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OPERATIVE SUSTAINABLE LOGISTICS MANAGEMENT SIMULATION

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ABSTRACT

Sustainable logistics concepts currently lack an *operative* transmission scheme: Strategic and customer requirements are increasingly prompting green concepts but on an operative level still quality, service and especially cost criteria are usually valued more important than sustainability concerns. Therefore this research article argues that further management and simulation models have to be developed, tested and implemented in order to help operational decision making in transport chains. This research contribution helps in this development by suggesting an operative sustainable logistics management scorecard and matching this with operational data from the DACHSER company, Germany.

1. INTRODUCTION

In general green and sustainable logistics concepts are focused on *strategic* decisions as e.g. location and general transport mode decisions. But nevertheless for future improvements and concept development also the dimension of *operative* logistics decisions is an important field of improvement. A significant environmental impact in this decision arena can be assumed as in most cases environmental impact worsens as time pressure is increasing and speed needs to be enhanced.

Therefore the concepts of supply chain event management have to be evaluated regarding sustainable information and decision making. As a guiding principle such day-to-day decisions (even automated ones in Supply Chain Event Management [SCEM] systems) should consider sustainable aspects as for example the implicated CO_2 emission by change in transport modes (e.g. air instead of seaway). Therefore existing calculation models addressing transport mode comparisons with emission criteria (Carter et al., 2008; Klumpp et al., 2009; Seuring et al., 2008; Zelewski et al., 2009) have to be merged with existing SCEM concepts. This is the topic of the following research paper.

2. SUSTAINABILITY AND LOGISTICS

The development of concepts in supply and logistics management towards more sustainability is driven by a *multitude* of factors, e.g. p*olitical influences* as e.g. the Kyoto Protocol of 1997, *media influences* expecting data, concepts and reactions from companies in order to prove their sustainable management policy and m*anagement influences* integrating the expected future raw material prices driven by shortages in raw materials due to restricted resources.

Literature regarding logistics, supply management and supply chain management is in many cases *cost* driven (Wiedmann et al., 2008, p. 63), *quality* (Bogaschewsky et al., 2008, p. 244) and *risk* oriented (Goll et al., 2008, p. 150). Sustainability concepts are to date only implemented as *sub-factors* in concepts within these three specific perspectives or for a specified industry sector (e.g. the food sector; Hamprecht, 2005, p. 2). Even optimization models with a per se *integrated* approach are missing sustainable parameters in their objectives (Kohler, 2008, p. 10).

From the literature it can be stated that the destinction between strategic and operative levels is not yet clearly established for sustainable logistics. Therefore table 1 is providing a first draft of such a distinction in order to provide further fields and topics of research. Operational sustainable logistics management deals with single transports, whether the decision time frame being short (event management) or long (contingency planning).

Table 1: Sustainable Logistics Dimensions

	Transport volume and interval: ***high/long***	Transport volume and interval: ***low/short*** (one-time)	
Decision time-frame: ***long***	Strategic Green Logistics (e.g. locations, transport mode)	**Green Logistics Contingency Planning (e.g. accidents)**	**Opertative Sustainable Logistics Management (OSLM)**
Decision time-frame: ***short***	Green Project Logistics Management	**Green Supply Chain Event Management (GSCEM)**	

3. INFORMATION MANAGEMENT IN SUPPLY CHAINS

Operational, event-driven systems allow the monitoring of stocks, orders and deliveries of goods along the supply chain. They identify expected events and unplanned incidents and inform the decision makers about their status with the aim of early identification of disorders and the states of emergency (Okhrin, 2008, p.111). Tracking and tracing of carriers and vehicles will be bundled provided and equipped with additional functions (e.g. warning functions) for better control and decision-support. Supply Chain Event Management requires for an efficient functionality a seamless flow of information within the corporate network. It allows the permanent monitoring of materials and goods flow along the entire value chain and implemented a coordinated management in the event of supply disruptions and emergency situations (Beckmann 2004, p. 113). The task of SCEM is an active and customer-oriented monitoring of the supply chain to the disturbances and variations in the value creation process in good time and to propose possible solutions. This increases the SCEM, the flexibility and responsiveness of the entire supply chain.

The SCEM is an interface between the created supply chain planning and pre-planned process and the course of the process in the operational process of supply chain execution (Arnold et al. 2008, p. 481). If deviations between the current actual state of the process and the planned course observed, the SCEM shall immediately initiate a series of reaction steps, which serve to address the malfunction and a planned continuation of the process and alternative solutions to pre-strike.

A SCEM system extends the functionality of tracking and tracing applications. The generic status messages are forwarded to the decision makers in real time. Later, the SCEM leads the target and actual analysis converts the signals into planned events or unplanned disruptions. The biggest advantage of the SCEM their transparency across multiple levels of the supply chain, since, ideally, all the individual processes are constantly monitored and controlled. However, making a high complexity and dynamics of the processes in a value chain, the effective implementation of the SCEM is a difficult task. SCEM has to realize thereby a permanent monitoring of material and goods flows along the entire chain and additionally has to make coordinated management action possible in case of supply disturbances and exceptional cases (Beckmann, 2004, p. 113). The task of SCEM is an active and customer oriented monitoring of the delivery chain to recognize disturbances and give possible solutions. Thus SCEM increases the flexibility and capacity of reaction of the entire supply chain.

