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LOGISTICS EVENT MANAGEMENT – AN OVERVIEW OF CONCEPTS TO INTERPRET LOGISTICAL REAL TIME DATA

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A transparent transport chain is a central issue for an efficient and effective supply chain. Problems may arise if unforeseen disturbances appear and quality specifications of the goods are at risk. In these cases it is important that the operational logistics planners will be alerted as early as possible about the deviations, in order to be able to respond quickly. Therefore, the objective of this work is to give an overview of the actual concepts and approaches of supply chain event management. In the second part, a general concept of interpretation of logistical real-time data is described, consisting of three components: monitoring, logistics event management and early warning. This concept is not only focused on supply chains, but also applicable on hubs.

Keywords: supply chain event management, logistics event management, status, events, tracking and tracing

1. Introduction

A continuous and undisturbed flow of goods from suppliers to customers is a central issue for an efficient and effective supply chain. Distribution networks consist of transport edges and transhipment nodes, where edges are traffic routes (rail, road, water, air and intermodal transport) and nodes are distribution centres (hubs). A transparent flow of goods is essential to cope with increasing complexity of transport chains and high customers´ demand [1]. Problems may arise if unforeseen disturbances appear with the common consequence that the goods show defects in the form of deviations from the contractually agreed specifications. In these cases it is important that the logistics planners will be alerted as early as possible about the irregularities and failures to respond quickly [1, 2 and 3]. Many of these problems happen in hubs, because there, the goods pass all three essential logistics processes, which are transport, transhipment and storage. In these nodes, the transport chain is interrupted, e.g. by transhipping goods from one transport unit to another, and in many cases it is not certain whether the specifications of goods are considered.

To achieve all requirements for the operational control of a hub, it is important to have a transparent flow of goods. Since more than 10 years, Tracking & Tracing software is used by logistics service providers. These systems generate status data of logistics objects and enable the costumer to check the status of their order by web applications. But to monitor a logistics system, tracking and tracing systems have a lot of deficits. The systems have been primarily developed for the transport sector and are not proactive. In addition, these systems do not share different information with different users and no decision support is implemented [4, 5]. These deficits induce an information overload and increase costs to find the right information [6].

The information overload overstrains the logistics planner, so that it is not possible for him to filter relevant information out of the data stream without any software tools, which filter, aggregate and interpret data in order to respond to irregularities and failures in the transport chain. However, this is a weak point. The interpretation of real-time data reveals a deficit of clear and generally accepted theoretical concepts for data acquisition and interpretation [7].

To counteract this, the theory of supply chain event management (SCEM) was created in the last 12 years, but the theory was not systematized, consequently there were various definitions of SCEM [3, 8]. Moreover, the concepts focus on supply chains and are not transferred to a more general point of view.

The current software solutions alert when a discrepancy occurs between the current and target status of a logistics object. But this knowledge is not sufficient to make a considered decision. It is necessary to have an overview about the current status of the system, current and future events and the causes and dependencies of the irregularity in the transport chain.

Therefore, the objective of this work is in the first part to give an overview on the current concepts and approaches of supply chain event management. In the second part, a general concept of interpretation of logistical real-time data is described. This concept consists of three components: monitoring, logistics event management and early warning and is not only focused on supply chains. Moreover, the concepts of supply chain event management will be considered with the general concept.

2. Supply Chain Event Management & Logistics Event Management

Since the year 2000, the term "Supply Chain Event Management (SCEM)" has become widespread in literature. One of the first definitions is published by AMRResearch:

> "Supply Chain Event Management (SCEM) processes and systems alert companies to any unplanned changes in supply lines or other events so they can respond with alternatives. The set of integrated functionality crosses the five business processes of Monitor, Notify, Simulate, Control and Measure supply chain activities." [9, p. 9, original source no longer accessible]

In [10], SCEM is described from three perspectives: management concept, software solution and software component. The three perspectives are dependent on each other; "the software component is a part of an SCEM solution, and the solution supports the SCEM management concept" [10, p. 1].

