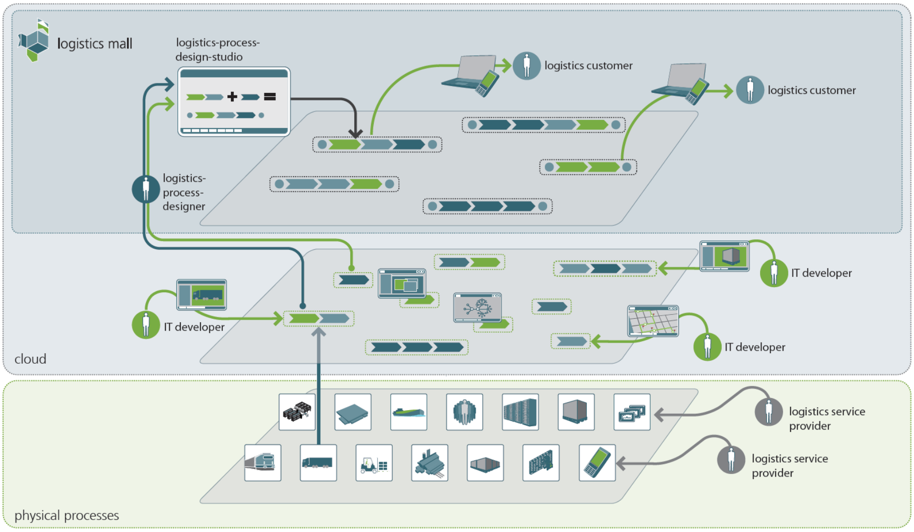

Fig. 1. Logistics service providing in the cloud

Prerequisite for the realization of a platform as the Logistics Mall is the creation of a cross-functional model that standardizes the exchange of information between business process applications syntactically and semantically.

The contribution deals first with the tasks of the business objects and their requirements. After a description of business object utilization a process model is presented that explains the development steps of a logistic business object domain model. Thereafter, a special focus is placed on the governance of the model, since this is an important element for the acceptance of Logistics Mall for providers of logistics IT services.

2 Requirements to Business Objects

Elements supporting the exchange of information between business process applications are the so-called business objects. These objects are building the cross-functional model mentioned above. To be appropriately used in the Logistics Mall business objects have to fulfill specific requirements which are explained in the following section.

As both business users as well as programmers have to deal with business objects there is a need of a functional and a technical representation of business objects at the same time. The functional view supports modeling of business processes on the business process model layer. It is used for identifying the required business objects. The technical view is used for the real communication on the business process applications layer driven by a process engine. The engine coordinates the sequences of the business process applications, it transfers the business objects from one business process application to the next one and it invokes each business process application when the one before has finished.

The architectures of the two business objects views differ in their complexity: The functional view presents a simplified abstract view of a business object only using the most important attributes and, thus, covering less information. The technical view, in contrast, is necessarily characterized by a detailed and complex model. It is featured by many attributes, differentiated values and complex correlations of the attributes according to business objects instances. When using business objects it is a challenge to assure the integrity and synchronization of the functional and technical view; both views have to be consistent and changes have to be made simultaneously.

A key performance element of the processes which are operated throughout the Logistics Mall is the exchangeability of services or business process applications representing these processes. Therefore, both business objects must interoperate with multiple systems or business process applications [4] respectively; and, they must support a standardized integration of different services and business process applications as well as a standardized communication between these services and business process applications.

Finally, another important factor is the continuity of business objects which must be realized throughout their structure. Such continuity enables a consistent development of business objects and it also enables a continuous enhancement and improvement of the objects when changes of the objects are necessary.

3 Utilization of Business Objects

The sophisticated structure of business objects supports the harmonization of the functional and technical views on these objects. Business objects build the basis for the communication of different software elements of the Logistics Mall. Therefore, they describe components which are of functional relevance for logistics processes and which can be structured by a number of attributes [5].

The functional view is represented by a simplified process model. According to this view, the changing of the business objects' state, driven by single process steps, becomes transparent. E.g., on the process model layer the letter of advice is identified as the input business object of the goods receiving process step (see Fig. 2). This process step manages the letter of advice and arranges for its state change. The real manipulation of the business object is done by the related business process application on the business process applications layer.

To realize the usage of business process applications driven by the business processes on the process model layer a mapping of the business process steps to their related business process applications must be established [6]. This mapping is realized throughout the integrated business objects view. The processing of a business object results in the change of specific attributes in its technical view. When an application has finished processing it provides this information to the process engine for invoking the following activity.

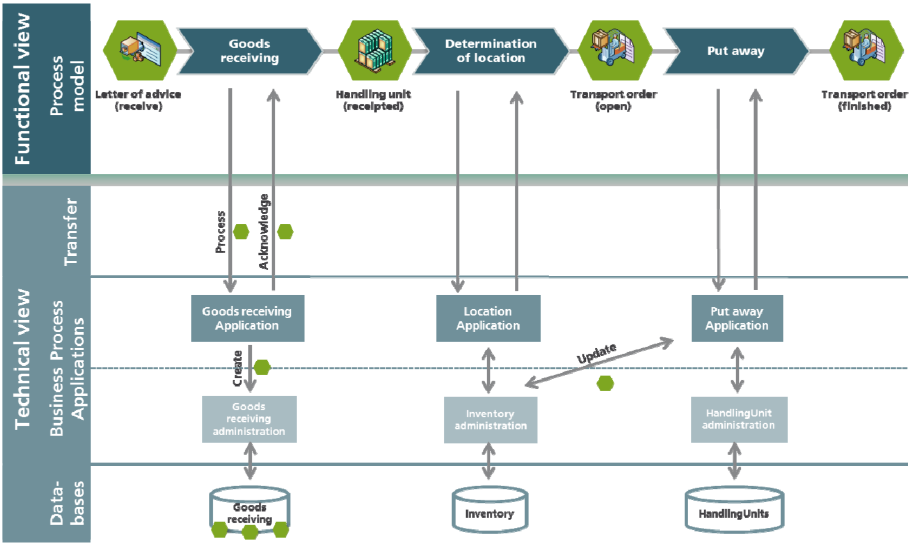

Fig. 2. Usage of business objects across different layers of the Logistics Mall

Also, business process applications themselves can use other business process applications, especially for master data administration. Therefore, they have to communicate with each other. Thus, a business object driven communication between the location application and the inventory administration application is realized during the processing; the handling unit business object is transferred between these two business process applications and manipulated by both of them.

4 Process Model for Developing a Logistic Business Object Model

Developing a data model containing all business objects needed in the herein considered domain of logistics and identifying the existing connections is a complex task. In accordance to the basic understanding in systems and software engineering, a phase based and iterative approach consisting of 5 stages was chosen.

Stage 1: Problem and requirements definition. In the course of this stage typical workshops with experts of considered domain (here: logistics and computer science) are held. As consequence of several workshops, supported by the use of creative methods such as concept card, brainstorming, the above mentioned requirements were identified (see section 2).

Stage 2: Analysis. Goal of this stage is to identify every needed business object within the considered domain. As predominant standards developing organizations like Open Application Group (OAGI) or GS1 have shown with their business document standards OAGIS [7] and GS1 XML [8], the best way to identify business objects is based on scenarios. In this specific case two EffizienzCluster LogistikRuhr scenarios (Supply Chain Planning [9] and Supply Chain Execution [10]) and one Logistics Mall scenario (contracted distributor) were developed and used for business object identification. However, experience within the team of problem analysts has shown that, in order to facilitate business object identification within the Logistics Mall, scenarios should be described on a much more detailed level than e.g. OAGI and GS1 use within their scenarios. This stems from the fact that not only business to business (B2B) communication should be facilitated but also communication between business process applications with one application being just a small fraction of today's range of functions of a Warehouse Management System (WMS), i.e. receiving (as shown in Fig. 2).

Stage 3: Design. Within this stage, identified business objects are designed. In this context design means, first the modeling of the business object´s interconnections (associations) and, second the definition of its attributes. Revealing interconnections is thematically very closely linked to stage 2 and may lead to frequent returns and reassessment of its findings. Therefore, it seems to be more efficient in terms of design efforts to first create interconnections and then to design the object itself in more detail. Certainly, the object´s attributes are closely related to the scenarios. Again, scenarios play a key role in this stage. But even though they are inevitable, they should be enhanced with information provided by existing standards in order to gain completeness of attributes – as far as possible. In case of the Logistics Mall, well-established business document standards (OAGIS [7]; GS1 XML [8]; EDIFACT [11]; openTRANS [12]) were chosen as reference.

Stage 4: Evaluation and Prototyping: This stage includes the transfer of the – up to this point – strictly functional model into a technical one. The functional model is built to support logistics process designer, and therefore represented by easily readable and accessible UML diagrams. In contrast, the technical model bases on XML-schema and is used for data transfer, for database design and within business applications (see Fig. 2). To implement a technical domain model a whole new set of tools and methods is needed. These go beyond the scope of this paper and should therefore not be illustrated explicitly here.

Stage 5: Maintenance. It is clear that no model is comprehensive and faultless right from the start – no matter how smart and thoroughly the design process is. Maintenance is therefore a key element of every process model and every model´s life cycle. The way this is managed by governance will be explained within the next section.

5 Governance

The set of business objects and their associations form a data model of the logistics domain. However, it is impossible to completely represent this complex industry with all its sub-disciplines. These circumstances led to a scenario-based approach for defining business objects (see section 4). Furthermore, practical experience proved that such domain models are subject to change as frequently as the domain itself. Hence, a fundamental assumption is that the business object model is experiencing permanent development.

Dealing with the change becomes a crucial challenge. The process of development requires guidance and control. This is exactly what governance of the object model aims at. It is incorporated into a „technical ecosystem", defining the concept of governance, identifying its inner actors and technical components and linking those by activities. Several policies apply to this ecosystem like a versioning specification or process instructions for changing the definition of a business object.

5.1 The Ecosystem

Governance denotes the responsible and sustainable organization and control of activities and resources regarding the business object model to aspire long-term benefit [13].

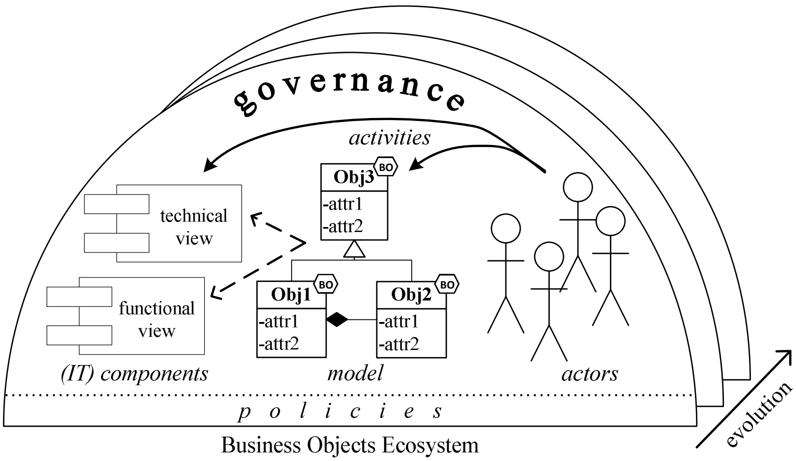

Fig. 3. Business Object Ecosystem

Resources can be subdivided into human actors, the business object model and (IT) components. Because all roles listed in Fig. 3 work with those business objects, they are incorporated into the ecosystem as users (stakeholders). Besides, two more groups of actors have been identified, people who actively develop the model (developers) and a board deciding in case of doubt or conflicts. Without such a board the process of development would certainly become ineffective due to the heterogeneous participants and their conflicting intentions. The business object model affects several (IT) components, which in most cases are artifacts of the overall Logistics Mall. The functional and technical views on the model are of great significance in this context because of their mutual dependencies.

Interactions among resources are represented by combining specific resources with an activity to form a use case. Amongst others the following activities have been identified: development, maintenance, implementation, testing and publishing of the model.

5.2 Evolution

Everything in the ecosystem will change over time. These changes occur on two different levels. Modifications of the business object model or their dependent components are considered to be substantial (content level). Controlling these is the main purpose of the ecosystem. But, in case a policy changes or a new activity is added, change takes place on a meta level. The ecosystem can control itself by corresponding (meta) policies, e.g. a policy on modifying content-level policies. Because the focus certainly is on the evolution of the business object model, it is the change process based on [14] that is briefly presented here. Amongst others it applies to the activities of development and maintenance.

Phase 1: The change request. The process already starts with the necessity to change the model. This can be expressed by every arbitrary combination of the following actions involving one or more business objects: Adding a new attribute / association, modifying an existing attribute / association, deleting an existing attribute / association. All developers within the ecosystem (see above) are eligible for submitting their suggestions to the board. The board then checks the technical and functional compatibility with the existing model. Besides, the decision on the approval can be influenced by strategic and economic aspects.

Phase 2: Realization. In case of approval, the changes are implemented into the business object model. The process of implementation is again subject to policies, containing rules and maxims set up for a consistent and high-quality result, independent of the individual performing the changes. The main result of this phase is a new business object model. Due to the dependencies new (versions of the) components are produced as well.

Phase 3: Quality Assurance. During this phase the board checks the compliance of the implementation regarding the policies of phase 2. In case discrepancies are found phase 2 is performed again. When the new model and the components are finally approved, they can be published.

Phase 4: Publish. A new release of the business objects is made available to the users of the ecosystem (respectively the Logistics Mall). However, not every implemented and approved change request will result in a new release. Changes performed within a certain period of time are combined into a single release.

There are important aspects to be considered for the process of evolution that were not mentioned here. All these are covered by dedicated policies. Examples are versioning and the lifecycle of a release or version.

6 Conclusion

For a syntactical and semantical standardization of the exchange of information between business process applications there is a need of a cross-functional business object model. This model is presented in this paper. Based on the expected benefits of the business objects model the requirements for this model as well as its architecture are described. The development of the business object model according to a specific domain follows a structured process model following defined process stages. To keep the business object model up to date there is a need of a governance methodology for its evolutional extension. Therefore, an ecosystem is presented which shows the interrelations of activities, components, models and actors. Based on this presentation the evolutionary extension of the business object model or its dependent components is described. This extension follows four defined phases which guarantee structured changes according to specific policies.

References

1. ten Hompel, M., Meinhardt, M., Lippmann, T.: Cloud Computing für Logistik. Akzeptanz zur Nutzungsbereitschaft der Logistics Mall bei Anwendern und Anbietern. Fraunhofer Verlag, Stuttgart (2011)
2. Terplan, K., Voigt, C.: Cloud Computing. mitp/Verlagsgruppe Hüthig Jehle Rehm GmbH, Heidelberg, München, Landsberg, Frechen, Hamburg (2011)
3. van der Molen, F.: Get ready for Cloud Computing. A comprehensive guide to Virtualization and Cloud Computing. Van Haren Publishing, Zaltbommel (2010)
4. Weske, M.: Business-Objekte: Konzepte, Architekturen, Standards. Wirtschaftsinformatik 41,1, 4–11 (1999); Wiederverwendbare und erweiterbare fachliche Komponenten für Anwendungssysteme. Wiesbaden, Vieweg (1999)
5. Patton, J.: Hierarchically Managed Attributes. In: The 11th Conference on Pattern Languages of Programs (PLoP 2004), Allterton Park, Monticello, Illinois, September 8 -12 (2004), http://www.agileproductdesign.com/writing/hierarchically_managed_attributes.pdf
6. Hentrich, C., Zdun, U.: Patterns for Business Object Model Integration in Process-Driven and Service-Oriented Architectures. In: Proceedings of the 2006 Conference on Pattern Languages of Programs. ACM, New York (2006)
7. Open Applications Group (OAGi): Open Applications Group Integration Specification (OAGIS) Release 9.0., http://www.oagi.org/oagis/9.0/
8. GS1 Germany – Anwendungsempfehlung, ECR Informationsfluss Logistik
9. EffizienzCluster LogistikRuhr: Verbundprojekt Supply Chain Planning, http://www.effizienzcluster.de/index.php?id=135
10. EffizienzCluster LogistikRuhr: Verbundprojekt Supply Chain Execution, http://www.effizienzcluster.de/index.php?id=138
11. DIN ISO 9735, Teile 1-10: Elektronischer Datenaustausch für Verwaltung, Wirtschaft und Transport (EDIFACT) - Syntax-Regeln auf Anwendungsebene. Beuth Verlag GmbH, Berlin (2004)
12. Specification open TRANS 2.1, Fraunhofer IAO, Stuttgart (2009)
13. Goeken, M.: Frankfurt School of Finance & Management, anlässlich der Auftaktveranstaltung der Zukunftswerkstatt IT, Frankfurt/Main (April 19, 2007)
14. Open Applications Group (OAGi), Developement Methodology, Version (2009), http://www.oagi.org/oagi/downloads/ResourceDownloads/2009_OAGi_Development_Methodologyv2.pdf

Challenges in the Planning, Organization, Execution and Control of International Supply Chains

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Abstract. This paper presents the results of an analysis conducted to identify the major challenges in the planning, organization, execution and control of international supply chains faced by project partners. Logistics managers, logistic service providers and consultants of partners companies in the project OrGoLo as well as other partner firms were interviewed. This analysis revealed challenges in the following areas: compliance, internal processes, external processes and information. It must pointed out that regardless of the different business models of the interviewees, a remarkable consensus was observed in what are the challenges they are facing up.

Keywords: supply chain, collaboration, governance, compliance, transparence.

1 Introduction

A common definition of "supply chain" is to refer it as the network to deliver products and services, from the place of production to the place of consumption through an organized information flow, physical distribution and payment [1]. Due to the trend of globalization during the past three decades, the global trading networks have changed dramatically. This has led to the emergence of new business models hence a new market dynamic that fosters new competition strategies; demands higher levels of efficiency and quality; and requires deep expertise in supply chain optimization.

In this globalized market, the supply chain became increasingly international as the network embraces several actors worldwide. The resulting internationalization of activities poses great challenges to companies as they are forced to operate in complex frameworks such as: intercultural challenges; geography and infrastructure; technologies for transport, handling, information and communication; political and legal framework; environmental and social responsibility; and international intermediary and service suppliers [2].

Regardless of the process complexity or the quantity and diversity of parties involved in a supply chain, every stage of it should add value to the product or service to be delivered. To achieve this goal, the supply chain management (SCM) plays an essential role. Together with the evolution of business models, the concept of SCM has changed through the years. According to the Council of Supply Chain Management Professionals [3], SCM encompasses the planning and management of all activities involved in sourcing and procurement, conversion, an all logistics

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management activities, including the coordination and collaboration with channel partners. This requires the integrated planning, organization, execution and control of material, information and financial flows between all channel partners to achieve the optimal network structure in terms of time, costs, quality and flexibility [4], [5].

This paper captures this cross-function approach in management and the main challenges companies face up during the planning, organization, execution and control of international supply chains.

2 Preliminary Remarks

A clear trend toward less hierarchical supply chains characterizes the new business models. Companies trust more responsibilities in their value chain to independent suppliers as they provide access to specialized assets and expertise, that otherwise would be only available at the costs of the company [6]. Advantage of this fragmentation is the promotion of specialization since the focus of the companies lays on their core competencies, and the sharing of risks among the parties [7]. However, the increase in the number of parties demands greater coordination efforts. This is a reality especially for small and midsize companies.

To optimize the entire supply chain, rather than optimizing only a part of it based on local interest, is a new initiative gaining importance in the last few years. The introduction of the governance dimension on the supply chain is this initiative. The term governance has been mostly applied on the economy sciences and it denotes that some steering activities take place [8] and the opportunities of learning through networks multiply [9]. In addition to these notions, this paper refers to supply chain governance to vertically coordinate international dispersed business activities in a value chain.

According to Humphrey and Schmitz [6], governance is important for the generation, transfer and diffusion of knowledge that leads to innovation and enables firms to improve their performance. With this background, the project OrGoLo[1] ("Organisatorische Innovationen mit Good Governance in Logistik-Netzwerken") seeks to develop science and tools that supports the decision making of the parties along a value chain. The aim is to enrich a conventional, traffic-economically supply chain with the new dimension of supply chain governance. This governance perspective pursues the target, not only of a cost-efficient, but also a responsible configuration of the international supply chain, with regards of enterprise-external regulations and the interests of stakeholders (good governance).

2.1 Survey

At the early stages of the OrGoLo project, an analysis of the framework conditions followed by a requirement analysis and the software design were performed. For this requirement analysis, best practices of the software requirements engineering were implemented such as the integration of potential users and the identification and

[1] OrGoLo is a research project with 12 partners founded by the German Ministry of Education and Research under the call "Efficiency Cluster Logistics Ruhr".

questioning of demand sources. For the requirements engineering the technique of surveys through questionnaires and semi-structured interviews were applied.

The survey was carried out by the Institute of Transport and Logistics of the University Duisburg-Essen and took part on it logistics managers, logistic service providers and consultants of partner companies in the project as well as some extern companies. All of them are small and midsize enterprises and potential users of the software Supply Chain Configurator to be developed in OrGoLo project. The interviewees have headquarters located in Germany who hold worldwide connections.

The data collecting process of the survey followed two phases. First, the surveyed answered a questionnaire. To supplement the results, an in-depth interview with these executives that are familiar with international supply chains was conducted.

