An Introduction to Logistics as a Service

Katja Klingebiel and Axel Wagenitz

Fraunhofer Institute for Material Flow and Logistics,
Joseph-von-Fraunhofer-Str. 2-4, 44227 Dortmund, Germany
{klingebiel,wagenitz}@iml.fraunhofer.de

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].

U. Clausen et al. (Eds.): Efficiency and Logistics, LNL, pp. 209–216.
springerlink.com

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)