2.1. SCEM as a Management Concept

Due to the existing concepts of supply chain planning, models of the supply chain generate a more precise image of the reality and the planning is more up-to-date than before (shorter planning cycles). The same applies to supply chain execution, which translates the plan in work instructions and documents. But both management concepts are not suitable to react to unforeseen disturbances [3]. Therefore, SCEM is defined as a mediator between supply chain planning and supply chain execution. [4, 6, 11, 12, 13, 14]

In [12], SCEM is understood as a concept to handle the registration, monitoring and evaluation of events within a company and between two companies. Otherwise, in [13], SCEM is defined as an early warning system for irregularities in the supply chain. For Wieser and Lauterbach [11], SCEM is a management concept which monitors and notifies deviations. SCEM is also seen as a proactive short-term planning and control concept [15].

The SCEM comprises two concepts, the first is management by exception (MbE), and the second is the event-oriented planning [2]. In [14] SCEM is equated with event oriented control of supply chains.

The benefit of SCEM for a supply chain is the reduction of the reaction time to a disturbance [2, 4, 6, 10, 11, and 13]. In [6], this benefit is referred to as SCEM in the narrower sense. Another benefit is the early detection of critical events and potential anomalies [10, 12, 13, and 15]. SCEM enables the evaluation of the supply chain performance [11] and reduces the flood of information [6]. With help of the management concepts of SCEM, the supply chain planner receives selected information about the supply chain, so that the complexity is reduced [6]. These benefits lead to a supply chain visibility and transparency [10, 14]. Otto states that the "visibility should be defined as an informational status. A supply chain is visible or transparent in case, if all the information needed to make a certain decision is available to the SCEM decision-making unit" [10, p. 4].

Heusler understands the long-term evaluation of critical events and disturbances as supply chain event management in the broadest sense [6]. Its aim is to identify trends and systematic errors [12].

Alvarenga and Schoenthaler systemize the various definitions of SCEM and identify that SCEM is "a new way to look at an old business operations problem" [8, p. 29]. For them, SCEM is "the application of statistical process, and technology identification and control solution to standard and nonstandard supply chain events" [8, p. 29].

Logistics event management (LEM) is seldom employed as an autonomous concept and is usually considered synonymous with SCEM. Real-time logistics event management has been interestingly defined as "The need for accurate and timely management of information in order to maintain on-time deliveries, reduce inventory levels and ensure that the right product is in the right place at the right time." [16]. Generally, LEM stands for event management in general logistical systems, whereas SCEM is specifically applied to event management in supply chains. However, the concepts und functionalities of SCEM are transferable to LEM.

2.2. SCEM as a Software Solution

To understand SCEM as a software solution, the view switches from a management view to a system view. The focus in this subsection lies on the functionalities of SCEM.

The functions of a SCEM solution, which stabilizes and re-synchronizes the internal logistical processes [10], are described in the literature in detail. There are three different concepts of functionalities identified which differ marginally from each other.

In the year 2000, the functionalities are described in [17] and were taken over from [2, 6, 11, 12, and 15]. Figure 1 shows these as five phases: `monitor´, `notify´, `simulate´, `control´ and `measure´.