By means of theses interviews, the present challenges faced by the project partners in the management of international supply chains were identified. Based on these findings the expected behavior of the OrGoLo software was described. It is presumed that in this way, the changes of high market-acceptance of the resulting tools will increase considerably.

3 Results

As a result of the interviews in the survey, the main challenges in the planning, organization, execution and control of international supply chains were identified and classified in the following areas: challenges in compliance, challenges in external processes, challenges in internal processes and challenges in information.

3.1 Challenges in Compliance

The global trade of products abroad national frontiers result in an extended supply chain aiming to the company's market expansion but at the same time this extension imposes the need to meet customs regulations as well as international standards. Thus, a company that extends its international presence will be increasingly involved in the organization and control of their processes to comply with laws, regulations and standards. If the companies disregard these requirements it would lead to: loss of the quick-wins that could be granted with preferential tariffs, delays in carriage or processes, confiscation of the products or the loss of import or export privileges, sanctions, fines and even the loss of freedom by the violation of the EG Anti-Terror Regulations Nr. 2580/2001 [10].

In this core element of every international transport and logistics management, the interviewees declared that missing, incomplete or incorrect custom documents causes important delays in the transport of goods. The classification of products according to the Harmonized Commodity Description and Coding System (HS) together with the correct assignment of the code digits; increases the complexity of procedures to ensure a compliance management. In this matter, the several sanctions lists and their continuous actualizations tangle these processes. Interviewees declared that there is a lack of automation to verify these lists and to keep a complete electronic protocol of the efforts to comply with them in order to ensure proof material in the case of an investigation. There is as well a lack of automation and guidance to assign HS-Codes.

An interviewee declared that even the lack of a historical control result in the assign of a different HS-Code for a same product cleared in the past, with negative consequences for the company by the customs authorities. The diversity of laws, regulations and standards across countries imposes a very hard workload when executing international transports to find and to be informed about the actual requirements for compliance.

3.2 Challenges in External Processes

In the area of external processes three themes were emphasized with great consistency as being a challenge: the lack of exploitation of the different transportation modes (truck, ship, train, and airplane), the lack of key information as volume and weight of the goods to transport or to receive and the difficulty to estimate the real end-cost for the transport of the goods. Interviewees declared that there is a lack of transparency in carrier prices what makes difficult an accurate and quick comparison of transport alternatives. In order to obtain prices offers, companies must contact different carriers to accumulate the information necessary for making a well-based decision. This procedure demands for a lot of resources from small and midsize companies. The time that could be saved in such a price research process means a strategic advantage for the company when calculating an offering price to potential customers. Not only could the calculation of carrier prices be valuable information but also the transportation times for calculating reorder points.

Another challenge takes place in the control and monitoring of the value chain. Checking milestones is performed on a single-consignment-basis, sometimes even by telephone. Disruptions over the supply chain are not timely detected what decrease the capacity of companies to react to such disruptions and excel the organization. Such information is a key to build supply chains that are resilient and withstand unexpected events. Historical data of what was planned to be a consignment and what was really out of it are not saved, nor classified and therefore not available for a quickly access from the administration to conduct a performance analysis neither for the complaint management when identifying responsibilities. Furthermore, a shortage of transport aid material was as well mentioned as a challenge by one of the interviewees.

3.3 Challenges in Internal Processes

In this issue area, interviews declared what they have identified on their own internal operations within their company's boundaries as main challenges.

A barrier to the increase of transparency and automation of supply chains is the reluctance of suppliers to go paperless. One of the surveyed companies declared that almost so much as 80 % of the order lines are introduced manually in the warehouse management system because of the lack of standard electronic documentation with suppliers. Furthermore, the lack of automation is behind a great amount of discrepancies and data missing in the forms that are utilized for the product inbound. Because there is a lack of automation on the data exchange it is also difficult to carry the on time data exchange between the stages in the international supply chain. As the products left one stage of the supply chain, the next stage is unable to prepare for the inbound of this consignment and therefore, it is not able to optimize its resources (manpower, equipment, space). The basic product data such as volume, quantity, and/or special storage conditions of the incoming products are frequently unknown. Interviewees agreed this problem could be overcome with the electronic exchange of the packing list and standardization of the data and linkage of fields.

The relevancy of this information is not only limited to the internal process in warehouse. An example of the preceding can be seen when preparing the customs declaration of a consignment due to arrive, since the accurate and full data of the good to be imported together with the transportation fees and certificates are frequently not available until the consignment arrived. Hence, the concluding of the adequate transportation and/or cargo insurance as well as the calculation of the import duties suffers delays.

Together with the characteristics of the products, it was identified that documentation of the state of the products is as well important. In case of complaints an optical reproduction of the transported goods in the different stages of the carriage would simplify the complaint management.

3.4 Challenges in Information

The last part of the survey dealt with challenges in the field of information. This field was centered on the discussion of gaps in knowledge. The issue here regarded as the biggest problematic is the lack of specific knowledge about the customs laws of the country where consignments are delivered. Identifying the certifications for transport aid materials according to the different legislations is hereby a topic to be addressed.

Together with the difficulties of researching entry requirements of importing goods, there is the complexity of identifying the entry requirements of packaging, protection or transportation aids that accompany the importing goods. The regulations that a lot of countries have applied on wood packing material are an example of these requirements. Again, these regulations vary among countries what places additional challenges for the organization of the value chain.

Information flows, within the company and between the partners, impose another challenge when managing international supply chains. International consignments involve a multiply of different intermediaries from the supplier to the buyer through freight forwarders, export management companies, export packers, customhouse brokers, goods surveyors and banks. The flow of information and documentation between these parties could take place via electronic means like e-mails, post, fax-machine or telephone. Interviewers agree that in a lot of companies, mainly the small and midsize enterprise, this information flow is not organized neither centralized. The documentation is being sent from one to another intermediary in a difficult to trace cascade. The information exchanged via written, verbal and electronic modes between two or more persons is not available for the rest of the parties of the value chain and therefore, workflow is hard to follow and control. The entire communication and documentation related to a consignment is not available in an accurate, nor timely nor comprehensive way for every supply chain intermediary. Heading for a diminution of this information gap, companies introduce enterprise resource planning system (ERP-Systems) to support a central database of the information. A well-known system in this matter is, for instance, SAP solutions which are attached to license fees and programming expenditure that could be not affordable for all the intermediaries. This leads to a fragmented network and the resulting loss of efficiency.

The supply chain integration initiatives that try to address this issue must very often confront incompatibility problems between the ERP-Systems of two different supply-chain-partners. In addition to this, the interviewers mentioned the language barrier as an additional element that makes difficult the interchange of information in international supply chains.

4 Conclusions and Future Work

Nowadays every party has the limited view of the processes occurring in their action ratios without considering the complete value chain as there are not systems neither rules that facilitate and promote the networking among them. The reason for this disproportionate development could be induced by virtue of the series of value chain actors with own subsystems, regulations, standards and information systems with meager interoperability. This point of departure makes intricate the development of solutions to automate these processes and encourage the efficient cooperation between them with good governance.

The most important characteristic of solutions to encourage the good governance is the access to information from all trading partners. Only with a central platform can transparency in the workflow be achieved and through the interconnectivity among all the key players is collaboration secured. On the other hand, the tools should be given with a series of applications that support the supply chain planer by the decision making with regards of the good governance dimension.

In the management of documentation and information along the value chain, the good governance tools should enable the controlled, comprehensive, timely and efficient flow of documentation and information. The coordination between the flow of information and the flow of the products minimizes the risk of missing time windows, paying penalties, incurring in extra charges or even loss of the goods to import. This coordination is a demanding task, since different parties perform the input of information at different times and locations. A coordinated and central management of this information should secure that they are available for the right party, at the right time, and in the right form.

A document management system should be here developed to facilitate de collaboration among the parties with a clear workflow that guarantees a high security level of the data storage, retrieval, work, distributing, and publishing processes.

In a collaboration environment the good governance tools should also secure that a knowledge community stands and users can be advised about the documentation requirements for a shipment. The most common documents are the commercial invoice, export packing list, pro forma invoice, bill of lading, generic certificate of origin, consular invoice and dangerous goods certificate. The instructions for completing each document are in most of the cases difficult to understand. Here, the good governance tools should give hints how to complete these documents.

The customs procedures for the import and export of duties are an important and often ignored element of any value chain with international movements. Planners lack information sources about process times and documentation required for declaring goods. Customs regulations vary from country to country. Hence is the acquisition of accurate information how to comply with these regulations a major challenge for planners. To aim at good governance, the tools should make possible the experience interchange between the members of the knowledge community in complying with custom rules.

The interviewers agree that such a knowledge community and supporting tools will be successful as long as its utilization is not associated with high investment neither operational cost. Here can represent the software delivery model "Software as a Service" (SaaS) an important contribution. The software of the good governance tools and its associated data could be hosted centrally and accessed by the user using a web browser over Internet. This will make possible the central maintenance of the data and its access for all register users.

The interviewers demand that the governance tools should offer as well features that allow the checking of the parties of a value chain against embargo/sanction lists and the display of international standards certifications each party is accredited for. Additional to this information, interviewers consider the definition of the key persons together with their contact data as a requirement for the interconnectivity between parties of a value chain.

For the support of the decision making, the supply chain planner should be helped in the calculation of transport costs as well as in the identification of availability and costs of transportation aids. This feature could represent a competitive advantage when calculating offer prices for their products and/or services. The transparency and availability of these costs is nowadays a not being met need.

Besides the transportation output, information should be as well displayed about the international procurement market. This output would make possible the complete planning of the value chain with regard of the working capital and service providers available that better meet the needs of supply chain parties in terms of costs, quality, quantity, time and location.

Additional to features that support the planning and organization of value chain, the good governance tools should be able as well to support the execution and control of them. A fundamental technology to achieve this goal is the introduction of tracking and tracing technologies. They will allow the planner to timely react to disruptions along the supply chain and secure the traceability of their consignments.

To further support the decision making, these tools should have at their disposal simulation features that enable the configuration of international routes with alternative modes of transport. Together with the ecological footprint of each route alternative, the value chain could be designed considering its ecological impact. Such a simulation feature would enable as well the evaluation of consolidation points. With the introduction of these points, the efficiency of the traffic volume bundling could be evaluated; what give an objective basis for the analysis of the performance of different alternatives networks. With this functionality it is expected, a better load factor of the transportation mode through the medium of efficient traffic volume bundling. To support the decision making process, a Supply Chain Configurator will be developed within the OrGoLo project, to assist the supply chain planners in the collaborative planning, organization, execution and control of international supply chains with a good governance.

The actual rich environment for research and development in the supply chain has been proven by the quantity of running projects such as AdiWa, RAN, SCE, E2Log and Green Logistics. The number and diversity of these projects prove the imperative call of new technologies in this field and confirm the importance of the challenges here identified.

As the projects above, OrGoLo pursue to contribute to the significant development of logistics that respect individuality, secure the supply of urban systems and look after resources and environment. The distinguishing strategy of OrGoLo relies in the development and implementation of not only parametric engineering tools but as well as knowledge and social engineering tolls to achieve this objective.

Interviews were valuable to achieve the complete picture of current challenges in the planning, organization, execution and control of international networks. On the basis of this input, the features of the good governance tools could be defined according to the market needs.

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References

1. Schönsleben, P.: Integrales Logistikmanagement – Operations und Supply Chain Management innerhalb des Unternehmens und unternehmensübergreifend. Springer, Berlin (2011)
2. Kummer, S., Schramm, H.J., Sudy, I.: Internationales Transport- und Logistikmanagement. Facultas. wuv, Wien (2010)
3. Council of Supply Chain Management Professionals: SCM Terms and Glossary (2010)
4. Kuhn, A., Hellingrath, B.: Supply-Chain-Management - optimierte Zusammenarbeit in der Wertschöpfungskette. Springer, Berlin (2002)
5. Wecker, R.: Internetbasiertes Supply-Chain-Management. Deutscher Universitäts-Verlag, Wiesbaden (2006)
6. Humphrey, J., Schmitz, H.: How does insertion in global value chains affect upgrading in industrial clusters? In: Regional Studies, vol. 36(9), pp. 1017–1027. Routledge, London (2002)
7. Gereffi, G., Humphrey, J., Sturgeon, T.: The governance of global value chains. In: Review of International Political Economy, vol. 12(1), pp. 78–104. Routledge, London (2005)
8. Humphrey, J., Schmitz, H.: Governance and Upgrading: Linking Industrial Cluster and Global Value Chain Research. In: IDS Working Paper 120, pp. 1–37. Institute of Development Studies, Brighton (2000)
9. Gereffi, G.: The Global Economy: Organization, Governance, and Development. In: The Handbook of Economic Sociology, pp. 160–182. Princeton Univ. Press, Princeton (2005)
10. Bundesamt für Wirtschaft und Ausfuhrkontrolle, `http://www.ausfuhrkontrolle.info`

Smart Tracking of Objects in Logistics Processes with the Help of Image Processing

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Abstract. This paper describes an innovative camera-based logistics analyzer for the generation of real-time information, for the reduction of intricacy with the smart tracking of logistics objects. The analyzer is to be applied in logistics environments for the identification, positioning and tracking of objects and for the acceptance, maintenance, and control of entire technical systems. Based on an autonomous IT conception, it can be used for the supplement of the existed system of observation, monitoring and quality control in the field of logistics.

Keywords: Logistics, Computer Vision, Tracking, QR-Code, Intra-logistics.

1 Introduction

Services in logistics have to be able to adapt themselves rapidly to the dynamically changing individual needs of actors and the general trend in the market. Getting additional information in a short time and responding to requests quickly is thus strongly required in logistics processes. A camera-based solution helps to response to such needs.

Nowadays, humans live in times of ubiquitous cameras. The widespread use of visual aids is meant for monitoring of people, objects, movement and system state. The manifold motivation behind the use of video surveillance of target systems lies in the need for security, control over the systems in order to ensure their reliability and stability. In addition, video film-analyzers contribute to data collection in order to extract information, esp. detection, identification, positioning, and tracking of objects [1], [2].

The aim of the research project TiLO[1] is to develop an innovative logistics analyzer based on cameras, RFID transponders and smart sensors for generating real-time information, reducing intricacy with the camera-based smart tracking of objects in logistics, and providing logistics actors with formerly inaccessible information. The analyzer is to be applied in different logistics environments for detection,

[1] TiLO (Tracing intelligenter LogistikObjekte) is a research project within German-based logistics cluster research project EffizienzCluster LogistikRuhr, funded by the German Ministry of Education and Research (BMBF).

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 253–260.
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identification, positioning, and tracking purposes as well as processes of acceptance, maintenance, and control of complete logistics systems.

By now, the advances and improvements in image processing and increasingly efficient technologies have led to the development of more and more sophisticated solutions. According to the respective application area, such technologies are adapted to their own needs and integrated into a value-creation process. A well-known example in the logistics domain is “pick-by-vision” using static image information displayed with help of “augmented reality” technology in order to support the picking process.

The dissemination of image processing takes place both via transfer of existing solution concepts to new application areas and via a ‘technology fusion’ merging cameras with other technologies. The progress is in full swing and develops in such a dynamic way that manifold innovation can be expected in the coming years [3].

Another aspect of the context in this project is the growing power of information systems. Current and particularly future IT systems will be able to process both more data and more different types of data. The efficient structures in the design of the software, and new processing technologies behind the computation of data should permit new forms of usage by transferring the information at the operational level.

Currently, operational systems happen to display a wrong image of reality which again may lead to considerable inefficiency, such as higher costs, time losses and opacity regarding actual reality. Such inconsistencies between system condition and reality are rooted in a number of media breaks and in non-continuous information updates. By means of a novel analyzer based on technology fusion, information can be extracted continuously from the recorded video films and used for real-time status monitoring, e.g. for real-time inventory management and instant quality checks immediately after the processing steps. Thereby, mismatches between reality and system status can be mitigated and the data quality improved.

One goal common to all application areas of vision components is the transparency gain which is oftentimes accompanied by efficiency increases. Both goals are served with the help of camera-based data collection, since additional information in order to attain both is easily obtainable. In particular, the above-mentioned goals, i.e. detection, identification, and tracking, increasingly play an important role since they address an optimization potential which is often gone disregarded till now.

Automation is another very popular and still continuing trend that has characterized especially the world of intra-logistics for several years [4]. Storage technology and IT-based support systems continue to find their way into warehouses in an unabated manner leading to process changes and optimization in the field of intra-logistics connected to positive effects on performance and cost. Technological support with the aid of a camera-based analyzer is thus dedicated to act as a catalyst for modifications of processes and organizations for streamlined processes in general [5], [6]. For instance, the analyzer can be used for defining or displaying the unexpected events which occur rarely in automation processes, and forecasting the possible effects to the complete system as well as initiating countermeasures, if applicable.

Against this background, ideal conditions exist for the present research project TiLO as the needs of the industry are directly addressed since the project outcome will meet these industry needs of detection, identification, positioning and tracking. After the adaptation of the analyzer to various application environments, the evaluation and analysis of video films and the generation of information in this project are examined in principle.

2 Application Areas

Many workgroups in many companies and at institutes or universities deal with common problems in the logistics sector and aspire to solve them with innovative technological solutions. Therefore, solutions like a camera-based analyzer are highly aspired for the realization of adaptable and flexible logistics systems and networks. These solutions help to solve problems in many different logistics sectors, to increase process efficiency and to realize advantages like immediate results and a real-time evaluation.

More precisely, all companies including small- and medium-size enterprises are to be able to measure and optimize their performance and processes with the aid of the new solution. For instance, real-time monitoring the alteration in the system, avoiding the inefficient use of forklifts, and reducing cost and time efforts during stock rearrangements belong to the major achievements.

Apart from the manifold benefits promised by the system, the cost factor plays a major role in order to attract many interested parties in a rather technology-avers industry. By focusing on low-cost hardware components, which can be easily acquired and substituted in case of need, even conservative decision-makers are prone to introduction of the novel camera-based analyzer.

Furthermore, the camera-based analyzer may even work as a stand-alone solution without direct technical connection with its systems environment, which allows a broader diffusion of the solution since warranty issues of the existing facilities are not influenced by the use of the new system.

The novel analyzer system is to be examined with regard to its yield of additional information to be used in block storage, cross-docks, and shelf-storage systems, e.g. for a novel forklift management system following the vision of scan- and laser-free tracing, positioning of goods in a warehouse or inventory optimization based on real-time information. For instance, a camera- or RFID-based positioning of forklifts would enable the identification and the tracking of the carried goods, the monitoring of the load statuses and of performance in general. Derived from the information about forklifts, deeper understanding of the inventory management principles and problems can be gained. On the verification of a simpler, more efficient and cost-saving method of data acquisition and utilization in principle, the data can be acquired in intra-logistics along the entire process chain, e.g. in returns management, at incoming and outgoing goods control, and for commissioning and shipping [7].

Once defining the exact position, orientation and sequence of objects will be possible, the analyzer promises vast potential in conveyer systems as well. Object detection and identification belong to the major application areas as much as throughputs analyses of and records of process times do. Assistance systems for acceptance and maintenance purposes and for quality analyses are counted to the expected scope of such systems as well.

3 Today's Limitations

In order to realize detection, identification, positioning and tracking, RFID technology has been marketed and fostered in recent years. Although RFID technology has been introduced to logistics environments frequently, it still exhibits some well-known technological barriers which need to be overcome in order to optimize RFID application and to enhance its prevalence. These barriers lie in the high investment costs of both tags and readers, the lack of security and privacy due to unauthorized reading opportunity and the susceptibility to interferences and disturbances. RFID technology allows a discrete tracking of objects only though since the object needs to pass the ranges of the respective readers.

Similarly, sensors exhibit limited scopes of application and downsides regarding costs, size and power consumption although the large variety of sensors does help to cover broad range of problems. In limited applications, the use of sensors pays off indeed.

Cameras have a limited field of view (FOV) which results in the need for multiple devices and thus leads to – proportional to the number of cameras – elevated costs. Moreover, the images recorded by the camera may have to reach a certain quality level according to the specific requirements of the targeted application environment. Then, high-resolution cameras with the on-board sensor technology and corresponding costs will be required.

The use of bar codes has been omitted due to its limited space to store information and its requirement of a certain orientation during the reading process. With the implementation of QR codes, these challenges are addressed effectively. Due to its wide spread, the importability and usability of such solutions has been proved.

4 Solution Approach

Surveillance and activity monitoring systems for evaluating and optimizing purposes are examples of camera-based applications today, just as object tracking has begun to be. In order to achieve the purpose, many state-of-the-art image processing methods have to be examined according to the feature of the target object, such as color or movement, in its application area and to be categorized in accordance with the respective feature [8]. Each algorithm has to be adapted to the particular needs of the object and its sphere of application.

Technically, tracking consists of two main components, as shown in Fig. 1: identification and modeling, with the earlier aspires to find the object in each frame and the latter to project two- or three-dimensional models of the captured object and its location.

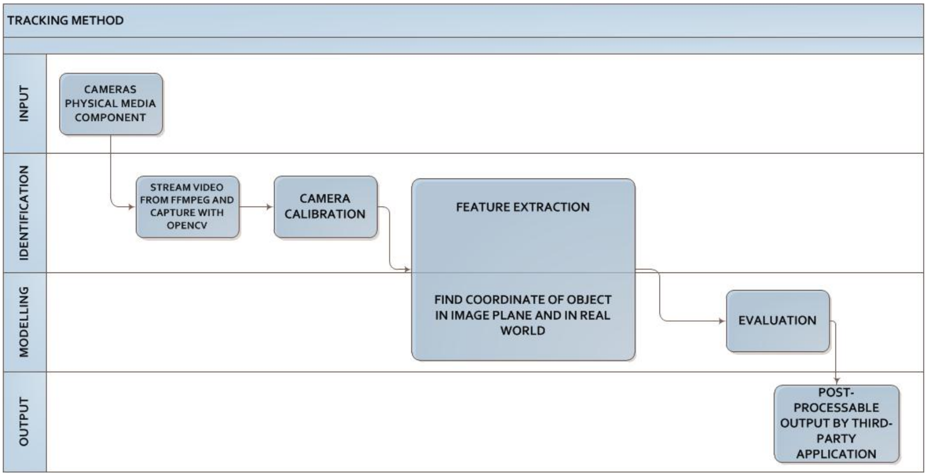

Fig. 1. The tracking method with the identification and modeling steps

4.1 Conceptual Design

The analyzer is conceptually based on camera technology, RFID transponders and sensors. Although each technology individually may have its lacks and downsides, the fusion of them lead to consistent system architecture enabling the reliable detection, identification, positioning and tracking of objects. Cameras, for instance, suffer from noise in images, non-rigid or articulated nature of object, information losses and complex object motion. These downsides can possibly be circumvented by applying RFID transponders or sensors.

Built in an experimentation area in a warehouse, the system consists of wired cameras, forklifts labeled with a simplified QR-Code, access to a Local Area Network (with accessibility restrictions according to the company policy), storage, and a video management system, as illustrated in Fig. 2.

Although wireless IP camera could have been used, wired IP cameras were used in this system because the extracting frames from IP camera is easy with the help of FFmpeg and OpenCV. Considering the large size of warehouses, wired cameras are preferable for the connection and transformation of signals over long distances, i.e. from the cameras to servers or computers.

Due to the FOV limitations of cameras, the design of the system includes multiple cameras in order to be able to cover the entire warehouse. For this purpose, it is only reasonable to use camera with overlapping FOV, so that several cameras can detect the object simultaneously. Without overlapping FOV, the danger of data loss, at least for a minimum period of time, exists.

The system is to run constantly and to record day activities frame by frame on system storage. The recorded data can be used for various purposes and kept in the storage as long as the companies need that data. The output of TiLO thus is post-processable data for third-party applications, e.g. for evaluation and optimization.

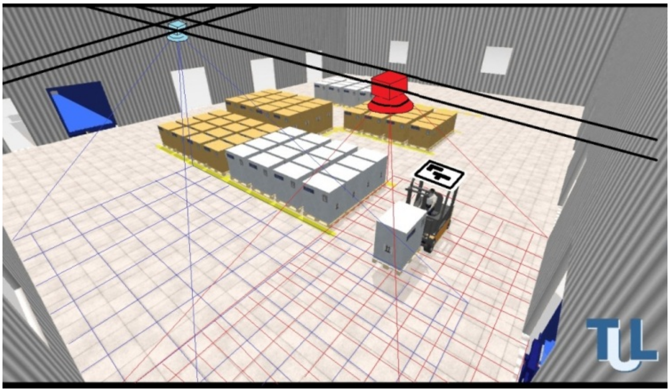

Fig. 2. The 3D model of the conceptual design

4.2 Technical Details

The complexities of object tracking are rooted in technical challenges like noise in images, complex object motion, non-rigid or articulated nature of object, the loss of information which are caused by the projection of a 3D world onto a 2D image, by partial and full object occlusions, complex shapes, illumination changes, and real-time processing requirements [8]. To eliminate some of the above-mentioned complexity, the simplest form of a QR code, shown at Fig. 3, has been selected as the external feature and embedded to the logistics object as a marker. The design of the code is a simple imitation of a Micro QR code, allowing simplified data-writing and data-reading and thereby abandoning of complexity [9]. The partnership between camera and QR code techniques provides a good solution to storage environments for reducing the referencing points, e.g. via scanning. After implementation, ideally two reference points remain necessary only since the residual referencing can be replaced with the continuous tracking of objects and their QR codes with the aid of a multi-camera system. As in every electronic or mechanic system solution, there are some restrictions such as illumination and distance. The illumination should be stable and enable detection of the marker by means of the algorithm. During testing, the distance between marker and camera and the light conditions have been alternated in order to extract the most stable contours in terms of illumination invariance and distance independence.

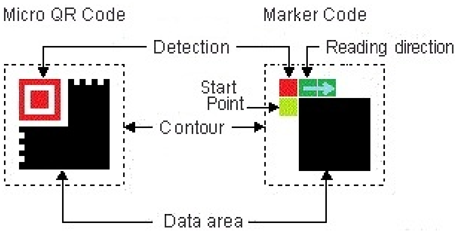

Fig. 3. The method of decoding the simplified QR code

This simplified marker form follows the same algorithm for the frame-by-frame extraction from crowded scenes as for the original QR code markers: After extracting the marker from the crowded background [10], it is decoded frame by frame. The process is explained step by step.

1. Determine a threshold algorithm by transferring the colored image into a black and white image. Convert the image to a set of black and white pixels using the threshold algorithm.
2. Find "the detection point". In case of detection of that point, the reading of the marker is possible. In case of no detection, the detection of the entire marker has failed in the respective frame. The detection of the marker can then be re-tried in the following frame.
3. Find "the reading direction".
4. Find "the start point" and then start to read the data segment according to reading direction.
5. Decode the data segment according to the respective reading method.

Camera-based tracking technically means extracting the object from its background, obtaining its unique identifier (UID) with the aid of a marker, and linking the UID to required process information regarding the object, such as coordinates, timestamps or counters, after the transformation from information from image level to corresponding information on reality level.

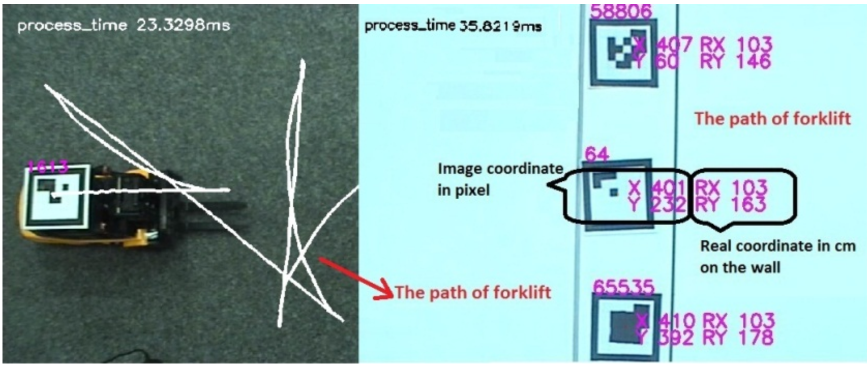

Fig. 4. Positioning and tracing an object by coordinates and trajectories

5 Conclusion

In this paper, an approach of camera-based tracking of object in logistics environments has been presented. During the research, the technology fusion turned out to be a better solution than the application of merely a single technology. By this, individual downsides of each technology could be mitigated and their strengths combined. Such a fusion between IP camera and QR-Code technologies is visible in Fig. 5, which shows a simplified representation of an industrial solution using highly sophisticated algorithms to solve the difficult natural circumstances like occlusion.

In the light of the findings above, the system was built and tested in an experimentation environment in which the real-time smart tracking of logistics object system is being developed. The tracking of the objects and the detecting of their coordinates only with cameras represent a promising future of this project and its outcomes. By the combination of different technologies, consistent data and sustainable logistics systems can be realized.

In future work, innovative solution will be implemented, tested and approved in the industrial test fields. The next steps will try to find answers to questions about both the further technical development and the fine-tuning of technology interaction and the ways of using the additional information for different application areas like real-time inventory management or the generation of key performance indicators.

References

[1] Bauer, N.: Handbuch zur Industriellen Bildverarbeitung. Fraunhofer IRB Verlag, Erlangen (2007)

[2] Hompel, M., Büchter, H., Franzke, U.: Identifikationssysteme und Automatisierung. Springer, Heidelberg (2008)

[3] Noche, B., Koc, S.: Leistungskennzahlen bei Staplern. Internationale Fachzeitschrift dhf intralogistik (1), 55–57 (2007)

[4] Noche, B.: Strategische Studien zur Analyse ganzer Fabriken. In: Simulation in der Automobilproduktion, pp. 139–149. Springer, Berlin (2003)

[5] Noche, B.: Vergleich von Distributionssystemen unter dynamischen Gesichtspunkten durch Anwendung der Simulationstechnik. In: 9. Magdeburger Logistiktagung, Magdeburg (2003)

[6] Noche, B.: Auswirkungen des Betriebs von Distributionszentren auf den Verkehr. In: Innovative Forschung und Lehre im Dienste einer nachhaltigen und integrierten Verkehrspolitik, pp. 165–177 (Mai 2003)

[7] AIA Vision Online, Whitepaper: The Advantages of Camera Systems for the Data Acquisition in Intralogistics, http://www.visiononline.org/

[8] Yilmaz, A., Javed, O., Shah, M.: Object tracking: A survey. ACM Journal of Computing Surveys 38(4), 13–58 (2006)

[9] Micro QR Code Overview, http://www.onbarcode.com/micro_qr_code/

[10] Suzuki, S., Abe, K.: Topological structural analysis of digitized binary images by border following. Computer Vision, Graphics, and Image Processing 30, 32–46 (1985)

TraCy

Tray Cycling – Logistics for Urban Mining (TraCy)

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Abstract. The increasing worldwide demand for resources, the shortage of raw materials and new EU directives form the basis for Urban Mining, the core concept of which comprises obtaining recyclable materials from solid urban waste and residual production materials. Up to now, secondary raw materials have only been insufficiently exploited as defined within the context of recycling management. Established material life cycles concentrate primarily on materials such as scrap glass or scrap paper that are available as mono-fractions. Mixed waste streams often containing highly valuable materials remain by and large excluded from any such considerations.

In order to enhance the use of secondary raw materials, robust logistics systems which meet the high quality and supply demands of their customers as well as an increased integration of waste disposal companies into the supply chain structures of manufacturing companies are essential. The TraCy project supports this approach by developing economically feasible models for closing materials cycles which are not found at all today, or at least not in sufficient quantities. The aim of this is the paradigm shift – "From supply chain management to supply cycle management".

Keywords: Urban Mining, supply cycle, secondary raw materials, container system, waste disposal, waste disposal logistics, material life cycle.

1 Introduction

The central theme of resource efficiency (or resource productivity; both terms are synonymous) was first discussed publically on a broader basis in 1972, prompted by the "The Limits to Growth" report to the Club of Rome [1] which examined five global trends: industrialisation, population growth, malnutrition, the exploitation of raw material reserves and the destruction of living space. Subsequently, several approaches were developed to counteract the negative consequences of an increasing shortage of resources. One of these was from Ernst Ulrich von Weizsäcker, who later became the founding president of the Wuppertal Institute for Climate, Environment and Energy. In his 1989 book, "Erdpolitik" ("Earth Politics"), von Weizsäcker pursued the approach of a resource strategy aimed at reducing the consumption of the environment through an "efficiency revolution" [2]. This led to the development in

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the years that followed of a variety of approaches and concepts addressing the measurement and increase of resource productivity. Some notable examples include the "Materialintensität pro Serviceeinheit" ("material input per unit of service") (MIPS) method [3] and the identification of "ecological rucksacks" that goods services carry when they arrive to consumers. Others include the "Factor 4" concept [4], aimed at doubling prosperity while simultaneously halving resource consumption. This was expanded later on in the "Factor 10" concept [5, 6] and the so-called "resource efficiency calculation" [7] which was implemented in a variety of manufacturing companies within the framework of the Care project that was sponsored by the German Federal Ministry of Education and Research (BMBF). Along with these approaches, numerous other initiatives and methods for increasing resource efficiency have been developed in recent years, but are not touched on in greater detail at this point[1].

This is also not a new topic in practical implementation, as recyclable material cycles aimed at resource efficiency have been working successfully since many years. Most of these established material life cycles encompass materials that are available either as mono-fractions (for example, scrap paper, scrap glass, steel scrap, plastic films) or other materials which can easily be separated from the waste streams (for example, shredder scrape, packaging plastics). These materials are traded on anonymous, often global mass markets, and pricing is mostly orientated on raw materials exchanges such as the London Metal Exchange (LME). In contrast, from a recycling management perspective neither the markets for composite materials nor regional markets have as yet been adequately developed. Solely those waste streams with high economical potential (e.g. platinum in automobile catalytic converters) have been focussed and developed up to know.

In particular, the direct redeployment of secondary raw materials into the production of the original products occurs rarely without first taking a detour through anonymous mass markets.

The task therefore is to develop new recyclable material cycles, a stipulation reflected of late in Germany in the recent amendment of its "closed substance cycle waste management act" for implementation of the stipulations of the European Waste Framework Directive. The legislation contains a five-stage hierarchy stipulating the process sequence prior to waste disposal and consisting of waste prevention, reuse, recycling and other uses, including energy recovery from waste materials [8]. Throughout the sequence, the higher ranking measure is to have priority[2].

This orientation on waste prevention and recycling also requires the participants in the industry to progress from waste disposal operators into secondary raw materials suppliers. Some of the central problems with this consist of guaranteed supply security, compliance with quality standards and the lack of sufficient integration of

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[1] These include the so-called PIUS-Check, the Ecoprofit® Method, the eco-efficiency calculation, the life cycle assessment, resource efficiency calculation [7] and more.

[2] On this refer to Sec. 8 (1) in combination with Sections 6 (1), (2) and 7 (2) of the Act for Promoting Closed Substance Cycle Waste Management (KrwG) [8].

secondary raw material suppliers into the supply structures of manufacturing companies. Furthermore, the logistics structures for the recirculation of old products (container systems, information flows, organisational structures) are often incompatible with the supply logistics of manufacturing companies, since their origins lie in the classic structures of the waste disposal industry and were therefore not developed with the supply of raw materials to manufacturers in mind.

To improve the utilisation rate of secondary materials, the necessary prerequisites must be created both in terms of processing technology and of logistics structures. This is the point from which the TraCy idea leads to the following research questions:

1. Why have waste disposal companies not yet been integrated into manufacturers supply chain management structures?
2. What kind of potentials (economical, ecological etc.) will derive from their integration?
3. What needs to be developed/implemented for the integration (e.g. containers, logistics processes, information flows, IT management tools)?
4. What are the problems of the integration and how can they be solved?

In order to answer these questions the following approaches will be proceeded during the TraCy project:

- The development of an integrated logistics concept for new products' supply and waste disposal.
- The improvement of the waste disposal companies' inventory management in order to achieve reliable information about the availability of secondary materials by using already established SCM methods .
- The integration of secondary raw materials suppliers into the supply chain management of manufacturing companies.
- The installation of a testing ground for the implementation of an exemplary overall concept.
- The development a new container system with which supply and waste disposal services can be coupled.

The findings from these approaches will lead to innovative logistics and management systems according to the rules of supply chain management through which waste disposal companies can fulfil their future role as raw materials suppliers.

By integrating waste disposal companies into the supply chains and recycling management of materials in production and economic systems, the paradigm shift of the linearly supply chain structures to supply cycle management will be accomplished. (see Fig. 1)

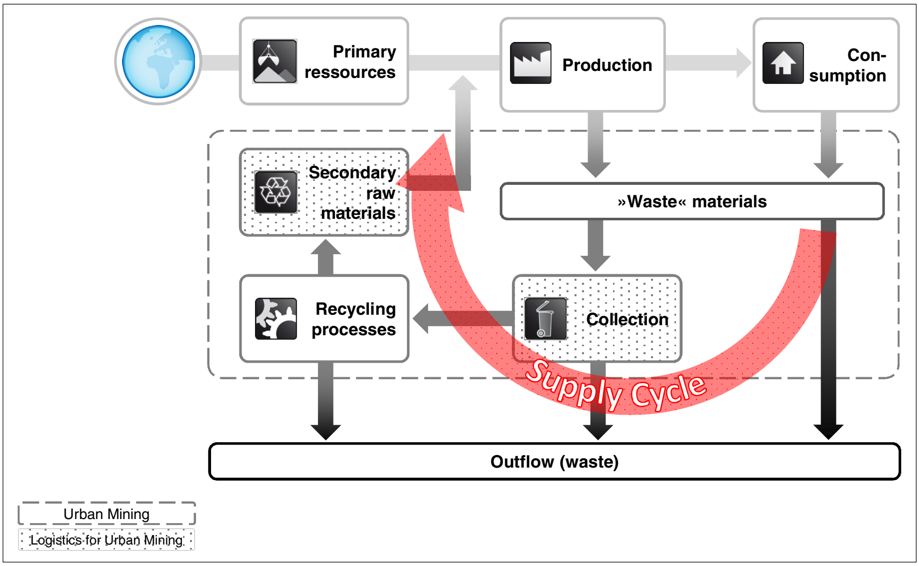

Fig. 1. From supply chain management to supply cycle management

Figure 1 shows the general overview of the TraCy project's aim – to accomplish supply cycles the collection and treatment of waste streams is necessary in order to get secondary raw materials which can be used for the production of new materials. The waste streams concerned will – in the near future – derive more and more from "Urban mining", which means the use of urban waste streams which are barely tapped up to now (e.g. construction waste or mixed fractions of private household waste). For all these activities solid logistics structures are necessary. The TraCy project focusses on the essential logistics structures for the reintegration of secondary raw materials into the supply chains ("logistics for urban mining").

All the findings from the project will be put into a compendium for waste disposal companies to support them with information about the question "how to develop solid and reliable logistics structures for supply cycles".

2 State of the Science and Technology

Management methods, container systems and logistic processes are important aspects when designing supply cycles. Therefore, these three aspects will be the focus of the following explanations.

The Application of Supply Chain Management Methods in Closed Substance Cycle Waste Management

Supply chain management comprises the in-house and cross-company planning and supervision of flows of material, finances and information along the entire value chain. Consistent, seamless planning and optimisation of the supply, production and distribution processes between all participants (suppliers, manufacturers, logistics service providers, retailers and customers) lead to increased efficiency and competitive advantages. In the wake of globalisation, planning tasks are becoming increasingly more far-reaching and complex due to the increasing level of interconnectivity between international companies. The sheer number of conceivable scenarios makes it impossible to resolve logistics problems by simply identifying them and assessing all the alternatives. Numerous research projects and dissertations have been completed in the last ten years on this topic. The realisation of supply chains in industries whose participants are positioned at the end of the chain and possess great market power (e.g. automobile industry, retail) has progressed significantly. Markets in which the participants possess significant market power and are positioned at the beginning of the supply chain (e.g. pharmaceuticals industry, health care systems) have only introduced supply chain management to a limited degree. Supply chain management is virtually nonexistent in closed substance cycle waste management. Positioned generally at the end of supply chains, waste disposal operations were previously also not components of a supply chain.

Large commercial companies require the electronic data exchange of order and invoicing documentation in accordance with the UN/EDIFACT Standard [3] from their waste disposal operators. However, as “End-of-Pipe” links, waste disposal operators are not fully integrated into the supply chain management. The integration of waste disposal operations (and processing operations) into the supply chain as suppliers of secondary raw materials nevertheless helps both sides profit from a management system. To this end, waste disposal operators must fulfil the requirements they are subject to as suppliers, such as the warranty and guarantee of product qualities or delivery quantities and agreed delivery schedules, for example. The electronic exchange of all the necessary information on deliveries, availabilities and ranges of in-stock inventories is equally required. Such processes are currently largely unrecognised in closed substance cycle waste management and there are no available interfaces. This applies for data interfaces, standards for product classification (eclass[4]) or catalogue management (BMEcat[5]) and for transport systems. While the XML interfaces of the waste disposal operator associations indeed represent a standard, they are nevertheless incompatible with the widely used United Nations UN/EDIFACT Standards, for example. Additionally, there is scarcely any form of article identification or labelling of containers for bulk goods.

Reusable Transport Container Systems in General

Millions of reusable transport container systems (“pools”) are utilised in freight transports in a series of industries (for example, the automobile industry) and above

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[3] UN/EDIFACT (the United Nations rules for Electronic Data Interchange for Administration, Commerce and Transport) comprise a set of internationally agreed standards, directories and guidelines for the electronic interchange of structured data between independent computerized information systems [9].

[4] eCl@ss is a nationally and internationally recognised, pan-industry, ISO/IEC norms-compliant product data industrial standard for the classification and clear description of products and services [10].

[5] BMEcat is an XML-based standard for electronic data transmission for product catalogues [11].

all in commercial trade operations. But frequently the containers used are not returned to their original location and are then misused, for example as storage boxes in one's private automobile or cellar. This necessitates the purchase of numerous new containers in order to maintain the performance capability of the systems. Combining the supply of goods with waste disposal at the delivery locations could contribute to more closely interlocking the supply chains and subsequently reducing these types of Container "losses". The transport containers in closed substance cycle waste management are large rubbish containers, skip containers, roll-off containers or hazardous waste containers that are only compatible in exceptional cases with the standards for means of transportation in other industries such as EUR-pallets and their variations.