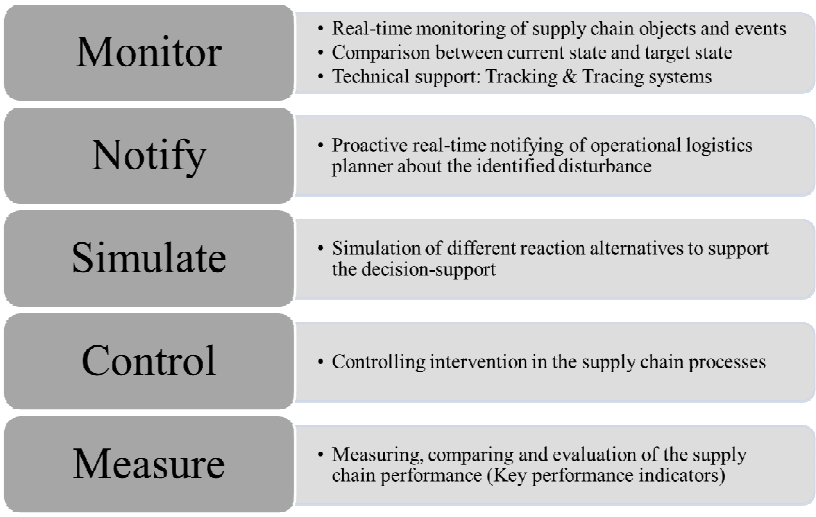

Figure 1. Functionalities of SCEM based on [2, 6, 11, 12, 15, 17]

In [10], the first three phases are transferred to a data-driven view and the focus is that the supply chain learns from the problems, see Figure 2. The first phase `monitor´ from Figure 1 is split up in three phases: `collect´, `document´ and `analyse´. The second phase `notify´ is contained in the second phase `document´.

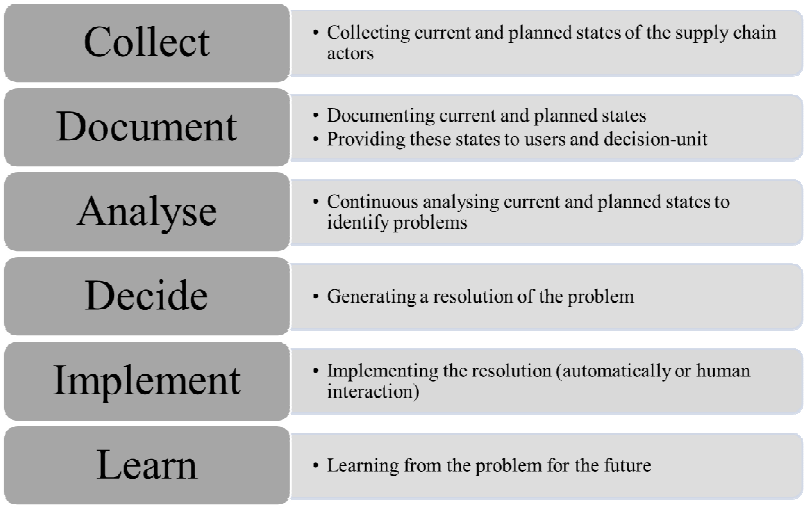

Figure 2. Functionalities of SCEM based on [10]

Kurbel and Schreber describe in [18] the SCEM functionalities based on intelligent mobile crisis response systems, which are detailed characterized in [19]. Figure 3 shows these six phases. Compared with the phases on Figure 1, the first two phases `monitor´ and `notify´ are supplemented with the phase `identification´. The last three phases are similar to Figure 1 and 2 and also focus on measurement of key performance indicators (KPIs) and supply chain performance.

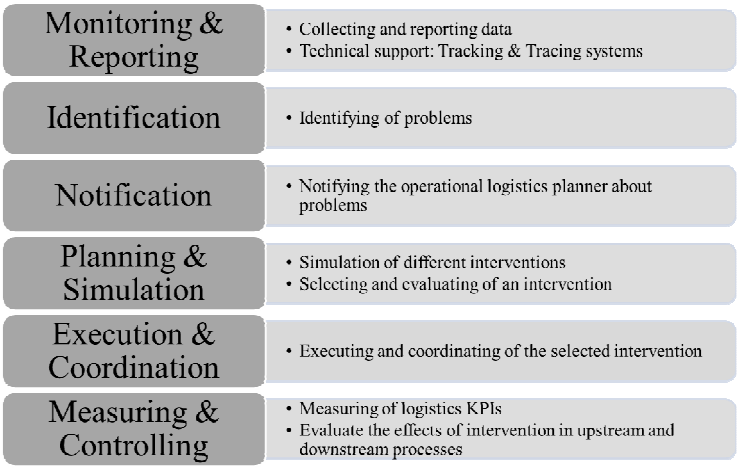

Figure 3. Functionalities of SCEM based on [18, 19, 20]

2.3. Event, Status and Situation

In the literature, there are various definitions of `event´ and `status´. For Nissen, events are messages from the logistical objects about the running process. The events are divided in `expected events´, `unexpected events´ and `expected events not occurred´. Based on this division, the SCEM decides if and to whom the `event´ should be notified [12].

In [4], `status´ is defined as information about the process status; all processes could be described as an infinite sequence of statuses. A `status´ will become an `event´, if an addressee exists to whom the status is essential to know. If the event induces an intervention (prevention of a delay), the event is critical.

Otto understands "event as milestone in a process, for which a status report is expected" [10, p. 2]. In this context, an event is not always a deviation. "An event message is a data feed that reports a predefined set of characteristics of an event" [10, p. 2]. There, "a deviation is defined as a difference between a planned status and an actual status of a particular attribute of the object" [10, p. 2]. If the value of the deviation exceeds or falls below a certain threshold, it is a problem [10].

Alvarenga and Schoenthaler define a supply chain event as "any individual outcome (or non-outcome) of a supply chain cycle, (sub)-process, activity, or task" [9, p. 29]. In this paper, an event category is developed as a logical group with an event probability index (EPI). The EPI is "a statistical measure, on a scale of 0 to 1, of the tendency of an event to occur within the supply chain (1 = always occur, and 0 = never occurs) over a given time interval" [9, p. 29]. Based on the EPI, a classification of events is given:

- EPI $\geq$ 0.50: Standard event,
- EPI < 0.50: Nonstandard event [9].

Moreover, Alvarenga and Schoenthaler define the event management plan (EMP), which is "a documented process that outlines the steps taken to control and react to an event" [9, p. 29]. If an EMP exists, the event is defined as planned event, otherwise as unplanned event [9].

In [6] not only negative events are defined, which show mistakes in the supply chain, but also positive events; these are events which accelerate the process and have positive influence.

The definitions of event and status are various, but most of the definitions distinguish between critical and non-critical events. Moreover, how critical an event is, is dependent on context and is different according to the addressee.

2.4. SCEM as Software Component

A lot of software products for supply chain event management exist, e.g. SAP Event Management [21] or PSI wms Event Management [22]. The software component is similar to an event management engine and has to consist of a mass interface, dialog interface and a core. "The mass interface handles the in- and outbound machine to machine-communication" [10, p. 10]. The dialog interface allows for the

communication with users. The core comprises an event processor, event handlers, expected event monitor and the rule processor [10]. The focus of the present article is not to describe the structure of the software component in detail; more information can be found in [10].

3. Concept to Interpret Logistical Real-Time Data

As described above, logistics event management is defined in this context as "the need for accurate and timely management of information in order to maintain on-time deliveries, reduce inventory levels and ensure that the right product is in the right place at the right time" [16].

On Figure 4, a concept for recording and interpreting of logistical real-time data is shown, according to [23]. A distribution centre with a storage and transport channels is represented as different measuring points, which are equipped with identification and location technologies. The measuring points generate primarily messages of current statuses and events about the logistical objects in the system to a server, where the messages will be stored and converted to a standardised format. Therein, current data will be stored as status and event protocols and past data will be stored in a data warehouse. The logistics control station is a software solution which consists of three components. The first is the monitoring tool, which visualises the real-time data as animations and plots. The monitoring tool is similar to the tracking and tracing systems, but mainly similar to the tracing system. The second component is the logistics event management, this component identifies situation (definition see below) and supports retrospective searches. The early warning system, the third component, simulates different scenarios to identify possible negative developments of the system and could also support the logistics planner to test different scenarios to react on a deviation [23]. The mesoscopic simulation is one possible simulation method which could support the early warning system [24].