The reusable plastic folding crates used frequently in the food retail sector for fruits and vegetables could apply as a "preliminary stage" of the linkage of supply and waste disposal via suitable container systems that is foreseen in the TraCy project. These load carriers are used in supplying food retailers with the goods, and the goods themselves are then presented on the sales floor in the selfsame load carriers. Once the goods have been sold, the load carriers are picked up from the food retailer, washed at a central facility and then made available to the producers again. Such systems are regularly used in a variety of food retail chains. The pool system developed by project partner Interseroh for the food retail sector was optimised by the integration of automated identification, a modern tracking process and statistics-based forecasting tools with the result that each participating company can go online and call up its current container stock and its forecast container stock at any time. Among other things, this allows for superfluous container stocks and the overall stock of containers to be reduced.

In the preliminary research on the project, no system approaches whatsoever could be identified that were similar to the project's intended approach for extensively linking supply logistics with the material flows of waste disposal in a standardised or automated fashion.

Coupling Supply and Waste Disposal Flows

Due to the savings potential in both economic and in ecological terms, the coupling of supply and waste disposal transports was and remains an object of German research projects and scientific considerations.[6] The ISOLDE city logistics and city marketing concept ('Inner-city service with optimum logistics services for retail') in Nuremberg, Germany pursues approaches for coupling supply and waste disposal. This city logistics model project offers both the main service of the bundling and usage-related delivery of goods shipments to the recipient as well as a waste disposal service for recyclable materials and packaging materials. The project examples that have been researched illustrate the great significance of coupling supply and waste disposal transports, but at present there are no further research projects within Germany or Europe that have comparable objectives.

[6] For example, the coupling of supply and disposal for large-scale catering operations was a focus of a BMBF research project . Furthermore, Fraunhofer IML has conducted examinations on coupling supply and disposal for construction sites, shopping centres, for foundry sands and for electronics scrap.

3 Project Contents

3.1 Analysis of Existing Approaches/Structures

An initial fundamental analysis will be conducted of the existing processes and structures as well as the required technical components used today for supply and waste disposal, such as:

- Container types and pool systems
- Container management systems (for example, Barcode, RFID)
- Software systems (ERP, material flow management, etc.) and interfaces
- Key data for description of the systems
- Participants (customers, competitors, technology and service providers, etc.)
- Legal framework conditions

With the help of an exemplary material flow model, exemplary application domains (value chain) are depicted, and their particularities in regard to the possible realisation of value cycles as defined by supply cycles are deduced. Four fundamental scenarios will be observed here: food retail, production, shopping mall and household collection. These material flow models depict the origin and disposition of a material in a particular application (value chain) over the entire course of its life cycle or a certain period of its life cycle. Questions such as those that follow are of interest:

- Which relevant material flows leave the application domains as waste materials?
- Which material flows are not executed at all today in the cycle or are only executed to a small extent? Is this due to technical, organisational, economic or regulatory reasons?
- What do the customer and supplier structures usually look like?
- How many stages usually make up the supply chains (exemplary)?
- Which supply chain management or supply chain execution systems are utilised (exemplary)? Are they suitable for making reliable statements at the material flow level?

3.2 Testing Ground

Within the project a testing ground will be implemented, which will demonstrate exemplarily a small-scale supply cycle for the use and re-use of incontinence system waste deriving from nursing homes for elderly people.

Sanitary products for incontinence patients are used within public medical facilities like for example nursing homes or hospitals as well as in private households. There, they derive as so called “incontinence system waste” after single use. This waste stream contains the following fractions:

- Cellulose fibres
- Plastics (LDPE, PP)
- Superabsorbent polymers
- Urine and excrement

This mixed fraction is collected by the disposal systems for municipal solid waste or similar commercial wastes. In Germany the waste is incinerated (with or without energy recovery) and adjacent landfilled. Due to the demographic change (and the increasing quantity of such waste thereof), the values of the contained material fractions as well as the intensification of the use of secondary raw materials, this waste stream is likely to become of high significance for waste companies.

In Germany, at present, no facilities for the recycling of incontinence system waste do exist. First approaches have been started by Knowaste BV in the late 1990s but have not been successful due to the complexity of the former legislative situation which led only to marginal waste quantities which could be used by the company.

Thus, within the TraCy project, a standardised logistics concept for supply and waste disposal will be developed on the basis of reusable containers, taking interfaces and technology standards into account. The objective on the one hand is to implement supply and waste disposal for commercial collection points, and on the other hand, after treatment of the waste material, the provision of secondary raw materials and all the necessary components of the supply cycle. This will lead to the following to cycles:

1. **The coupling of supply and waste disposal flows for nursing homes for elder people.**
   Waste disposal companies attend their customers regularly when doing the disposal services. Therefore, the coupling of supply services (with new napkins for incontinent patients) and disposal activities (incontinence system wastes) seems to be reasonable.

   The question of how such processes might be coupled is not yet new – related projects showed as well positive as negative results. The TraCy project will reconsider this approach once again – as it might be an opportunity to reduce transports and thus, also negative ecological effects which might derive from the separate collection of further waste streams.

2. **Treatment of incontinence system wastes to get secondary raw materials as well as their reintegration into industrial processes for new products.**
   The second cycle focusses on the reintegration of secondary raw materials into industrial processes. This reintegration shall be done by the waste disposal companies themselves as, within this context, they should become material suppliers. Thus, all necessary framework conditions will be examined which have to be fulfilled to operate successful supply cycles.

The following figure illustrates the testing ground and the cycles mentioned.

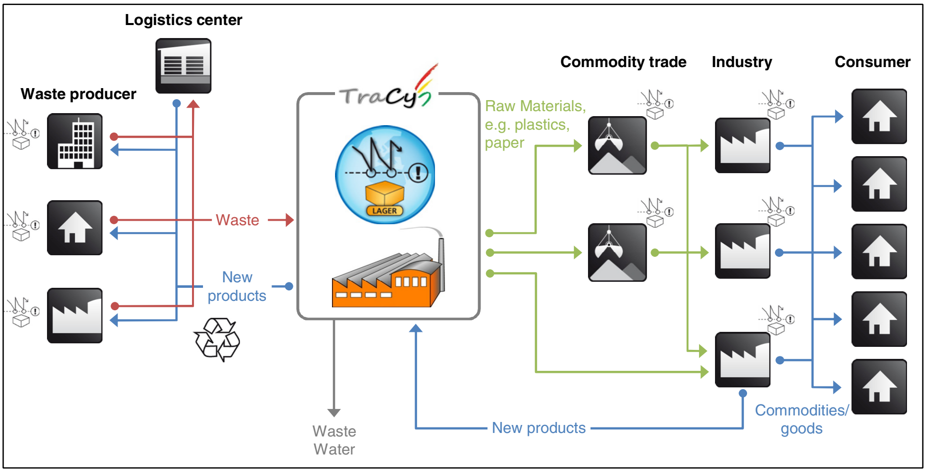

Fig. 2. The TraCy testing ground – rough outline of the process cycles

3.3 Generic Supply Cycle Model

One of the projects aims is to develop methods, which will help waste companies to "create" new supply cycles in an easy way. This leads to the necessity of a reference model which systemises and uniformly depicts the conceptual framework of business processes of recyclable material cycles. This reference model will be prepared on the basis of selected material flows, the application domains as well as the testing ground.

If a waste company wants to assess in advance, if a new supply cycle and related services might be reasonable, it furthermore needs to have methods for the ecological and economical assessment. The reference model will also form the basis for this "supply cycle assessment".

The model and assessment methods should follow the guideline, "As general as possible but as specific as necessary". Therefore, a model must be developed that will be applicable to as many future fields of application as possible (in this case, material life cycles) [12, 13].

The contents of the supply cycle model (see Fig. 2) include the following aspects:

- Process descriptions for supply and waste disposal concepts (e.g. expansion and examination of the SCOR model in relation to supply cycles)
- Definition of the participants and their roles (cooperation between the process participants)
- The principles for quantity flow/material flow management
- Information management (ERP, web solutions, mobile solutions)
- Container management

The Supply Chain Operations Reference Model (SCOR Model) is a reference model specifically for supply chain management that was developed and published as a pan-industry supply chain management standard by the Supply Chain Council (SCC) [14].

The objective of this model is to visualize, standardize and configure processes within supply chains and make them assessable by key performance indicators as well as best practices [15,16]. The model has proven its' value since years and it is often used as it offers a flexible framework for the creation of business processes, key performance indicators, business practices as well as system technologies which can be combined in a simple way.

But within the waste disposal sector the SCOR model is not used at all yet. This fact leads to the problem that the concepts of supply chain management and waste disposal logistics are not linked together in any way at the moment – possible synergies are not used.

Therefore, one of the TraCy project's tasks is to find out the possible synergies when linking supply chain management and waste disposal concepts in order to create supply cyles and thus, to implement waste companies into the SCM structures of manufacturers. The result shall be a unified structure which helps improving the communication between all SCM partners as well as the efficiency and effectiveness of SCM planning and control.

3.4 Container and I&C Systems for Supply Cycles

In addition to bulk goods logistics, which in Europe are essentially based on the dimensions of the EUR-pallet (other container systems and vehicle interior diameters are generally designed to be compatible with the EUR-pallet), roll-off and skip containers are generally used in waste disposal logistics processes. But these standards are not compatible with one another. Within the framework of this operating point, advantages and disadvantages of using the different standards will be analysed, and in conclusion one standard will be selected that is to be complied with by the container systems in the TraCy concept. Corresponding requirements for in-house developments will be defined and transferred into new concepts for containers to be used in coupled supply and waste disposal services.

A resource management information and communications system will be developed for the planning, supervision and optimisation of all the necessary processes such as acquisition or distribution. The integrated, improved inventory management and material flow management systems enable the enhanced management of stocks and the ability to make sound statements on the availability and quality of secondary raw materials.

The framework of the plan also includes the examination of the automated transfer of data between business partners that is triggered by specific actions in the logistics chain (for example, quantity notifications, pick-up orders, electronic invoices and the like). In order to enable the automated processing of these data, all of the participants must be familiar with the structure of these messages and the transfer must be conducted via standardised interfaces. A concept for the data transfer (form and content of messages) will be developed for this purpose and the open standards for the data transmission will be established.

3.5 Assessment Methods

The effort and complexity involved in the collection of waste materials for the manufacture of recyclable materials will increase in the future. It is therefore necessary for waste disposal industry companies to assess the economic and ecological effects of a new system concept with an eye on the future.

Criteria will be established within the framework of the project which enable the application domains to properly assess whether supply cycle management methods can be successfully applied. A method for the assessment of resource efficiency in logistics networks for supply and waste disposal (supply cycles) will be prepared which takes these aspects into account.

The accustomed procedures for classification and assessment will be applied and close cooperation will ensue with the Logistik Ruhr efficiency cluster cooperative projects, “Green Logistics” and “Sustainable Sourcing Excellence”, in which important assessment principles are also to be prepared.

3.6 Transferability of the Results

An important element of the TraCy project is to transfer the obtained findings to other material flows. Two approaches will be pursued to this end:

1. Propagation of the “Urban Mining” approach via *the examination of additional sources of the* material flow observed on the testing ground. This process will entail the determination of border conditions for applying the developed supply and waste disposal container and information system to new user groups for the same material flow, as well as the deduction of modification measures for the inclusion of new participants (source-sink profiles) for the expansion of the collection structures.
2. The *identification of new waste disposal objects* for the construction of additional supply cycles (scenario analysis). This process will entail the observation for example of legal and economic developments, raw material prices, new processing technologies, altered consumer usage patterns (for example, rental instead of purchase) and new technical products as they emerge.

Criteria will be derived from this regarding the applicability of the findings obtained in the project to new material flows (for example, value, segmented detail character of the objects, number of sources, accrual quantities, costs, risks, etc.).

4 Conclusion

It is the declared objective of the TraCy project to prepare utilities that support the progression of waste disposal companies into suppliers of secondary raw materials and thereby support the development of new recyclable material cycles.

The guidelines and checklists prepared within the project provide guidance and assistance in the economic and ecological assessment and the selection of suitable material flows. In addition to the development of standards (containers for supply and waste disposal services, I&C technologies, calculation models etc.), the results can additionally be applied to other material life cycles.

This provides waste disposal companies with the opportunity to assess the requirements placed upon them for the development of material life cycles in advance and to implement sustainable solutions into their operational practice.

References

1. Meadows, D.H., Meadows, D.L., Randers, J., Behrens III, W.W.: The Limits to Growth. Universe Books (1972)
2. Weizsäcker, E.U.V.: Erdpolitik - Ökologische Realpolitik als Antwort auf die Globalisierung, Darmstadt, neubearb. Taschenbuch (1997)
3. Wuppertal Institut für Klima, Umwelt, Energie: MIPS Online, http://www.wupperinst.org/de/projekte/themen_online/mips/index.html
4. von Weizsäcker, E.U., Lovins, A.B., Lovins, L.H.: Faktor vier. Doppelter Wohlstand – halbierter Naturverbrauch; ISBN 3426268779
5. Schmidt-Bleek, F.: Wieviel Umwelt braucht der Mensch?: Faktor 10 - das Maß für ökologisches Wirtschaften. Deutscher Taschenbuch-Verlag, München (1997)
6. Wuppertal Institut für Klima, Umwelt, Energie: Öko-Innovationen: Faktor Vier, Faktor Zehn und aktuelle Ansätze (February 15, 2012), http://www.wupperinst.org/projekte/themen_online/oeko_innovationen/index.html#c2140
7. Orbach, T., Beucker, S., Lang, C.: Computergestützte Ressourceneffizienzrechnung in der mittelständigen Wirtschaft: Status quo Analyse und Auswertung bzgl. Ressourceneffizienz. In: Ergebnisbericht aus Arbeitspaket KP 2 Analyse der wissenschaftlichen Grundlagen. Inst. Arbeitswiss. und Technologiemanagement, Stuttgart (2002)
8. O. V.: Gesetz zur Förderung der Kreislaufwirtschaft und Sicherung der umweltverträglichen Bewirtschaftung von Abfällen (KrWG). Bundesgesetzblatt Jahrgang 2012, Teil I Nr. 10, ausgegeben zu Bonn am 29 (February 2012)
9. United Nations Economic Commission for Europe (UNECE): Introducting UN/EDIFACT (February 15, 2012), http://www.unece.org/cefact/edifact/welcome.html
10. eCl@ss e.V., Köln: eCl@ss – eine Zusammenfassung (February 15, 2012), http://www.eclass.de/eclasscontent/standard/overview.html.de
11. ebusiness Standardization Committee: BMEcat – Leading companies agree on a standard for electronic trade (February 15, 2012), http://www.bmecat.org/English/index.asp?main=Ueber&pid
12. Corsten, H., Gössinger, R.: Einführung in das Supply Chain Management. 2. Auflage. Oldenburgverlag, München Wien (2008)
13. Poluha, R.G.: Quintessenz des Supply Chain Managements. Springer, Heidelberg (2009)
14. Supply Chain Council: What is SCOR? (February 15, 2012), http://supply-chain.org/scor
15. Werner, H.: Supply Chain Management. Gabler Verlag, Wiesbaden (2008)
16. Lawrenz, O., Hildebrand, K., Nenninger, M., Hillek, T.: Supply Chain Management, Konzepte, Erfahrungsberichte und Strategien auf dem Weg zu digitalen Wertschöpfungsnetzen. Vieweg Verlag, Braunschweig (2001)

Resource Efficiency of Facility Logistics Systems

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Motivation

Nowadays, far-reaching changes in the economic challenges do not only affect production systems, but also the associated facility logistics systems. To counter the unsteady economic conditions and to ensure the necessary availability current common facility logistics systems are robustly[1] designed [1]; [2].

Based on several field studies, the following theses regarding facility logistics can be stated [3]; [4]:

- Facility logistics systems are mainly oversized.
- Maintenance of facility logistics systems is not a core competence of the manufacturer.
- Neither operators nor manufactures possess knowledge of maintenance in necessary width and depth.
- Maintenance of facility logistics systems is carried out per breakdown or periodically by the operators according to the manufacturer's instruction.
- The manufacturers do not know all failure causes for breakdowns.

In light of these deficits, the Logistical Experimental Field for Condition Monitoring Technologies (Logistisches Versuchsfeld für Condition Monitoring Technologien – VCM) has been established.

Logistical Experimental Field for Condition Monitoring Technologies - VCM

The VCM is a logistical experimental area for testing the applicability of Condition Monitoring Technologies in facility logistics systems (Fig. 1). Condition Monitoring is

[1] Robustness describes the capability of a facility logistics system to stay operational under every operating condition. A robust facility logistics system possesses redundant components, respectively alternative routes and is hardwearing, over-loadable and not susceptible to failure. Therefore these systems have a low need of maintenance. Subsuming those characteristics, the most important capability of a robust system is to be inured to volatile operating conditions to assure the operability. [4]

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defined as “a maintenance scheduling tool that uses vibration, infrared or lubricating oil analysis data to determine the need for corrective maintenance actions” [5].

The VCM was established by the Fraunhofer Institute for Material Flow and Logistics in cooperation with the Chair for Factory Organization at the TU Dortmund. The common research objective is to examine, for the first time, the interdependence between utilization and wear and tear of facility logistics systems by means of Condition Monitoring Technologies. Regarding the required lifetime, this information enables the construction of facility logistics systems by preventing a waste of resources.

Fig. 1. Experimental Field for Condition Monitoring Technologies

The facility logistics system of VCM consists of different facility logistics subsystems:

- Miniload automated storage and retrieval system (AS/RS) with 120 small load carriers,
- MultiShuttle[2]-system with two vehicles,
- Vertical conveyor,
- Roller conveyors,
- Automated Guided Vehicle system (AGV).

The layout of the VCM conforms to the typical design of facility logistics systems, thus a direct transfer of the collected data to the real operation in different industries is possible.

In cooperation with suppliers of IT and Condition Monitoring Technologies, different sensors to measure the wear and tear of the components according to the utilization were installed in the experimental setup of the VCM (Fig. 2).

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[2] The MultiShuttle makes use of combined warehouse and transport vehicles which can both operate autonomously in the warehouse and supply directly targets in the hall by means of ceiling- or corridor-mounted rails [6].

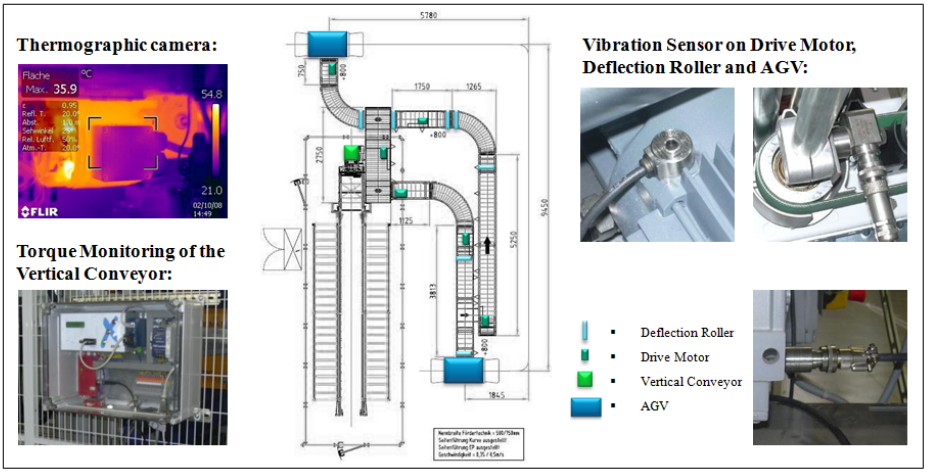

Fig. 2. Condition Monitoring Technologies

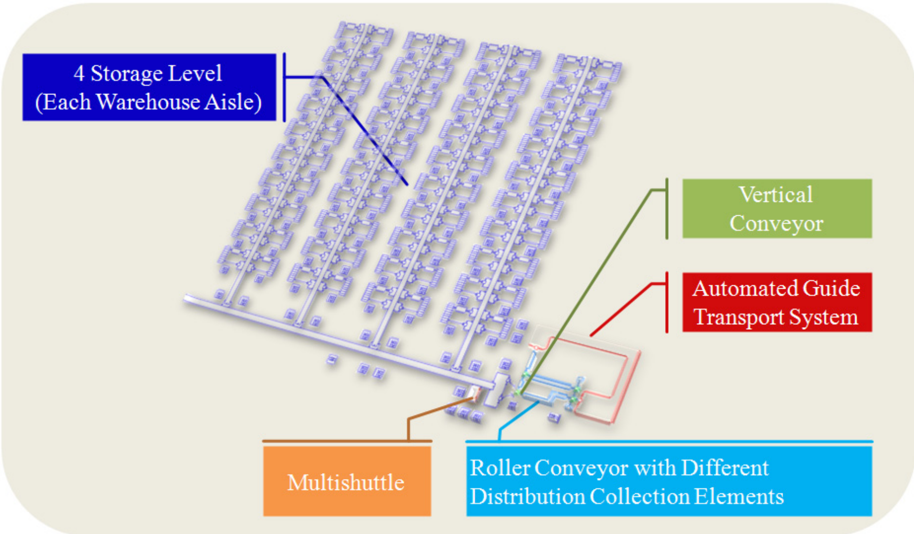

Fig. 3. Simulation Model of the VCM [8]

The following monitoring systems are currently deployed in the experimental setup:

- Vibration monitoring system (online, mobile),
- Torque monitoring,
- Current consumption monitoring,
- Compressed air measurement,
- Thermometry,
- Thermography.

In addition to the real facility logistics system, a discrete event oriented simulation model (Fig. 3) was created by the Chair for Factory Organization. The simulation model supports the analysis of the current and future system load on basis of different utilization profiles[3] which impact the system.

Following up the introduction of the VCM and its tools, the resource saving potential of facility logistics systems will be discussed. This potential can be revealed by the VCM to confirm the previous stated theses.

Resource Savings Potential through Condition-Based Maintenance

As already stated in the motivation, a great number of facility logistics systems are oversized and are maintained breakdown- and time-based. Herein also rests the considerable potential for resource savings. In this context resources are [9]; [10]; [11]:

- Resources for production (energy, material)
- Resources for operation (electric power, compressed air, gas, etc.)
- Spare parts,
- Equipment (tools, etc.),
- Working aid (jig, ladder, etc.),
- Transportation aids (palettes, small load carrier, etc.),
- Operating supplies (lubricant, etc.),
- Personnel (own maintenance personnel),
- Services (external maintenance personnel),
- Organization aid (information and communication technology, etc.),
- Space (depends direct on the stock of spare parts, thus not explicit considered),
- Capital (not considered for the time being) and
- Information (not considered for the time being).

The research project Resource Efficient Maintenance Logistics (Ressourceneffiziente Instandhaltungslogistik - ResIH) of the Efficiency Cluster Logistics Ruhr (EffizienzCluster LogistikRuhr) has different focal points of resource savings. Cooperation partners are Xervon GmbH, InfraServ GmbH & Co Knapsack KG and Fraunhofer IML. One main focus is the reduction of spare parts. This enables the optimization of the warehouse organization for an efficient execution of maintenance activities. Another main focus is to assure the resource efficient handling of logistic services by reducing wear and tear as well as improving the maintenance of logistic equipment. A further focus of research is the development of a condition-based and resource saving maintenance strategy for facility logistics systems. Therefore experiments with the VCM will be conducted.

The main focus of this article is explicit on the latter one. In the following it will be demonstrated, how the resource usage of facility logistics systems can be reduced by means of Condition Monitoring Technologies. A roller conveyor consists usually of several electric powered conveyor components. For the actuator of roller conveyor

[3] Utilization profiles represent the individual load and stress of an item [7].

components different gear designs are used in practice. According to the kind of power transmission there appears to be a transfer loss within an actuator (Fig. 4). On the condition that in every actuator transfer losses appear, a huge saving potential exists.

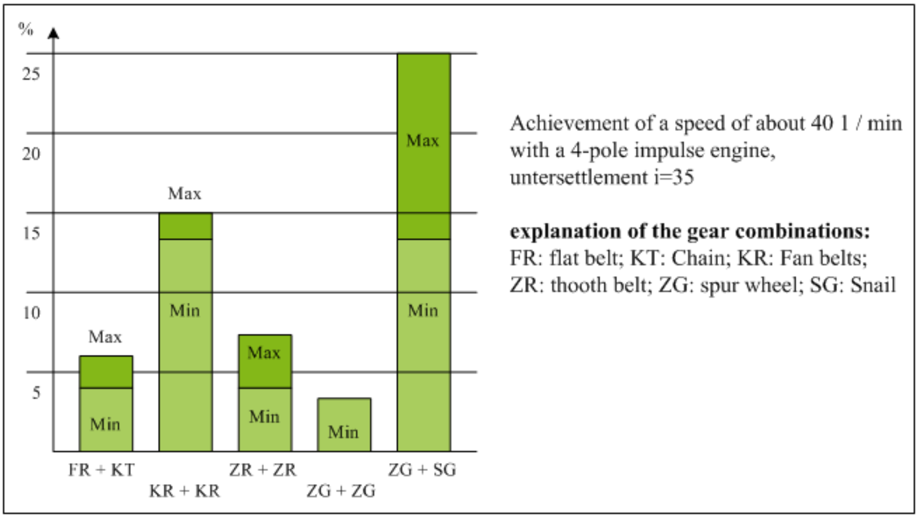

Fig. 4. Transfer losses of different gear designs [12]

To estimate the saving potential, profound knowledge of the interdependence between utilization and wear and tear needs to carve out with the research project ResIH in VCM and by means of the available tools. The utilization degree of a facility logistics system can be examined with the discrete event oriented material flow simulation tool (Fig. 3). With the simulation model different profiles of utilization can be examined and afterwards evaluate in practice on real facility logistics systems [13].

The wear and tear appearing at different utilization profiles can be taken into account, for example with an infrared camera. The camera allows determining a change of temperature within the actuator due to different utilization profiles. A deviation between the measured temperature and the nominal temperature means an energy loss. Furthermore, temperature is also an indicator for possible damages of the actuator.

Energy efficiency can be calculated from the combined results of the utilization based simulation and infrared camera. Hence, new dimensioning methods and replacement strategies can be derived using a comprehensive evaluation and visualization tool. This leads to a sustainable reduction of the energy consumption.

Conclusion

It is necessary to examine the interdependence of wear and tear and usage. Based on this knowledge it is possible to design facility logistics systems according to the actual requirements and avoiding oversizing. On the other hand Condition Monitoring Technologies enable the early identification of most probable damages. A major contribution is achieved by the results of mentioned research projects. Within the scope of ResIH project, experiments can now be conducted over a longer period. It provides information about the degree of oversizing and a condition-based, resource saving maintenance of facility logistics systems.

References

1. ten Hompel, M., Nagel, L., Schmidt, T., Jünemann, R.: Materialflusssysteme. Förder- und Lagertechnik. 3. Aufl. Springer, Heidelberg (2007)
2. Dullinger, K.-H.: Grenzen der Automatisierung im Lager. In: Logistik für Unternehmen, pp. S.61–S.62 (June 5, 2008)
3. Sonderforschungsbereich 696 (Hrsg.): Forderungsgerechte Auslegung von intralogistischen Systemen - Logistics on Demand. Antrag zum SFB 696. TU Dortmund. 2 Bände (2005)
4. Kuhn, A., Bandow, G., Kohlmann, B., Wenzel, S.: Zuverlässigkeit von Intralogistiksystemen - Überdimensionierung vs. Nutzungsabhängige Instandhaltung. In: Seeliger, A. (Hrsg.) AKIDA. 1. Aufl., pp. S.269–S.276. Zillekens, Stolberg (2008)
5. Mobley, R.K.: Condition Based Maintenance. In: Handbook of Condition Monitoring, 1st edn., pp. 35–53. Chapman & Hall, London (1998)
6. Schroer, W.: MultiShuttle - universell einsetzbar. Hebezeuge und Fördermittel 45(1-2), S.34–S.36 (2005), `http://www.hebezeuge-foerdermittel.de/sites/dev.hebezeuge-foerdermittel.de/files/HF01-0205_34-36.pdf`
7. Wenzel, S., Bandow, G.: Prognosemodell für den Abnutzungsvorratsverlauf von Intralogistiksystemkomponenten. In: Bandow, G., Holzmüller, H.H. (Hrsg.) Das ist gar kein Modell!. Unterschiedliche Modelle und Modellierungen in Betriebswirtschaftslehre und Ingenieurwissenschaften. 1. Aufl., pp. S.295–S.309. Gabler, Wiesbaden (2010)
8. Wötzel, A., Bandow, G., Epping, D.: Changeability by anticipatory change planning - Increasing of the changeability for intralogistics systems and production systems. In: Proceedings of the 6th International Congress on Logistics and SCM Systems (ICLS 2011), pp. S.238–S.246 (2011)
9. Käppner, M., Laakmann, F., Stracke, N.: Dortmunder Prozesskettenparadigma – Grundlagen. Hrsg. v. Sonderforschungsbereich 559 "Modellierung großer Netze in der Logistik". TU Dortmund. Dortmund (Technical Report 02005) (1992)
10. Kuhn, A., Winz, G.: Einführung in das Prozessketteninstrumentarium. In: Kuhn, A. (Hrsg.) Prozesskettenmanagement. Erfolgsbeispiele aus der Praxis, pp. S.9–S.24. Praxiswissen, Dortmund (1999)
11. N.N: Das Dortmunder Prozesskettenparadigma. In: Clausen, U., ten Hompel, M. (eds.) Wege zur innovativen Fabrikorganisation, pp. S.11–S.17. Verl. Praxiswissen, Dortmund (2010a)
12. N.N.: Fördertechnik für Industrie und Gewerbe. Hrsg. v. Deutsche Energie Agentur und BMWI (2010b)
13. Wötzel, A., Bandow, G.: A Concept to evaluate resource and energy efficiency through an utilization-based maintenance for anticipatory change planning. In: Proceedings of the 16th International Symposium on Logistics: Rebuilding Supply Chains for Globalised World (ISL 2011), pp. S.433–S.440 (2011)

Supply Chain School – A Logistics and Supply Chain Management Education Platform

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Abstract. The existing and upcoming challenges of logistics and supply chain management industry demand new employee abilities and competences that address growing complexity, internationalization, and new knowledge domains. Particularly in the field of occupational training, however, there is a significant expertise gap, which cannot be closed by existing institutions and didactical concepts. We address this gap by presenting a research agenda that aims at planning, creating and implementing a logistics and supply chain management education platform: This platform is characterized by competence-based and self-regulated learning paths. Furthermore, we present first results regarding the derivation of standard job-profiles.

Keywords: Supply Chain School, Blended Learning, Competency-Based Learning, Supply Chain Education, Logistics Education, Return on Education.

1 Introduction

Logistics and supply chain management (SCM) are of growing importance for the economy's development. By coaching employees, the individuals' and organizations' innovative potential, organizational competence and execution can be better used. Furthermore, the increase in individuals' and organizational competence levels improves the logistics' efficiency [10], [11] and [12].

To address the logistics training market in Germany, we align existing concepts like blended learning to the specificities of SCM in the context of the EffizienzCluster LogistikRuhr project Supply Chain School. Therefore, we describe these specificities and trends in SCM education. Subsequently, existing approaches and didactical concepts to close the resulting gap between training offerings and demand are presented and evaluated (e.g., competence-based learning, self-regulated learning, e-learning, transfer of scientific results into practice, and return on education).

The need for holistic and integrated concept in SCM education is highlighted by presenting a research agenda that aims ultimately at implementing an educational SCM institution: the Supply Chain School (SCS). The SCS will provide a platform that integrates technological and didactical concepts to improve SCM education.

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Learners will be encouraged to study based on their existing competences and to self-regulate their learning paths. Furthermore, the return on education will later be evaluated to prove the extent of learning progress. Finally, we present first results regarding the derivation of standard job-profiles that build the basis for competence-based learning paths in the SCS.

2 Foundations

Recent societal developments and new global challenges make great demands on recent and future SCM managers [13] and [20]. Training and further education of specialists will be one of the major future aspects in SCM's development.

2.1 Logistics and Supply Chain Management Education in Germany

The industry's demand for logistics specialists and executives exceeds the educational institutions' supply [1]. The logistics and SCM industry is the third largest in Germany [18]. Currently, 2.8 million people work in the area of logistics; in 2010, 50,000 new jobs were created. In 2011, a similar growth in employment is expected. Another study on the logistics industry additionally underlines the need for adequately trained logisticians [9]. Accordingly, there is a skills gap numbering a minimum of 3,500 executives in logistics annually in the German market.

According to a survey conducted by the German Federal Ministry of Education and Research (BMBF 2009), about one third of the surveyed logistics companies will train employees that newly take on a role in a logistics job. Companies see the biggest need for training employees in executing activities in the fields of basic logistics knowledge, security and environmental protection, and in dealing with logistics engineering. Employees who are entrusted with conceptual and planning activities, like logistics specialists, also have demands in logistics concepts and IT user knowledge. Therefore, information regarding the employees' training needs shows that specific qualifications, which exceed the present employees' qualifications, are relevant, e.g. training concerning social and personal qualifications, as well as planning and controlling, are especially relevant for employees on the lower and middle management level.

Cost pressures and careers that are oriented across enterprise barriers in logistics force organizations to analyse the value of investments in education and training. Established concepts like the return on investment (ROI), which is based in finance and controlling, are only suitable to a limited extent [17] and [2]. In the context of e-learning, preliminary discussions are held regarding a concept to assess the return on education (ROE) [28].

2.2 Recent Concepts in Education

During recent years, lifelong-learning concepts have gained increasing importance in Europe. Lifelong learning describes the process of an education which exceeds formal learning in education and training institutions, in order to meet the requirements of a developing society with changing demands [7].

However, the accreditation of further education is a considerable challenge. The German Federal Ministry of Education and Research streamlines strategies to simplify the accreditation of non-formal acquired competences through further education, promoting permeability between further education and higher education, and in this way supporting the lifelong learning process [5].

According to recent studies, a combination of presence events and e-learning modules – which is called blended learning – is more effective in the learning results and leads to a higher motivation by the attendee to participate [15] and [24]. By combining different educational concepts many advantages can be achieved – both for employees and for companies. Employees profit from an education which is more tailored to their individual requirements, especially regarding flexibility in terms of learning time and place [24]. Nevertheless, social aspects like networking or communication can still happen in organized learning events.

A recent organizational concept in education is the corporate academy, a strategic instrument of long-term employee development within a company [25]. Employees are trained exclusively in a company-specific created learning and training concept. The aim is to expand knowledge and to work out interests and focuses of employees in order to support early and effective in-house careers. In Germany, corporate academies mainly focus on a very limited target group such as the management level and management trainees [28]. Organizationally, corporate academies are independent institutions which collaborate with one or several education providers.

3 Towards the Integration of New Concepts in Logistics and Supply Chains Management's Education

To ensure qualification levels in logistics and to close the aforementioned executives' education gap, disadvantages of existing educational concepts have to be overcome and adapted to market demands and organizational requirements. Existing corporate universities and academies focus on business executives and management levels. A suitable offer does not yet exist for other professional fields and levels – especially not for logistics. Additionally, existing approaches focus too much on class lectures or e-learning. The individual's learning needs are rarely taken into account. New flexible learning situations will ensure that participants can use non-productive time for continuing education, at various locations or, respectively, at home. Consequently, companies can make training more attractive for employees, since knowledge is a strategic resource in global competition.

To address the identified gaps, we present a research agenda that incorporates the development of a framework for an integrative educational platform. This institution has to bring together the whole spectrum of logistics' knowledge with the advantages of blended learning. Supplementary studies that focus on individual as well as company interests will be conducted; namely self-regulated learning, competency-based learning, return on education, and transfer of research results into practice. These concepts have to be integrated within a holistic learning platform and will be briefly outlined in the following sections.

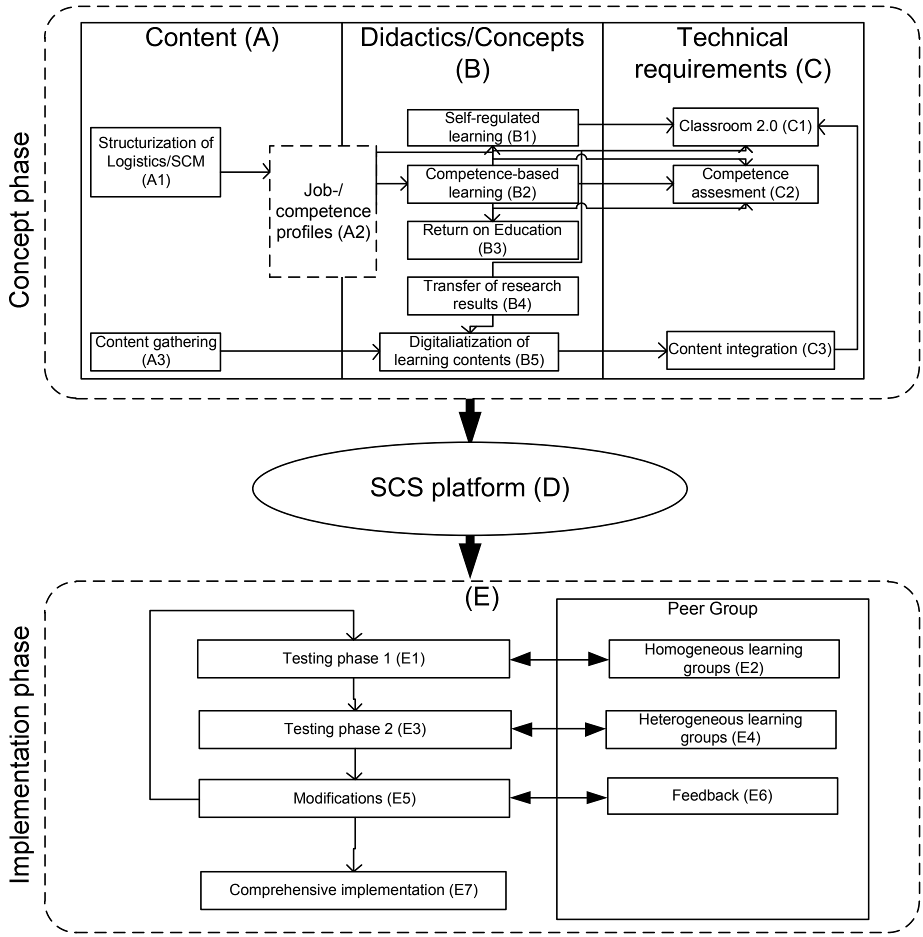

Fig. 1. Research Agenda for the Supply Chain School

Figure 1 depicts the research agenda that is reflected by the Supply Chain School's project structure. The research process is divided into two major phases. During the initial concept phase, the basis for the subsequent SCS platform's structure will be developed.

Three interrelated categories are developed during the concept phase by the research team. First, logistics' and SCM's content are gathered (A3) and structured (A1) for further application using a taxonomy. For this task, the practical relevance of the theoretic structuring is particularly emphasized. The taxonomy simultaneously acts as a structuring for job and competence profiles of logistics' staff (A2), whose further development will be addressed by didactical concepts (B) during the research project.

The didactical and organisational studies are developed synchronously. Hence, a close coordination is needed. For example, concepts for self-regulated learning [29], [3] and [23] are developed (B1), from which the technical requirements for the e-learning platform (C) that has to be implemented can be derived. The so-called classroom 2.0 (C1) will eventually be a suitable learning environment in terms of blended learning.

The need for personal development is addressed by the competence-based learning concept (B2) [4], [26] and [8]. Existing competences should be assessed using a competence taxonomy and compared with the requirements of potential job and competence profiles. This will allow individual and demand-oriented further development.

Appropriate instruments and indicators to demonstrate the trainings' benefits are evaluated using the concept of return on education (B3) [2] and [27]. This subproject aims at developing a holistic concept for the evaluation of on-the-job training's effectiveness in logistics by considering both monetary and non-monetary aspects. Therefore, investment costs of further education will be compared with the companies' and learners' benefits. The procedure model allows evaluating on-the-job training's effects. Thus, transparency regarding the companies' and learners' costs and benefits can be established. Besides monetary effects, the project also analyzes the impact of qualitative factors that can be achieved by subject-specific on-the-job training.

The ongoing coordinated transfer of research results into practice (B4) that allows keeping the learning content up to date and assures the training's quality, is another important aspect [21] and [19].

The concept phase's final steps include the digitalization of learning contents (B5) and the integration of these contents into a technical e-learning system (C3). Owing to the high demand for integration of the technology, content and didactic-related subprojects, there has to be an ongoing communication and coordination within the research team.

The first project phase's results will be consolidated into a learning platform (D). This, again, will be tested for its relevance and rigor during the implementation phase (E). For this purpose, a peer group is available, which consists of large-scale logistics companies with an intensive need for training and further education. Both homogeneous (E2) and heterogeneous learning groups (E4) are represented by peer group participants. Members of homogeneous learning groups are part of one company division with similar learning needs. Members of heterogeneous learning groups have more specific learning needs. In the testing phase, all parts of the training process from capturing the needs for training, conducting the appropriate training, to assessing the learning outcome, are tested (E1-E5). The platform will be technically and/or conceptually adjusted and retested [16]. The final objective of the research process is the comprehensive SCS's implementation as an institution (E7).

4 First Results

For comparative purposes, a common understanding of job profiles which are based on a transparent competence framework is necessary. The reason for this is a job market which is characterized by heterogeneous descriptions as well as requirements. This lack of definitions leads to overlapping of job profiles and a different understanding of relevant competences of logistics jobs.