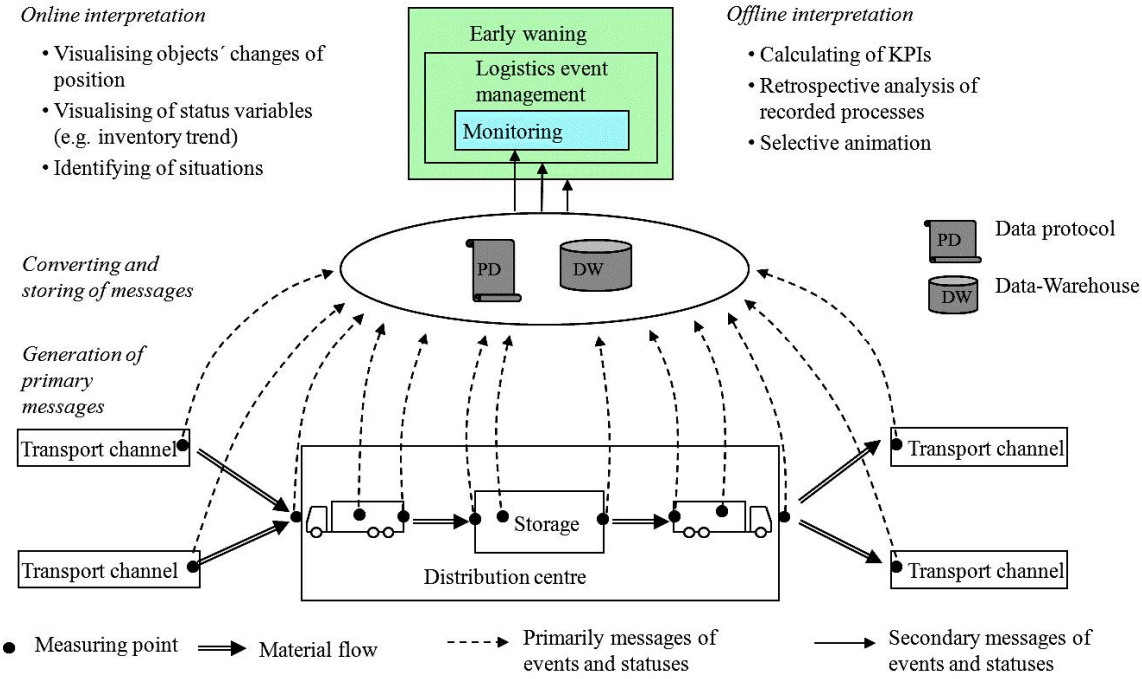

Figure 4. Concept for recording and interpreting of logistical real-time data, according to [23]

After a comparison of the phases from Figure 3 with the concept on Figure 4, it becomes obvious that the `monitoring´ component implies the first phase `monitoring & reporting´ and the third phase `notification´. The logistics event management is similar to the phase `identification´ and the early warning software includes the phase `simulation & planning´. The last phase `measuring & controlling´ is an offline interpretation of the logistics data and similar to the well-known concepts of logistics controlling.

As basis for such a concept, it is important to have a general data and system model, which is focused on an event- and object-driven view.

3.1. Conceptual basis

Based on the object-oriented perspective, two different classes of objects are defined: physical and abstract objects [7, 23, 25, and 26]. The different types of physical objects are listed in Table 1.

Table 1. Types of physical objects [7, 23, 25, 26]

Physical objects		
Moving objects	**Stationary objects**	**Complex objects**
Goods	Transport channel	Loading unit
Loading unit	Storage/transfer point	Means of transport
Means of transport		Transport channel
		Storage/transfer point

Another class of objects contains abstract objects which have been generated automatically or have been defined by humans. The different types of abstract objects are listed in Table 2. The objects of both classes are defined by different attributes, e.g. ID, position, status and physical parameters.

Table 2. Types of abstract objects [7, 23, 25, 26]

Abstract objects		
Defined by humans		**Generated automatically or defined by humans**
Business objects	Groups/fragments	Information objects
Contracts	All goods from one supplier	Objects that include data from physical or abstract objects
Orders	Specified storage zone	
Deliveries	…	

This concept additionally incorporates an event-oriented perspective to define an object's current state [7, 23, 25, and 26]. Various definitions of event and status are described in Chapter 2.3. For this concept, the definitions of [7, 23, 25, and 26] are used. An object's current status is described by its attributes, which have been predefined by humans. A multidimensional vector with the current time stamp in the first component and the current value of predefined attributes in all other components describe an object's current status [7, 23, 25, and 26].

An event is an alteration of at least one attribute of an object. An autonomous event describes the changes of only one of the object's attributes. When more than one attribute of the object change, the event is an associated event [7, 23, 25, and 26].

The interpretation of the overall system requires focusing on more than either the current state of an object or an event. Closer scrutiny of the combination of states and events is more important. A system's situation is defined as the current state of the system together with current and future events [7, 23, 25, and 26].

4. Conclusions

The objective of the work presented here is an overview of the concepts and approaches in supply chain event management. It is shown that there are different approaches for supply chain event management but no systematic and standardised concept. In the second part of this work, a general concept to interpret logistical real-time data is described. The general concept is applicable on supply chains and transhipment nodes. Furthermore, it is compared to and classified into the existing concepts of the first part. The term logistics event management is introduced and defined as well.

To conclude, the methods presented in literature on SCEM and LEM indicate a serious need for further in-depth research. The conceptual basis for the presented concept is developed. In the next steps, methods from information technology will be tested to identify critical situation and important information about the situation to support the decision-making process of the operational logistics planner.