Table 1. Preliminary definition of standard job profiles

No.	*Job profile*	*Hierarchy level*	*Topic*
JP01	Head of after sales logistics	Strategic	After sales logistics
JP02	After sales logistics expert	Operative	After sales logistics
JP03	Head of purchasing	Strategic	Sourcing & Purchasing
JP04	Manager strategic purchasing	Tactic	Sourcing & Purchasing
JP05	Strategic purchasing expert	Operative	Sourcing & Purchasing
JP06	Manager operative purchasing	Tactic	Sourcing & Purchasing
JP07	Operative purchasing expert	Operative	Sourcing & Purchasing
JP08	Transportation manager	Strategic	Transportation
JP09	Manager export & customs	Tactic	Transportation
JP10	Export & customs expert	Operative	Transportation
JP11	Manager disposition	Tactic	Transportation
JP12	Disposition expert	Operative	Transportation
JP13	Transportation planner	Tactic	Transportation
JP14	Warehouse manager	Strategic	Internal logistics
JP15	Internal logistics planner	Tactic	Internal logistics
JP16	Manager incoming goods	Operative	Internal logistics
JP17	Manager stock & supply	Operative	Internal logistics
JP18	Manager order picking	Operative	Internal logistics
JP19	Manager outgoing goods	Operative	Internal logistics
JP20	Warehouse specialist	Operative	Internal logistics
JP21	Head of production logistics	Strategic	Production logistics
JP22	Head of production engineering and planning	Tactic	Production logistics
JP23	Production engineering and planning expert	Operative	Production logistics
JP24	Manager materials management	Tactic	Production logistics
JP25	Materials management expert	Operative	Production logistics
JP26	Supply Chain Controller	Strategic	Performance Measurement
JP27	Assistant Supply Chain Controlling	Operative	Performance Measurement
JP28	Head of Supply Chain Management	Strategic	SCM & Strategy
JP29	Project manager Supply Chain Management	Tactic	SCM & Strategy
JP30	Supply Chain Management specialist	Operative	SCM & Strategy
JP31	ERP-/WMS-logistics consultant	Tactic	IT & Communication
JP32	Logistics software engineer/designer	Operative	IT & Communication
JP33	Head of quality management	Strategic	Quality management
JP34	Quality management specialist	Tactic	Quality management

Standard Job Profiles

To establish a transparency of logistics' and SCM's job profiles, standard job profiles were derived by evaluating companies' job advertisements. Therefore, in a time-frame of one year, more than 900 job advertisements were collected and clustered into logistics main topics. Jobs which are related to one cluster were compared and associated with strategic, tactical or operational levels [22] inside the main topic. The competences' frequency of occurrence in one level was checked and recurrent competences were summarized into one standard job profile. This resulted in 34 standard job profiles in logistics and SCM with related tasks and competences (see table 1).

The German qualification framework (DQR) [14] offers a framework of eight levels to assign the learners' competences and to map them into a German and European qualifications framework. In future steps, we will proceed to describe the generated standard job profiles regarding the DQR's competence domains. Thus, competences and their specific levels needed for job profiles' requirements will be described. This procedure is done in close coordination with the DQR, which is already used in other industries. Figure 2 exemplary provides a standard job profile subdivided into the DQR categories.

Standard job profile		
Description	Warehouse manager	
Alternative description	Head of warehouse, Depot manager	
General requirements	• Completed studies at college/university with a major in logistics/SCM in the field of engineering, industrial engineering, business studies or vocational training with specialized qualifications • Several years of work experience	
PROFESSIONAL COMPETENCE		
	Knowledge	Skills
Task 1: *Management, planning and optimizing of operative warehouse processes (from goods storage, consignment to distribution)*	Operative warehouse processes (from goods storage, consignment to distribution)	Coordination of critical points analysis Coordination of process analysis Designing Sankey-diagrams
…	…	…
PERSONAL COMPETENCE		
	Social competence	Autonomy
	Leadership ability Communication and presentation abilities	

Fig. 2. Exemplary standard job profile (Warehouse Manager)

The next step will be to validate these standard job profiles within a peer group. In cooperation with the research project, the participating logistics companies will verify the profiles in practice. The standard job profiles support a targeted and efficient training by matching the individual learning path with the required competences of a logistics job. Furthermore the standard job profiles can be treated as a set value during the Return on Education calculation.

5 Conclusion

Our research project contributes to both research and practice. The practical gap for training in logistics and SCM is addressed by the implementation of a platform that incorporates didactical, technological and organizational concepts. The research gap is addressed by integrating the applied studies and by aligning recent concepts to international frameworks that foster mobility and lifelong learning.

The presented research agenda provides a holistic and integrated view of relevant approaches, and allows the didactical and technological realization of the applied studies. First results already allow the structuring of contents and competences, and the mapping of job profiles. The results will form the basis for capturing competences that already exist and that need to be developed.

The next steps in working out the research agenda will allow implementing and conducting individualized and self-regulated training programs that will considerably improve the targeted logisticians' education in the future.

Our research agenda will ultimately offer benefits in practice, by allowing logistics organization to enhance their employees and to react promptly to changing requirements in industry. Furthermore, the research agenda contributes to future research in vocational training and logistics respectively SCM. Didactic concepts, which have up to now been individually handled, will be integratively developed, tested, modified and implemented. Besides the development of a platform, progress for the separate approaches is expected. Through a targeted connection of competence-based and self-regulated learning to international lifelong learning plans, the individual approaches will be placed in a broader context of interpretation.

References

1. Backes-Gellner, U., Kräkel, M., et al.: Demographischer Wandel, alternde Belegschaften und Betriebsproduktivität. Beiträge zur Personal- und Organisationsökonomi. Rainer Hampp Verlag, München (2008)
2. Bartel, A.P.: Measuring the Employer´s Return on Investments in Training: Evidence from Literature. Industrial Relations 39(3), 501–524 (2000)
3. Baumeister, R.F., Vohs, K.D. (eds.): Handbook of Self-regulation, Research, Theory and Applications. Guilford Publications, New York (2004)
4. Bersin, J.: Competency-Based Learning: The Resurrection of a Classical Approach. Media Tec. Publishing Inc. (2007)
5. BMBF, Accreditation of Prior Learning from Vocational Education & Training and work for Higher Education Programmes. Bonn, Bundesministerium für Bilung und Forschung (2005)
6. BMBF, Qualifikationsanforderungen der Betriebe im Bereich Logistik (2009)
7. Commission of the European Communities, A Memorandum on Lifelong Learning. Commission Staffworking Paper. Brussels, Commission of The European Communities (2000)
8. Deimann, M., Bastiaens, T.: Competency-based Education in an Electronic-supported Environment: An Example from a Distance Teaching University. International Journal of Cont. Engineering Education and Life-Long Learning 20(3/4/5), 278–289 (2010)
9. Ehmer, P., Heymann, E.: German Logistics Sector Back on Growth Track. T. Just. Frankfurt, Deutsche Bank Research (2011)

10. Ellinger, A.E., Ellinger, A.D., et al.: Logistics Managers' Learning Environments and Firm Performance. Journal of Business Logistics 23(1), 19–37 (2002)
11. Esper, T.L., Fugate, B.S., et al.: Logistics Learning Capability: Sustaining the Competitive Advantage Gained through Logistics Leverage. Journal of Business Logistics 28(2), 57–81 (2007)
12. Flint, D.J., Larsson, E., et al.: Exploring Processes for Customer Value Insights, Supply Chain Learning and Innovation: An International Study. Journal of Business Logistics 29(1), 257–281 (2008)
13. Gammelgaard, B., Larson, P.D.: Logistics Skills and Competencies for Supply Chain Management. Journal of Business Logistics 22(2), 27–50 (2001)
14. German Qualifications Framework Working Group, A. D., The German Qualifications Framework for Lifelong Learning, German Qualifications Framework Working Group (AK DQR) (2011)
15. Graham, C.R.: Blended Learning Systems: Definition, Current Trends, and Future Directions. In: Bonk, C.J., G.C. R. (ed.) The Handbook of blended learning: Global Perspectives, local designs. Pfeiffer Publishing (2004)
16. Hevner, A.R., March, S.T., et al.: Design Science in Information Systems Research. MIS Quarterly 28(1), 75–105 (2004)
17. Kirkpatrick, D.J.: The Four Levels of Evaluation. In: Brown, S., Seidler, C., et al. (eds.) Evaluating Corporate Training: Models and Issues, pp. 95–112. Kluwer Academic Publishers, Boston (1998)
18. Klaus, P., Kille, C., et al.: TOP 100 in European Transport and Logistics Services (2011)
19. Kumar, S., Thondikulam, G.: Knowledge Management in a Collaborative Business Framework. Information Knowledge Systems Management 5, 171–187 (2006)
20. Mangan, J., Christopher, M.: Management development and the supply chain manager of the future. International Journal of Logistics Management 16(2) (2005)
21. Pawlosky, P.: Begründung eines Wissensmanagement. Wissensmanagement, Erfahrungen und Perspektiven, pp. 7–45. Gabler, Wiesbaden (1998)
22. Schwab, A.: Managementwissen für Ingenieure: Führung, Organisation, Existenzgründung. Springer, Berlin (2008)
23. Sitzmann, T., Ely, K.: A Meta-Analysis of Self-Regulated Learning in Work-Related Training and Educational Attainment: What We Know and Where We Need to Go. Psychological Bulletin 137(3), 421–442 (2011)
24. So, H.-J., Bonk, C.J.: Examining the Roles of Blended Learning Approaches in Computer-Supported Collaborative Learning (CSCL) Environments: A Delphi Study. Educational Technology & Society 13(3), 189–200 (2010)
25. Sponheuer, B., Vernau, K.: Corporate Academies: lebenslanges Lernen aus Unternehmens- und Hochschulsicht. In: Birkholz, K., Maaß, C., von Maravic, P., Siebart, P. (eds.) Public Management - Eine neue Generation in Wissenschaft und Praxis: Festschrift für Christoph Reichard, p. 375. Univ.-Verl., Potsdam (2006)
26. Union, E.: Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning. Official Journal of the European Union (2008)
27. Wang, M., Vogel, D., et al.: Creating a performance-oriented e-learning environment: A design science approach. Information & Management 48, 260–269 (2011)
28. Wimmer, K.: Die Bewertung von E-Learning. VDM Verlag Dr. Müller, Saarbrücken (2007)
29. Zimmerman, B.J.: Self-Regulated Learning and Academic Achievement: An Overview. Educational Psychologist 25(1), 3–17 (1990)

Integration of Case-Based and Ontology-Based Reasoning for the Intelligent Reuse of Project-Related Knowledge

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Abstract. The knowledge management techniques case-based and ontology-based reasoning are applied to the domain of complex, especially international logistics or supply chain management projects. The aim is to support the "intelligent", i.e. content-addressed ("semantic") reuse of knowledge about such projects. We present as an example a recommender system for the acquisition and reuse of knowledge about international transport projects based on relevant ontologies integrated in the well-known CBR cycle. The recommender system is implemented using the open source CBR development framework jColibri.

Keywords: Case-based reasoning, knowledge management, knowledge reuse, logistics / supply chain management / transport projects, ontologies.

1 Knowledge Management for Logistics Projects

The management of projects is a well known part of management science. But until now, purely quantitative and "hard" project management techniques like the critical path method (CPM) and the project evaluation and review technique (PERT) have been dominant. This main stream approach can be characterized as:

- numerically data driven,
- primarily operative,
- focused on limited quantitative and isolated objectives, and
- developed only for "hard" performance indicators.

With this main stream approach, only simply structured logistics projects can normally be managed. Complex, especially international logistics projects are often characterised by the following aspects: they cannot be described by simple, primarily numerical data, because numerous non-numerical, i.e. qualitative influence factors, must be considered. Due to the often serious and long-term consequences for the affected logistics service providers, both an operative and a strategic approach is

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necessary. The complexity of a project also manifests itself in that multiple, often conflicting and, first and foremost, qualitative objectives must be taken into account. Due to the qualitative objectives, "soft" performance indicators also need to be considered when evaluating the success of a project.

The following list makes clear the diversity of influence factors and objectives which can play a role in complex international logistics projects and which can often only be represented in non-numerical i.e. qualitative ways.

- means of transport used (e.g. lorries, goods trains, freighters) and traffic carriers (e.g. roads, railway tracks, shipping routes) including their combinations;
- transport links and networks used;
- project-relevant, specialized geographic knowledge of transports links, networks, and junctions;
- regional, national and international transport regulations and usances, which are important for the project;
- indication as to whether the logistics project in question is a one-off or to be repeated: e.g. one-off transport of a large-scale plant or repeated transport of building materials or consumer goods;
- export control regulations and compliance specifications including the prohibitions and limits resulting from them;
- HS-Codes (EU tariffs, foreign tariffs) for customs duties;
- customs formalities and customs preference rules;
- credit rules and document check routines;
- detailed description of the goods to be transported: type of good (e.g. according to the customs catalogue), quantity of the good, size of the good (measurements, weight or volume), packaging of good, possible deployment of a container;
- specifically for goods packaging the following aspects should be considered: packaging material (e.g. wooden boxes, cartons, pallets), packaging aids (e.g. crumpled paper, Styrofoam, nails), package (unit of transport whose packaging material surrounds the product and diverse packaging aids), packing (work involved to pack completely an unpackaged good);
- skills or competences (in the sense of employee qualifications) which were especially important for the execution of the project;
- security precautions to be taken in terms of goods, transport, population, government, environment and data;
- extra legal, ecological and social factors which affect the organization of the logistics project – e.g. configuration of the supply chain or the modes of transport to be used (e.g. climate policy, green logistics, carbon-footprint discussions, corporate ethics and corporate social responsibility);
- critical success criteria or "key performance indicators", which have been identified as especially important for the success or failure of a project;
- quantitative objectives, e.g. project execution duration, violation of due dates, project costs, project revenues, market share;
- qualitative objectives, e.g. customer satisfaction, strengthening the competitiveness, gaining hardly to imitate or to substitute project management competences, increasing the reputation of being cable to manage complex international logistics projects.

The management of such complex, especially international logistics projects, in which influence factors and objectives, like the examples mentioned above, play a key role, is normally referred to in "modern" business literature as supply chain management. Therefore, the terms "complex logistics projects" and "supply chain management projects" will be used interchangeably. Moreover, one must be aware that the qualitative or "soft" influence factors and objectives cannot really be adequately represented by simple performance indicators and corresponding numerical data on business processes, though.

To this end, more complex cognitive structures are required. These are generally denoted as "knowledge". In addition to project management, knowledge management is therefore required for our approach to computer-supported supply chain management. The management of such especially qualitative knowledge, which relates to business (operative and strategic), legal, ecological and social aspects of the design of supply chains, is the so called "good governance" focus of the joint research project OrGoLo which is part of the efficiency cluster "Logistics Ruhr". The acronym OrGoLo stands for "organizational innovations and good governance in logistics networks". The CBR tool presented here is one of the building blocks in the OrGoLo project.

For the reasons mentioned above, the management of complex logistics projects or supply chain (management) projects under consideration here can be regarded as a special logistics or supply-chain-related and project-related variant of knowledge management. The focus of this contribution is, therefore, the knowledge management of complex, especially international logistics projects, which can also be considered synonymously as supply chain management projects.

The knowledge management of projects is dealing in most cases with the acquisition of project-related knowledge, the "intelligent" reuse of the knowledge about previous projects and its adaptation to similar, new projects. The project-related knowledge mostly exists in the form of documents which represent the "lessons learned" of previous projects in natural language with little structure. Because such documents containing know-how, know-what and know-why about both successful and unsuccessful projects exist in large numbers, it is desirable to deal with this knowledge with the help of computer-based systems and make it available for the management of new projects.

Despite the promising preconditions to support the knowledge-intensive business processes of knowledge management with instruments of e-business, the current knowledge management systems are generally restricted to a "naive" or "technical" retrieval of similar documents. The search for a similar document takes place on a purely syntactic level with the help of simple search terms ("string matching"). A content-addressed and therefore "intelligent" search for reusable knowledge does not happen in this way. In the light of knowledge management there is still a lot of knowledge that could be used in new projects but is currently unused. So it is a big challenge for project-related knowledge management to prepare knowledge of experience from finished projects in a computer-accessible way [1].

2 Case-Based Reasoning for "Intelligent" Knowledge Reuse

One of the most interesting business economics approaches of reusing knowledge from already realized projects for new projects is the concept of case-based reasoning or – for short – CBR, which originates from information systems research and artificial intelligence research. [2, 3, 4, 5, 6, 7]. In this paper we will show how project management can be supported by the knowledge management technique of case-based reasoning.

A concrete logistics or supply chain management project is called a "case", and forms the so called case-base or knowledge base (a database containing the case descriptions, case results and case evaluations, see fig. 1 below). The cases also take into account the design, especially the planning, execution and control of logistical process chains and networks (in short: supply chains). Such supply chains contain the transport of goods and information between dispatchers and recipients.

The management of supply chains is usually based on experience and expert knowledge. The experience knowledge can be structured and stored in databases. Expert knowledge does take into account but also goes beyond experience. It integrates a large amount of experience with creative capabilities. The creativity allows for solutions which are new in the sense that they are not directly available from the stored data and cannot directly be derived from first principles. One approach to approximate such expertise in a systematic manner is case-based reasoning.

The reasoning process based on the knowledge stored in the knowledge base of a CBR system is usually divided into four phases of the so called CBR-cycle (see fig. 1): retrieve, reuse, revise, and retain.

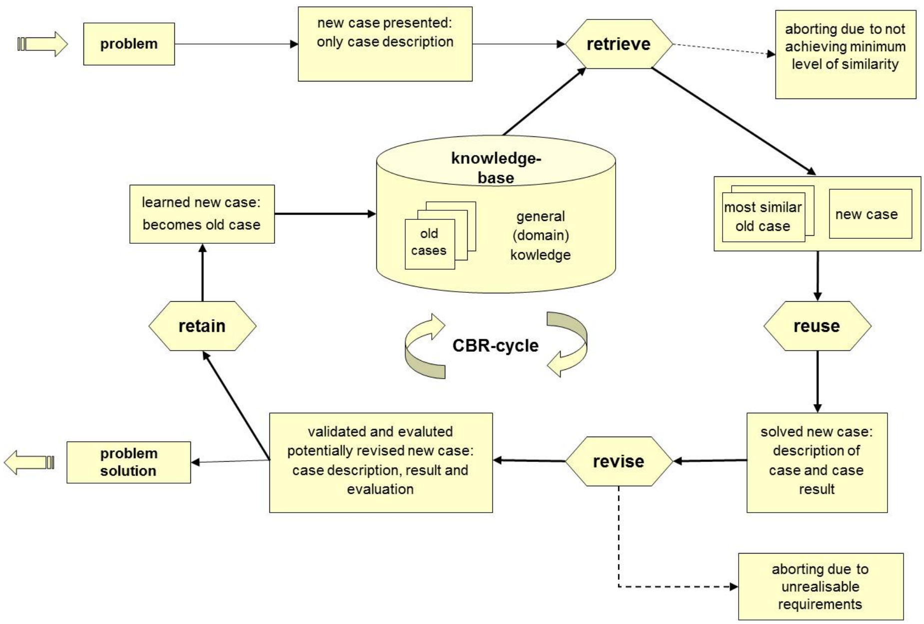

Fig. 1. The CBR cycle according to [2] and [1]

The description of a new case is used to retrieve at least one sufficiently similar and – if several sufficiently similar cases exist – at least one most similar case in the knowledge base. Having found such a sufficiently and most similar case in the knowledge base, the result of this case is reused by adopting it to the new case. The adopted result for the new case is potentially revised according to validation and evaluation criteria. The description, result and evaluation of the new case are combined in order to form a "learned new case" which is stored in the case base in order to retain the new acquired knowledge.

The case-based reasoning process sketched above turns out to be very interesting from a business perspective, because it provides a computer-based reconstruction of how people, both in private as well as in business, solve everyday problems. They orientate themselves to the successful solutions which were created by themselves or a third party for similar problems and which were carried over into the collective memory of a person or a company. Therefore, case-based reasoning has, from the perspective of business decision makers, the advantage of a higher cognitive adequacy

The situation can be compared to the problem of diagnosing an illness from the symptoms and prescribing a therapy. If one knows about similar cases in the past (i.e. similar symptoms), the diagnosis and therefore the therapy can be transferred to the case under consideration. The task is therefore to find those previous problems which are most similar to the current problem. For such similar problems it can be expected that the knowledge concerning the previous problems, i.e. their solutions as the case results, can be transferred and adopted to the new problem.

Considerable difficulties do, however, exist in the concrete application of the general concept of case-based reasoning in business practice. This is why it has been used for very simple, purely numerically characterized logistics problems so far, e.g. to solve travelling salesman problems. The application problems extend to three main areas. Firstly, it is extremely difficult to judge the similarity of projects (cases) especially if qualitative influence factors and objectives belong to the realistic case description. The difficulties arise because, on the one hand, similarity is a genuinely quantitative term and is in need of a metric measure of similarity, whereas, on the other hand, qualitative influence factors and objectives make such a quantification impossible prima facie. Secondly, there is much leeway in the application of case-based reasoning in terms of defining threshold values for "sufficiently" similar cases and – if several sufficiently similar cases exist – how many of these cases should be used in the construction of a solution for the new case. Thirdly, there are no generally applicable algorithms for adopting the results of old cases to gain a solution for the new case.

In the interests of brevity, only the first of the three difficulties mentioned above will be examined in more detail here to judge cases on their similarity when qualitative influence factors and objectives belong to the case description.

3 Representing Knowledge about Logistics Projects by Ontologies

The few attempts to use case-based reasoning for project management [8, 9, 10] failed up until now because of the difficulties when identifying those previous projects which contain useful, especially qualitative knowledge for the current project. It is difficult to measure similarity between knowledge collections (documents), though. They are written in natural language and usually heterogeneous with respect to the terminologies used. The use of natural language is necessary for representing qualitative knowledge but is an obstacle for the quantitative measuring of similarity between projects. The heterogeneity of terminologies cannot be avoided in complex, especially international logistics projects with a lot of involved actors (persons, companies, governmental and non-governmental organizations) which are used to express their thoughts within different company or organization specific and national languages.