References

1. Bretzke, W.-R., Stölzle, W., Karrer, M. and Ploenes, P. (2002). *Vom Tracking & Tracing zum Supply Chain Event Management - aktueller Stand und Trends.* Düsseldorf: KPMG Consulting AG.
2. Karrer, M. (2003). Supply chain event management – Impulse zur ereignisorientierten Steuerung von Supply Chains. In W. Dangelmaier, T. Gajewski, and C. Kösters (Eds.), *Innovationen im E-Business: die 5. Paderborner Frühjahrstagung des Fraunhofer-Anwendungszentrums für Logistikorientierte Betriebswirtschaft*. Paderborn: Fraunhofer-ALB.
3. Bensel, P. Fürstenberg, F. and Vogeler, S. (2008). Supply Chain Event Management. In *Digitale Schriftenreihe Logistik*, 3. Berlin: Technische Universität Berlin.
4. Bretzke, W.-R. (2002). SCEM – Entwicklungsperspektive für Logistikdienstleister. *Supply Chain Management*, III, 27-31.
5. Nyman, H.J. (2012). An exploratory study of supply chain management IT solutions. In Proceedings of the Hawaii International Conference on System Sciences, (pp. 4747-4756). Hawaii.
6. Heusler, K.F., Stölzle, W. & Bachmann, H. (2006). *Supply Chain Event Management: Grundlagen, Funktionen und potenzielle Akteure.* WiSt.
7. Schenk, M., Tolujew, J., Barfus, K. & Reggelin, T. (2007). Grundkonzepte zu logistischen Echtzeitsystemen: Monitoring, Event Management und Frühwarnung. In H. Wolf-Kluthausen (Ed.), *Jahrbuch Logistik 2007*. Free beratung GmbH.
8. Alvarenga, C.A. & Schoenthaler, R.C. (2003). A new take on supply chain event management. *Supply Chain Management Review*, March/April, 28-35.
9. Ijioui, R., Emmerich, H., Ceyp, M. & Diercks, W. (2007). Supply Chain Event Management als strategisches Unternehmensführungskonzept. In R. Ijioui (Ed.), *Supply Chain Event Management: Konzepte, Prozesse, Erfolgsfaktoren und Praxisbeispiele* (pp. 3-13). Berlin, Heidelberg: Physica-Verlag,
10. Otto, A. (2003). Supply chain event management: Three perspectives. *The International Journal of Logistics Management*, 14(2), 1-13.
11. Wieser, O., Lauterbach, B. (2001). Supply Chain Event Management mit mySAP SCM (Supply Chain Management). In S. Meinhardt (Ed.), *Fertigungsmanagement in der Supply Chain*.
12. Nissen, V. (2002). Supply Chain Event Management. *Wirtschaftsinformatik*, 44(5), 477-480.
13. Mors, M. (2002). Supply Chain Event Management System. *Supply Chain Management*, II, 25-28.
14. Reiche, F., Hofstetter, J.S. & Stölzle, W. (2009). Ereignisorientierte Steuerung von Lieferketten: Nutzen, aktueller Stand der Nutzung und Potenziale. In *Die St.Galler Supply Chain Event Management-Studie*. Göttingen: Cuvillier.
15. Steven, M. & Krüger, R. (2004). Supply Chain Event Management für globale Logistikprozesse: Charakteristika, konzeptionelle Bestandteile und deren Umsetzung in Informationssysteme. In T. Spengler, S.Voss & H. Kopfer (Ed.), *Logistik Management: Prozesse, Systeme, Ausbildung* (pp. 179-195). Physica Verlag.
16. Gourdin, K. (2006). *Global Logistics Management.* Blackwell Publishing.
17. Bittner, M. (November, 2000). AMR Research: E-Business Requires Supply Chain Event Management. In *The Report on Supply Chain Management.* Boston. (original source no longer accessible, reference as [Wieser2001])
18. Kurbel, K., Schreber, D. (2005). Mobile SCEM Agentenbasiertes Event-Management in globalen Logistiknetzwerken. *Industrie Management*, 21(5), 21-24.
19. Yufei, Y., Detlor, B. (2005). Intelligent mobile crisis response systems. *Communications of the ACM*, 48(2), 95-98.
20. Teuteberg, F. Diffusion und Anwendung von Technologien des Ubiquitous Computing zur Selbststeuerung im Supply Chain Event Management. In: *Ijioui, R., Emmerich, H. and Ceyp, M., (eds.), Supply Chain Event Management: Konzepte, Prozesse, Erfolgsfaktoren und Praxisbeispiele*, Physica Verlag, pp. 15–35.
21. SAP. Retrieving date of access June 2, 2012 from http://www.sap.com/germany/solutions/business-suite/scm/featuresfunctions/coordination key.epx,
22. PSI. Retrieving date of access June 2, 2012 from http://www.psilogistics.com/de/log-application/log-wms/log-event-management/
23. Tolujew, J., Reggelin, T. & Sermpetzoglou, C. (2007). Simulation und Interpretation von Datenströmen in logistischen Echtzeitsystemen. In C. Engelhardt-Nowitzki (Ed.), *Management komplexer Materialflüsse mittels Simulation : State-of-the-Art und innovative Konzepte. Leobener Logistik cases* (pp. 215-231). Wiesbaden: Dt. Universität Verlag.

24. Reggelin, T. (2011). *Mesoskopische Modellierung und Simulation logistischer Flusssysteme*. Magdeburg: Otto-von-Guericke-Universität Magdeburg.
25. Brandau, A., Tolujew, J. (2010). Logistics event management. In Proceedings of the *XXIV* on *MicroCAD; Szekció: Anyagáramlási rendszerek, logisztikai informatika.* (pp. 7-18). Miskolc, Hungary.
26. Brandau, A., Tolujew, J. (2011). Logistics event management. In M. Schenk (Ed.), *Proceedings of the 9th-10th IFF-Colloqium on „Forschung vernetzen – Innovationen beschleunigen“*, (pp. 47-52). Magdeburg.