To some extent, the idiosyncrasy of particular projects can be mitigated by broadening the case base (knowledge base) of a case-based project management system. Then, many case (i.e. project) descriptions have to be searched when a new project is planned. This task requires the help of computers. Therefore, the project-related knowledge has to be structured on the one hand to be suitable for storage in searchable databases or – more precisely – in case or knowledge bases. On the other hand, the representation of project-related knowledge must be flexible enough to be as close to the reality of project management as possible.

Ontologies offer a way to overcome the defects of operationalization regarding the concept of similarity between qualitative and heterogeneous knowledge about projects, because with the help of ontologies it is possible to "measure" the *semantic* distances between natural language terms which are used for the representation of especially qualitative knowledge about different projects.

In more general terms: an ontology is an explicit and formal language specification of these linguistic means of expression which are considered necessary for the construction of representational models of a common conceptualization of real phenomena used by several actors. Thereby the conceptualization extends to these real phenomena which are regarded by the actors as observable or imaginable in the subject- and goal-dependent restricted real world situation and which are used or needed for the communication between the actors [1].

The development of ontologies for business relevant domains has not yet progressed far. Up until now, ontologies have unfortunately been presented as being developed, as a rule, by computer scientists and engineers who possess little feel for the subtle differences in business terminology.

Especially for the domain of complex, international logistics projects (and –synonymous – supply chain management projects) there are as of yet no ontologies which were acceptable from a business perspective. Therefore a fundamental goal of the joint research project OrGoLo is to construct a set of ontologies which cater for the above mentioned domain. In fig.2 below, an extract from such an ontology is referred to, which is represented in the form of a graph with nodes and directed edges (ontology graph). The nodes represent some of the linguistic means of expression which are necessary for the articulation of knowledge of projects from the aforementioned domain. The directed edges represent some of the taxonomic ("is a") and non-taxonomic relations, which are typical for the content dependencies between these linguistic means of expression.

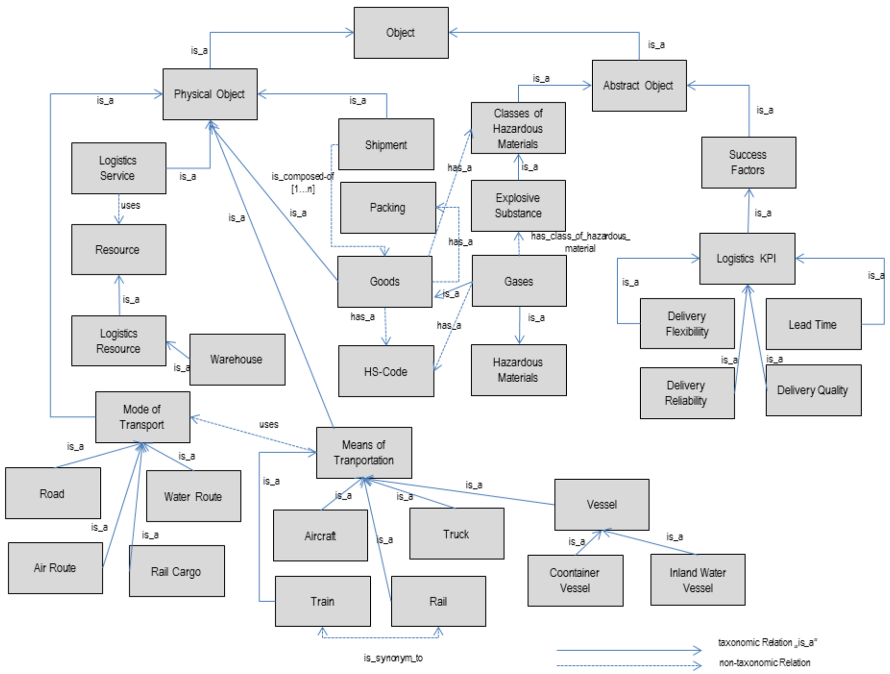

Fig. 2. Part of an ontology for the domain of complex logistics projects

One big challenge for the joint research project OrGoLo is to develop ontologies for the domain of complex, especially international logistics projects and – synonymous – supply chain management projects which can do justice to both the linguistic usage in practice in companies and other organisations as well as the stricter requirements of business terminology. Moreover, it is necessary in these ontologies to include different descriptions for the same data in different languages as well as different standards, e.g. HS-Code. Finally, it is desirable to expand the ontologies to inference and integrity rules ("heavy weight ontologies") which allow for the comprehension of such knowledge over and above purely terminological knowledge, which allows for the production of new knowledge (inferences) and the protection of the consistency of existing knowledge (integrity).

4 Integrating of Case-Based and Ontology-Based Reasoning

It is a special "craft" of ontologies to compare *qualitative*, which means non-numerical attributes of projects and display them on a *quantitative* similarity scale for case-based reasoning. First approaches at solving this highly difficult problem already exist [3, 11, 12, 13, 14, 15, 16]. Thus recent combinations of case-based reasoning and ontologies have attracted interest [11, 12, 17, 18]. However, these first approaches remain limited to simply structured domains with principally quantitative knowledge.

For the domain of complex, especially international logistics projects and – synonymous – supply chain management projects with considerable qualitative knowledge relevance there has been, in contrast, no corresponding research presented. Therefore, one central goal of the joint research project OrGoLo is to design an ontology-based and case-based reasoning system for the domain mentioned above and to develop it with computer support.

In order to implement this ontology-based CBR system in a user-friendly way, the CBR development framework jColibri, described in detail e.g. in [17, 19, 20], is used within the joint research project OrGoLo. The jColibri framework comes with a detailed example called "Travel Recommender". This example application is used as a blueprint for the "SCM Project Recommender" that supports projects managers with respect to the management of supply chain projects in the context of complex, especially international logistics projects. The major aim of the "SCM Project Recommender" is to assist e.g. dispatchers, when managing supply chains by providing access to expert knowledge from previous projects.

The basic development work for the ontology-based CBR system extends, on the one hand, to implementing domain specific ontologies within the jColibri development framework and, on the other hand, to developing a benchmark for the similarity of projects which refers primarily to qualitative project-related knowledge which is expressed in terms of natural language. The domain-specific ontologies were mentioned in chapter 3.

A benchmark for the similarity of projects on the basis of primarily qualitative project knowledge was developed in the joint research project OrGoLo and can also be found in the CBR development framework jColibri. This similarity benchmark is conceptually based on the measurement of the path lengths in a tree or network like graph, with whose help the domain-specific ontology is represented. See the exemplary ontology graph in fig. 2 above. On such an ontology graph the nodes represent linguistic means of expression (concepts or classes) and directed edges represent semantic dependencies (relations) between these linguistic means of expression. The knowledge of a supply chain management project can be classified on such an ontology graph. On this basis, similarities between projects are defined in which the length of paths between nodes, which represent content-wise similar knowledge of aspects of projects, is measured. In this way, it is possible to evaluate the mainly qualitative project-related knowledge, which is available in documents on previous projects, e.g. as lessons learned, with the help of quantitative similarity benchmarks. With regard to the details of this demanding transformation of primarily qualitative project-related knowledge into quantitative similarity measurements, please see the detailed commentary in [1, 11].

For example, a part of the retrieval phase of the ontology-based CBR system implemented in jColibri is shown in fig. 3. The user provides information on his new project ("case") regarding transport relation, goods, and other terms (e.g. customs). The weights of the different influence factors can also be specified. These weighted influence factors determine the search for similar cases in the knowledge base. The "SCM Project Recommender" searches for the most similar projects and presents part of them – i.e. the "problem solutions" (case results) – to the user. If the suggested solutions are acceptable, they are then adopted to the new project description to form a new case which can be revised and – if successfully revised – be retained within the knowledge base.

Fig. 3. Screenshot for the setting of the parameters of the similarity function implemented in the SCM Project Recommender (in German)

5 Summary and Outlook

In this paper it was shown how possible it is to intelligently reuse knowledge of supply chain management projects in the context of complex, especially international logistics projects through the integration of case-based and ontology-based reasoning. By means of this integration between two knowledge management techniques, which were developed independently of each other on the part of information systems research and artificial intelligence research, it was possible to define an operational, computer-supported calculable benchmark for the similarity between projects (cases) when the knowledge of these projects is primarily represented in natural language, i.e. qualitative form. A prototype CBR tool called "SCM Project Recommender" was developed to demonstrate the feasibility of this integration approach. This tool was implemented using the CBR development framework jColibri.

However, only the first of the three challenges which need to be mastered to be able to use the general concept of case-based reasoning in practice was examined here. It deals with the solution to the problem of judging cases regarding their similarity when case descriptions are available with qualitative knowledge. In contrast, more research is required to define "expedient" values for "sufficiently" similar cases and – if several sufficiently similar cases exist – to ascertain the number of cases which should be used in the construction of a solution for a new case. On the one hand, the effectiveness and the efficiency of case-based reasoning systems are influenced by the definition of the values and the number of cases. On the other hand, no theoretical or empirically secure knowledge exists on how such definitions affect the effectiveness and efficiency of the system. Furthermore, it is necessary to develop novel algorithms to adopt the results of old cases to gain a solution for a new case. This development task represents a particularly big challenge because with regard to such adopting algorithms only very rudimentary approaches exist, which are limited to very narrowly defined areas of application and cannot be transferred to other areas.

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References

1. Zelewski, S., Bruns, A., Kowalski, M.: Ontologies for Guaranteeing the Interoperability in e-Business: A Business Economics Point of View. In: Kajan, E., Dorloff, F.-J., Bedini, I. (eds.) Handbook of Research on E-Business Standards and Protocols: Documents, Data and Advanced Web Technologies, pp. 154–184. IGI Global, Hershey (2012)
2. Aamodt, A., Plaza, E.: Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches. AI Communications (AICOM) 7(1), 39–59 (1994)
3. Xiong, N., Funk, P.: Building similarity metrics reflecting utility in case-based reasoning. Journal of Intelligent & Fuzzy Systems 17(4), 407–416 (2006)
4. Riesbeck, C., Schank, R.: Inside Case-Based Reasoning. Lawrence Erlbaum Associates Publishers, Hillsdale (1989)
5. Kolodner, J.: Case-based reasoning. Morgan Kaufmann Publishers, Mateo (1993)
6. Watson, I.: Applying case-based reasoning. Techniques for enterprise systems. Morgan Kaufman Publishers, San Francisco (1997)
7. Avramenko, Y., Kraslawski, A.: Case based design – Applications in process engineering. Springer, Berlin (2008)
8. Dogan, S., Arditi, D., Asce, M., Günaydin, M.: Determining attribute weights in a CBR model for early cost prediction of structural systems. Journal of Constructions Engineering and Management 132(10), 1092–1098 (2006)
9. Chou, J.: Web-based CBR system applied to early cost budgeting for pavement maintenance project. Expert Systems with Applications 36(2), 2947–2960 (2009)
10. Li, Y., Xie, M., Goh, T.: A study of project selection and feature weighting for analogy based software cost estimation. Journal of Systems and Software 82(2), 241–252 (2009)
11. Beißel, S.: Ontology-based case-based reasoning – development and evaluation of semantic similarity metrics for the reuse of project knowledge in natural language. Doctoral dissertation, University of Duisburg-Essen. Gabler, Wiesbaden (2011) (in German)
12. Assali, A. A., Lenne, D., Debray, B.: Case Retrieval in Ontology-Based CBR Systems. In: Mertsching, B., Hund, M., Aziz, Z. (eds.) KI 2009. LNCS, vol. 5803, pp. 564–571. Springer, Heidelberg (2009)
13. Assali, A.A., Lenne, D., Debray, B.: Heterogeneity in Ontological CBR Systems. In: Montani, S., Jain, L.C. (eds.) Successful Case-based Reasoning Applications - I. Studies in Computational Intelligence, vol. 305, pp. 97–116. Springer, Heidelberg (2010)
14. Maedche, A., Staab, S.: Measuring Similarity between Ontologies. In: Gómez-Pérez, A., Benjamins, V.R. (eds.) EKAW 2002. LNCS (LNAI), vol. 2473, pp. 251–263. Springer, Heidelberg (2002)

15. Elleuch, W.Y., Jéribi, L., Tmar, M., Hamadou, A.B.: Case based reasoning using semantic annotations to assist the information retrieval on the Web. In: Schaaf, M. (ed.) ECCBR 2008: The 9th European Conference on Case-Based Reasoning – Workshop Proceedings, pp. 23–32. Tharax Verlag, Hildesheim (2008)
16. Wu, Y., Cao, C., Wang, S., Wang, D.: A Laplacian Eigenmaps Based Semantic Similarity Measure between Words. In: Shi, Z., Vadera, S., Aamodt, A., Leake, D. (eds.) IIP 2010. IFIP Advances in Information and Communication Technology, vol. 340, pp. 291–296. Springer, Heidelberg (2010)
17. DeMiguel, J., Plaza, L., Díaz-Agudo, B.: ColibriCook: A CBR system for ontology-based recipe retrieval and adaption. In: Schaaf, M. (ed.): ECCBR 2008: The 9th European Conference on Case-Based Reasoning – Workshop Proceedings, pp. 199-208. Tharax Verlag, Hildesheim (2008)
18. Roth-Berghofer, T., Adrian, B., Dengel, A.: Case Acquisition from Text: Ontology-Based Information Extraction with SCOOBIE for myCBR. In: Bichindaritz, I., Montani, S. (eds.) ICCBR 2010. LNCS, vol. 6176, pp. 451–464. Springer, Heidelberg (2010)
19. Recio-García, J.A., Díaz-Agudo, B., González-Calero, P., Sánchez-Ruiz-Granados, A.: Ontology based CBR with jCOLIBRI. In: Ellis, R., Allen, T., Tuson, A. (eds.) Applications and Innovations in Intelligent Systems XIV, pp. 149–162. Springer, London (2006)
20. Díaz-Agudo, B., González-Calero, P., Recio-García, J.A., Sánchez-Ruiz-Granados, A.: Building CBR systems with jCOLIBRI. Science of Computer Programming 69, 68–75 (2007)

Scientific Further Training in Logistics. New Paths in Vocational-Operational Qualification as an Aim of a Joint Research Project as Part of the LogistikRuhr Efficiency Cluster

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Abstract. This article focuses on the qualification requirements in logistics using the example of the joint research project "Scientific Further Training in Logistics (WiWeLo)", which is being carried out within the framework of the LogistikRuhr Efficiency Cluster. Starting from key logistical framework data, the research concept is presented together with initial result trends from the part-studies that have been carried out on various subject areas. The project aims to develop concepts which are adapted to the site of the Port of Duisburg for vocational-operational training in close cooperation with the port-based logistics companies. The central idea is the establishment of a network into which various players can incorporate their skills in order to implement tailor-made qualification measures for the companies and their employees. The establishment of DIALOGistik Duisburg at the port is intended to provide a facility which brings together the communication processes between the partners, provides design stimuli for the fields of work which are considered relevant, translates innovations into practice and oversees the implementation steps.

1 Further Training and Qualification in Logistics

Logistics is classified as an industry of the future with significant growth potential. With a volume of approximately €200 billion (see Klaus/Hartmann/Kille, 2010), Germany is the logistics leader in Europe. In terms of the national economy, the industry ranks second behind the automotive industry, followed by mechanical engineering and chemistry. With its dominant market presence and overall economic importance, the industry encompasses a core labour market (2010) of 2.57 million jobs, which is supplemented by a further 700,000 jobs in the supply industry and 1.7 million additional jobs in employment induced by logistics in other economic sectors. Despite the dynamic growth that has been achieved, the number of employees in most areas of logistics has decreased which has not only led to the compression of work processes, but is also being accompanied by higher qualification requirements (see Klaus/Hartmann/Kille, 2010; Doelfs 2011, Mehlis/Eberwein/Quante-Brandt 2010). This development is also accompanied by demographic change, which is currently

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 301–311.
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ongoing, and will in the future result in increasing demand for qualified personnel. Further factors which can be considered to influence the industry are the increasing international integration and accelerated innovation density (see Klumpp 2010, amongst others), which also demand a broadening of the individual skills base among employees. In this respect the development of customised training concepts as part of comprehensive occupational skills development represents a particular challenge if the industry wishes to avoid losing its international competitiveness. As a consequence, a realignment of the workplace qualification policy is therefore required, particularly with regard to new skill profiles of employees in the port sector (see Hasel/Tornau 2011; Mehlis/Eberwein/Quante-Brandt 2010). In so far the question has to be answered how the new adjustment of operational planning options and the relevant aspects of the new dimensions of contents can be conveyed. Furthermore, the establishment of new learning accesses and arrangements as well as the prospect of a changed personnel-political image, mainly for small and medium sized businesses need to be implemented (see Ahlene/Dobischat 2009).

Considered in historical terms, vocational and academic training have up to now been two largely insular qualification fields, which also apply to the logistics industry. The range of offerings in the education and further training system with its structure-defining function only permit a very low level of permeability from vocational to academic education. However, this strict demarcation is beginning to break down. One of the driving forces for this is the introduction of the German Qualification Framework, which intends to make a contribution towards the formal equivalence of vocational and academic qualifications. A further stimulus can be seen in the fact that the operational skills requirements are coming increasingly under the influence of the entire value chain among the industrial and commercial companies, logistics providers and transport companies. In order to that, the traditional delineation for academic and non-academic groups of workers in industrial and commercial areas of activity is slowly becoming blurred. As a consequence, innovative qualification concepts are needed that build conceptually on these development paths, as only broad-based qualification and training concepts can form a foundation for innovation across the entire supply chain to ensure the more efficient design of logistics processes.

As long ago as 2002 39% - and subsequently even 62% - of the companies surveyed considered cross-company knowledge management to be an urgent task (see Baumgarten/Thoms 2002). The increasing emphasis on knowledge management over recent years points to a changing professional field for the logistics company with a newly-defined skills profile (see Hasel/Tornau 2011). Especially because logistics not only moves steadily increasing flows of goods, but above all it also allows the targeted control and use of information on its way through companies and value chains (see Hasel/Tornau 2011, Baumgarten/Thoms 2002). Accordingly, the future requirements are not only limited to practical experience and theoretical expert knowledge, but also involve the knowledge of processes, forms of ethical and social skills, as well as communicative and analytical capabilities. Here the danger is seen that the traditional career path in the German logistics industry - with vocational training followed by operational management based on professional experience - can no longer satisfy the increasingly complex requirements, which in the international comparison might well turn out to be a growth inhibitor (see Schröder, 2011). The communication of cross-subject skills along the logistics value-added chain in particular (see Doelfs 2011) can form the basis of a new connection between practice-related knowledge based on experience and academic training in higher education. With the developments for opening the universities for professionally qualified people without the formal requirements via appropriate acceptance procedures, a possible solution has been found in terms of education policy and legality. However, this needs more practical implementation (see Kuda/Strauß etc. 2012, Dobischat/Ahlene/Rosendahl 2010).

2 Aim of the WiWeLo Joint Research Project[1]

The logistics sector is of particular importance not only nationally, but also for the regional economy, because with the globally networked division of labour, the logistical performance of a region takes on the role of an important location factor[2]. It is well known that with its large urban metropolises such as Duisburg, the Ruhr Area has been undergoing a major structural change for the past few decades. In the meantime the city of Duisburg has developed into a centre for logistics, commerce and services, which with the Rhine-Ruhr port as the largest inland port in Europe has become a regional logistics hub with a considerable amount of charisma. The companies located in the port employ around 40,000 people and therefore represent one in seven jobs in the city (see Sywottek 2011). It is primarily the linking of logistic flow processes with technological and work-organisation innovations (e.g. in the field of RFID technology) that forms the basis for further developing the logistics location of Duisburg by positive incentives for the labour market and employment and expanding existing competitive advantages (see Underberg 2011).

At the core of the underlying philosophy of the project "Scientific Further Training in Logistics (WiWeLo)" is the working hypothesis that innovation corridors (technical and organisational, personnel) can only be sustainably opened up by appropriate

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[1] The joint research project "Scientific Further Training in Logistics (WiWeLo)" is a research project sponsored by the Federal Ministry for Education and Research (BMBF) as part of the Excellence Cluster Competition of the Federal Government (High-Tech Strategy) and is a part-project of the LogistikRuhr Efficiency Cluster. This joint project is scheduled to run from October 2010 to September 2013. Besides the University of Duisburg-Essen (Institute for Vocational and Further Training, Department of Business Education) as the lead manager of this research project, further scientific project partners such as the Development Centre for Ship Technology (DST), the Institute of Logistics and Service Management (ild) at the University of Economics and Management (FOM), as well as practical partners such as the Port of Duisburg AG (duisport), the firm Servicegesellschaft für Spedition und Logistik mbH (SSL) and the Association for Forwarding and Logistics of North Rhine-Westphalia (VSL-NRW) are also involved. More detailed information on the joint project can be found at `http://www.uni-due.de/zlv/effizienzcluster/wissenschaftliche-weiterbildung-in-der-logistik.php` or at `http:// www.logistikruhr.de`

[2] For the location of the inland port in Duisburg see `http:// www.duisport.de` and for the Logistics Initiative Hamburg `http://www.hamburg-logistik.net/start.html`

training measures. However, this implies a scientific analysis of the content dimensions that are to be communicated, the process-related supervision of the testing of the appropriate measures, as well as the evaluation and documentation of the results and effects achieved. Ultimately this involves the development, implementation and evaluation of models of tailor-made, demand-based qualification concepts. In order to achieve this, a variety of players from the logistics sector are involved, who contribute their expertise towards various subject areas: On the one hand through the development of both conceptual and learning organisation arrangements that are developed in close coordination with the expectations put forward by the representatives of practical applications. On the other hand by scientific analyses of the target corridor of the requisite qualification requirements for specific operational target groups on different levels of the job hierarchy (see Volk 2012). On this basis, a bridge is to be created between vocational and higher education with the perspective of certified qualifications. For example, in the field of the "inland waterway" form of transport it is planned to develop a recognised professional certificate with a master's qualification which paves the way for access to higher education in accordance with the formal requirements of the German Qualification Framework, and therefore participation in scientific further training.

Since the scientific project work would be difficult to implement without institutional support, a service organisation is being established for knowledge transfer, qualification and logistics efficiency, namely DIALOGistik Duisburg with

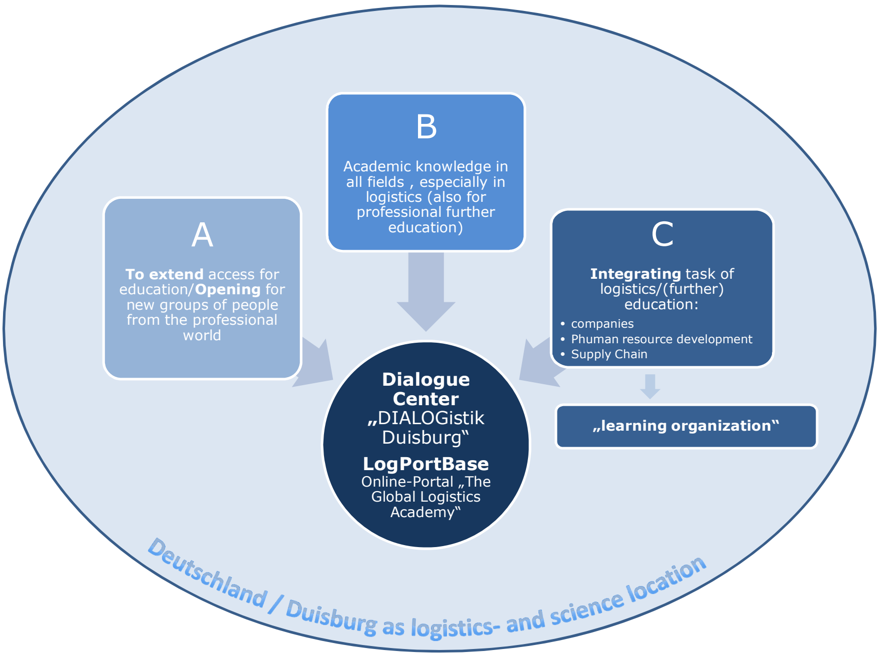

Fig. 1. Concept of the WiWeLo project

Source: own representation

headquarters in Duisburg. In this organisation the project activities of the participating partners are bundled together, so that it acts as a communication platform between science and practice. On this basis the future aim is to establish a Global Logistics Academy (see Figure 1).

3 Research Approach and Initial Result Trends from the WiWeLo Project[3]

The nucleus of the project is the identification of tailor-made education and qualification measures. It is well known that the leveraging of specific requirements is problematic, as they are not directly known by the experts themselves, especially when they are only present in a latent form and first have to be differentiated and operationalised for implementation in training concepts. For this purpose it is necessary to carry out systematising scientific analyses, which usually implies a multi-stage procedure for obtaining empirically reliable information. This methodological access was provided through the use of various qualitative and quantitative data collection tools. In an initial approach the regional labour and training market was analysed by means of logistics-related indicators and influencing factors with respect to potential skills requirements. A further analytical step was the evaluation of the national and local education market by means of criteria-based Internet research[4] and an analysis of documents. The aim of this part-study was to obtain an overview of the logistical further training opportunities in order to highlight the contents of relevant subject areas for the planned qualification measures. This evaluation was rounded off by analysing the issue of access to higher education for those with vocational qualifications from the field of logistics in order to place the objective of WiWeLo, i.e. permeability between vocational and academic education, at the focal point of the qualification activities. The results from these part-studies formed the basis for identifying the training needs at the Port of Duisburg location. For this purpose, a standardised data collection tool was created, which was sent by means of an online survey to all businesses at the Port of Duisburg. On the basis of the data analysed, in-depth, guideline-supported expert interviews were conducted with representatives of regional educational institutions and businesses in order to further specify the information obtained for pilot projects for training programs.

According to the results of a prognosis study (2009), the Port of Duisburg is considered to have above-average growth potential in the future, which gives rise to the expectation of quantifiable stimuli for the regional employment market in the field of logistics. However, the increasing demand for skilled workers might lead to a problem with respect to company recruiting. From the initial results of the training and employment market analysis it is clear that with an above-average proportion of training enterprises, i.e. 33%, in logistics-specific occupations, the Port of Duisburg is already taking into account the associated challenges in comparison to the data for the

[3] All of the empirical results and tools listed below have been developed in the WiWeLo joint research project within the framework of the LogistikRuhr Efficiency Cluster.

[4] For the methodological approach of an indicator-based training market analysis (see details contained in Ahlene/Dobischat 2008).

city of Duisburg, as well as the state- and nationwide training rates (see Federal Institute for Vocational Education, 2011). With the indicator-based area monitoring of the regional training and employment market developed within the project, the existing data and information base will be further expanded and consolidated during the future course of the project. Hence in the final stage the regional players can be provided with a permanent, data-based monitoring system through DIALOGistik Duisburg as a planning and design tool. An additional component of the monitoring is the education market analysis that is carried out. The information obtained in this context from expert interviews and analyses of documents shows that there is strong demand for operational qualifications and skills. However, this requires detailed differentiation in conjunction with cooperative-communicative processes through the inclusion of DIALOGistik Duisburg. The results of the survey of the skill requirements at the Port of Duisburg concretise the situation with respect to the contents of these requirements. For example, three out of four enterprises refer to qualification necessities with respect to the linking of transport and logistics systems through inter-regional supply chain management. Furthermore they refer to the interconnection of intermodal transport systems, with 90% of the companies seeing this as being of very high importance for the location of the Port of Duisburg and its development. A further aspect that received high approval ratings was that of a cross-sector connection between logistics and the fields of manufacturing industry, commerce and services, which is also reflected in a clear vote in favour of intensifying the regional networking of logistics companies. In this context, vocational education and training is given high priority without any restrictions, with the relevance of vocational training outweighing that of further training. The fact that the businesses located in the Port of Duisburg are active in the fields of education and training is shown by the findings of the study. One in three businesses provides training in logistical and logistics-associated professions, which is equivalent to a training rate of 77% for the companies surveyed, who according to their own statements intend to maintain or even increase this level in the future. The commitment to vocational further training (84%) is higher than the level for standard training. Amongst other things, this relatively high level of activity is due to the fact that the demand for skilled workers - particularly at the level of intermediate qualifications such as a master or technician - might cause procurement problems with respect to the external recruitment of personnel. The requirement situations in terms of the qualification of the workforces vary depending on the status groups. According to the above, planning, technology-associated and legal themes are of greater significance for the executive group than for the employees working in the operational planning and commercial sectors. The same applies to the requirements placed on the communication of general management skills and specific intermodal qualifications, the need for which is seen by 47% of the companies. However, qualification requirements are referred to not only for the executives, but - at 40% - such a requirement is also seen for the middle tier of skilled workers, especially when the emphasis is on the acquisition of competency clusters which are induced by tailor-made innovations for carrier-specific and intermodal activity profiles. As a cross-brace for the qualification of all operational status groups, the field of multidisciplinary skills is characterised by social, personal and cultural/foreign language aspects. For the corporate target groups working in the operational field of warehousing, transshipment and transport, the highest priority is given to the communication of social and personal skills. The subject areas of quality assurance, document control and verification, as well as specific loading skills (e.g. hazardous materials), however, also achieve high approval rates among the corporate players who were surveyed. Although the companies can provide a relatively clear outline of their current and future range of qualification requirements, there are considerable gaps in information and a lack of transparency with respect to the further training offers provided by regional educational institutions to cover the demands of businesses. It follows from this that in the future, increasing convergence between operational requirements and the training offered by the regional further training institutions should be initiated by DIALOGistik Duisburg in order to promote the Port of Duisburg site and push forward with the projected aim of a professional school and port academy. The WiWeLo project and its research activities will be able to provide an important impulse for this.

4 DIALOGistik Duisburg - a Tool for Knowledge Transfer, Qualification and Logistics Efficiency

With the institutionalisation of DIALOGistik Duisburg, a company-related network is being implemented which sees itself as a communication platform from the perspective of bundling information, knowledge and product results at the site of the Port of Duisburg and making it available for transfer to the regional players. From a company-related perspective it will act as a location for the design of further training and education in the context of company personnel policy in order to increase the skills base of the employees through workplace-related training. Thereby a contribution to a data-based improvement in the transparency of the regional training and employment market will be made. The innovative approach of DIALOGistik Duisburg can therefore also be seen as the conception of exemplary, certified training measures in a communication process involving all network partners which are intended to enable permeability between academic and vocational training. This is aimed at increasing not only the value of vocationally acquired skills through formal recognition processes, but also improving operational and inter-company mobility and opportunities for promotion for employees through extended options within the personnel deployment concepts associated with personnel policy. The bringing together of operational interests with respect to the use of their workforces, as well as individual employee interests in terms of their training and employment aspirations from the point of view of operational and workplace-related career structuring, can be seen as the core tasks of the work of DIALOGistik Duisburg. In this context it will also be necessary to examine whether concepts such as the introduction of company learning time accounts, which are to be understood as a regulatory tool for the structuring of learning times within the framework of vocational-operational training (see Ahlene/Dobischat 2011) can be activated by the project.

The concept of Duisburg DIALOGistik can be broken down into four different task areas (see Figure 2). DIALOGistik Duisburg is a ***place to exchange experiences*** between different partners in the logistics industry, and at the same time an interface with other sectors on the peripherals of logistics that are integrated into the logistics value chain. Through various procedures and tools of community building, special target groups (e.g. personnel developers, hazardous goods officers) are incorporated into a communication process that deals with subject areas that are relevant to practical applications and searches for appropriate solutions to problems. This exchange process is accompanied by the element of the ***dialogue between science and practice*** in order to define new contents and fields of work to the benefit of all players and feed these in turn into the communication process. A further range of tasks is operational and individual ***consulting and coaching*** along educationally-relevant issues such as vocational, training and health advice. This addresses the central aspect of the design of logistical ***education and training***. The focus of this range of tasks is on the provision of support services for small and medium-sized enterprises, which can in particular offer these businesses cost advantages and synergies within the framework of joint learning networks. The aim on the one hand is to create transparency in the regional education market, while on the other hand it is necessary to solve matching problems between specific company qualification requirements and further training offers outside the companies. In this context, the training monitoring function which is currently being developed, and which is to be operated as a permanent regional monitoring and evaluation tool by DIALOGistik Duisburg, will provide a valuable contribution. Coupled to the monitoring facility will be an online platform "LogPortBase", which will provide port-specific knowledge in a compressed and practically-relevant form in order to enable the faster and smoother cross-company transfer of knowledge.

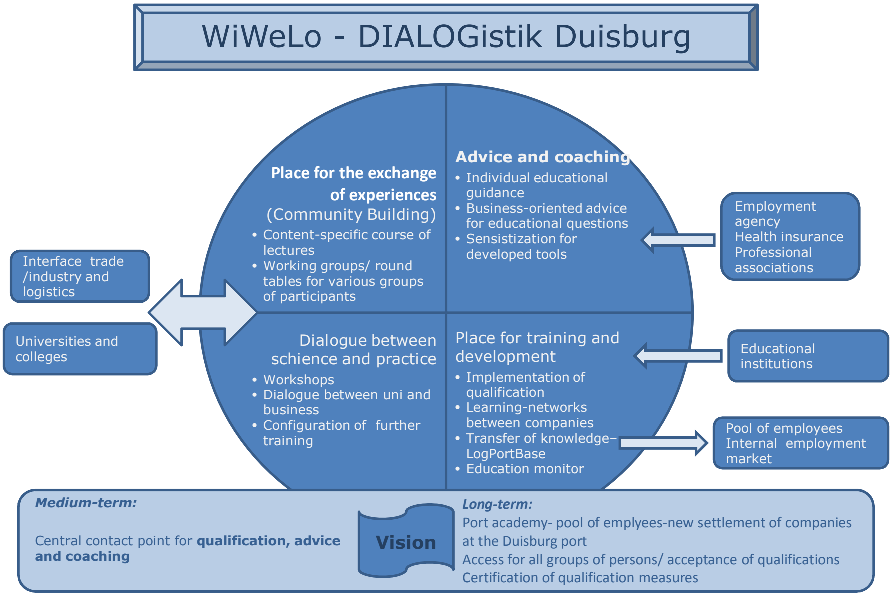

Fig. 2. DIALOGistik Duisburg concept

Source: own representation

DIALOGistik is linked in the long term to a development horizon in which it will be made use of as a "germ-cell" for the development of a Port Academy in which the operational requirements of education and training will be systematically determined and implemented with appropriate measures for the regional business network. At the same time an employee pool could be established for the Port of Duisburg to enable cross-company mobility of the workforces, secure continuous employment at the port and prevent qualified workers from moving away.

5 Conclusion and Outlook

The project results obtained up to now show that it has been possible to explore in greater detail the operational qualification requirements of businesses. It has also become clear that businesses are currently not in a position to define these requirements by themselves, let alone cover them. For this reason, the external support of the project is required. This also addresses the aspect of linking operational learning processes and human resource strategies, which the project has found to be a key range of tasks for DIALOGistik Duisburg. However, it has also been determined that businesses are only receiving limited assistance from the regional educational institutions in resolving their training and staffing problems, as there are significant gaps in information and a lack of communication on both sides. This is where the WiWeLo joint research project comes in by setting itself the task of developing tailor-made, modular-certified and transferable qualification measures in a close dialogue with company experts for different target groups. So an overall training concept that is marketable and accepted by the market in the field of "intermodal transport" and inland waterways can be drawn up. The point of reference here is to widen the bridge from vocational qualification to academic education in order to meet the requirement for more permeability in the education system and enable more individualised educational mobility for the purposes of opening up wider professional and career opportunities.

Through the project work that has already begun the WiWeLo joint project is making an important contribution to the overall direction taken by the LogistikRuhr Efficiency Cluster by initiating new impulses through qualification concepts and the synergetic release of innovations in research, development and cooperation. This process can make a contribution by means of "more intelligent logistics solutions" and support the strategic goal of the LogistikRuhr Efficiency Cluster. The central focal point in this context is DIALOGistik Duisburg, which processes a wide range of tasks and takes on the function of regional interface management for pending reorganisation processes at different levels. This takes into account the strategically important goal of the overall cluster, namely that of pushing forward with strengthening competitiveness in the region, since the long-term institutionalised alignment of DIALOGistik Duisburg can offer the best guarantee of sustainable results and effects in achieving logistical efficiency. With the cluster motto "Focus on the Individual", DIALOGistik Duisburg considers itself to be particularly committed to the aim of acting as a centre of excellence in the region. This generates and communicates knowledge, transfers the results from product developments of other projects of the cluster and performs interdisciplinary research across several branches of science, as well as making important contributions to the development of design skills in logistics.

References

1. Ahlene, E., Dobischat, R.: Betriebliche Lernzeitkonten – Zwischenbilanz einer Debatte. In: Berufsbildung für Wissenschaft und Praxis (BWP), vol. 1, pp. S.44–S.47 (2011)
2. Ahlene, E., Dobischat, R.: Qualifizierung zum Projektmanager Internationale Kontraktlogistik – Ein Beitrag zur systematischen Kompetenzentwicklung in kleinen und mittelständischen Logistikunternehmen. In: Borchert, M., Heinen, E., Zühlke-Robinet (Hg.) Systematische Gestaltung von Leistungen und Prozessen in KMU – Voraussetzung für erfolgreiche Internationalisierung von Dienstleistungen, pp. S.105–S.123. Verlag Dr. Jochem Heinzmann, Ingolstadt (2009)
3. Ahlene, E., Dobischat, R.: Qualifizierung durch Bildungsdienstleister – Angebotsanalyse als Methode zur Identifikation von beruflichen Kompetenzen im Tätigkeitsfeld der Kontraktlogistik. In: Borchert, M., Heinen, E., Zühlke-Robinet (Hg.) Kompetenzentwicklung in kleinen und mittleren Unternehmen – Voraussetzung für erfolgreiche Internationalisierung von Dienstleistungen, pp. S.79–S.107. Verlag Dr. Jochem Heinzmann, Ingolstadt (2008)
4. Baumgarten, H., Thoms, J.: Trends und Strategien in der Logistik: Supply Chains im Wandel. Technische Universität Berlin, Berlin (2002)
5. Bundesinstitut für Berufsbildung: Beschäftigungsstatistik der Bundesagentur für Arbeit; Stichtag jeweils 31. Dezember; Berechnungen des Bundesinstituts für Berufsbildung. Abrufbar unter (2011), http://bibb.de/dokumente/pdf/ausbildungsquote_gesamt_1999-2010.pdf
6. Dobischat, R., Ahlene, E., Rosendahl, A.: Hochschulen als Lernorte für das Lebensbegleitende Lernen? Probleme und Perspektiven für die (wissenschaftliche) Weiterbildung. In: Report. Zeitschrift für Weiterbildungsforschung, vol. 2, pp. S.22–S.33 (2010)
7. Doelfs, G.: Entlang der Wertschöpfungskette – ein Branchenreport. In: Mitbestimmung (Das Magazin der Hans-Böckler-Stiftung), pp. S.16–S.19 (March 2011)
8. Hasel, M., Tornau, J.F.: Die Hafenarbeiter von heute sind Computerspezialisten. Interview mit Heinz Brandt. In: der Hamburger Hafen, A., Logistik, A.G. (eds.) Mitbestimmung (Das Magazin der Hans-Böckler-Stiftung), pp. S.20–S.23 (March 2011)
9. Klaus, P., Hartmann, E., Kille, C.: Die Top 100 der Logistik. Marktgrößen, Marktsegmente und Marktführer in der Logistikdienstleistungswirtschaft. In: Ausgabe 2010/2011 Fraunhofer-Arbeitsgruppe für SupplyChain Services SCS, Deutscher Verkehrs-Verlag (2010)
10. Klumpp, M.: FOM Hochschule für Oekonomie & Management. Institut für Logistik- und Dienstleistungsmanagement (ild). ild Schriftenreihe Logistikforschung, Band 11 (Juni 2010)
11. Kuda, E., Strauß, J., Spöttl, G., Kaßebaum, B. (Hg.): Akademisierung der Arbeitswelt? Zur Zukunft der beruflichen Bildung. VSA-Verlag, Hamburg (2012)
12. Mehlis, P., Eberwein, W.: Quante-Brandt: Nachhaltige Beschäftigungsperspektiven für Arbeitslose und Geringqualifizierte durch berufliche Weiterbildung. Erste Befunde aus einem Forschungsprojekt zur Qualifizierungsoffensive in der Hafenwirtschaft. In: von Büchter, K., Meyer, R., Gramlinger, F. (hg.) Berufs- und Wirtschaftspädagogik (BWO)-online, Berufliche Weiterbildung, Ausgabe Nr. 19 (Dezember 2010) Abrufbar unter, http://www.bwpat.de/ausgabe/19/mehlis_etal_bwpat19.pdf

13. PROGNOS AG (2009),: Zukunftsatlas Branchen 2009 – Auf einen Blick. Basel et al. Abrufbar unter, http://www.prognos.com/Zukunftsatlas-2009-Branchen.656.0.html
14. Schröder, M.: Entscheidungskompetenz immer höher – Universitäre Weiterbildung wird wichtiger. In: LOGISTIK HEUTE (2011) Online Dokument unter, http://www.logistik-heute.de/node/6736
15. Sywottek, C.: Die Brache lebt. Das Logistikzentrum Logport I im Duisburger Hafen ist ein Paradebeispiel für gelungenen Strukturwandel. In: Mitbestimmung (Das Magazin der Hans-Böckler-Stiftung), pp. S.10–S.15 (March 2011)
16. Underberg, B.: RFID und mehr. Innovationstransfer. Im Effizienzcluster LogistikRuhr haben sich 130 Unternehmen zusammengeschlossen, um intelligente Versorgungskonzepte zu entwickeln. Im Blick sind auch die Qualifikationen der Beschäftigten. In: itbestimmung (Das Magazin der Hans-Böckler-Stiftung), pp. S.31–S.32 (March 2011)
17. Volk, G.: Mit "LOQUO" in die Zukunft. Die SICK-Logistik-Qualifizierungs-Offensive für Beschäftigte von der Basis bis zur Führungsebene. In: Berufsbildung in Wissenschaft und Praxis (BWP), pp. S.37–S.38 (January 2012)

Author Index