The first theoretical bases of SCEM were already compiled in the form of elaboration about management by exception (MBE) in the middle of the last century, whereby beginnings of practical field use can be found in the bases of the tracking and tracing (Hunewald, 2005, p. 9; Wildemann, 2007, p. 13). Characteristic for the MBE approach is the fact of reducing control and steering activities of the responsible person. An intervention is only necessary if an event cannot be processed and/or settled independently by the SCEM system (Bittel et al., 1964, p. 5). With SCEM an interface is provided between the pre-defining supply chain planning (SCP), the planned process and the real operational sequence along the supply chain execution (Arnold et al., 2008, p. 481; Nissen, 2002, p. 477).

If deviations between the current actual condition of the process and the planned process are observed, SCEM introduces immediately a set of reaction measures, which serve for the recovery of the disturbances and a regular continuation of the process and/or suggest alternative solution types. Things like tracking and tracing, the traceability and on-line arrangement of goods, charge carriers and vehicles are bundled with additional functions (e.g. warning functions) for the better control and decision support provided. SCEM cannot replace the fundamental SCP but builds further on this (Bretzke, 2002, p. 28).

A SCEM system can extend the functionality of tracking and tracing applications. The generated status messages are passed on to the decision maker in real time. These of all participants of the supply chain collected data are supervised and interpreted by the event management system. In the further process SCEM accomplishes a comparison of nominal and actual values and designates the signals in planned events or unplanned disturbances (Klaus, 2004, p. 13).

This is the main task of the SCEM system. If the system registers an incident, thus a plan deviation from the defined specified condition, it tries to make a rapid reorganization of the process available on the basis of pre-defined solution alternatives. However this is only possible if a potential scenario is programmed in the event system and possible alternative solutions are implemented (Karrer, 2003, p. 188).

The biggest advantage of SCEM is transparency over several stages of the delivery chain, since ideally all individual shipments can be constantly supervised and steered. High complexity and dynamics of the processes in a value chain, however, make the effective implementation of SCEM difficult. Thus it is required that all processes are integrated along a supply chain in the event management system, because only with completely integrated and not partly omitted processes can an optimal reaction of the event management take place (Wildemann, 2007, p. 41).

As a condition for this a greatest possible information transparency along the entire supply chain has to be ensured (Wildemann, 2007, p. 44). In the course of constantly growing requirements of participants in the supply chain (shipper - service provider - customer) gains in particular the use of SCEM increasingly in meaning. Tracking and tracing, warning functions and further telematic components increase the quality and topicality of information about the whole supply chain. In direct consequence these tools permit optimal planning extending reactivity and effectiveness with deviations and exceptional cases.

SCEM can improve the efficiency and security of logistics processes. SCEM deployment optimizes the yield situation and customer satisfaction. The information gain concerning business processes secures a positive prognosis for the enterprise used by SCEM.

In order to *integrate* all the specified perspectives needed in a operative sustainable logistics a holistic management model is drafted in figure 1.

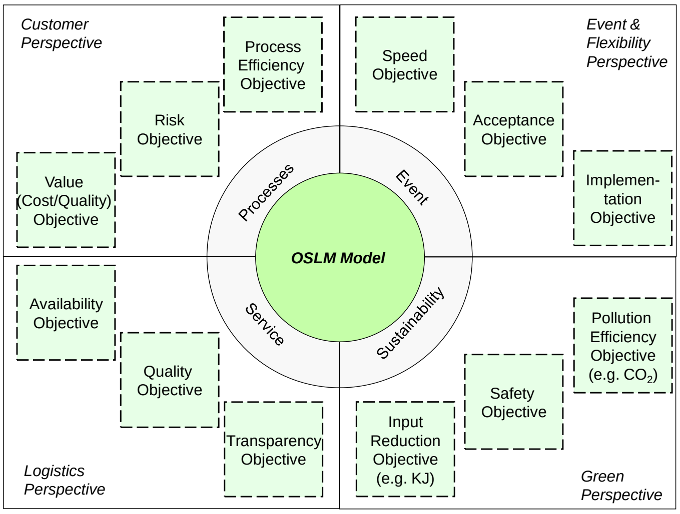

Figure 1: Operative Sustainable Logistics Management Model

First there is a *sustainability* or *green perspective* (Anderson et al., 2009; Archel et al., 2008; Darnall et al., 2008; Krause et al., 2009; Middendorf, 2008; Rodrigue et al., 2001; Straube et al., 2008) containing the following:

- *Input Reduction* objective calling for lower inputs of non-renewable materials as e.g. energy and raw materials needed for transport equipment and transport and logistics services.
- *Safety* objective describing the absence of harmful events such as oil and other dangerous goods spills in natural habitats or human injuries.
- *Pollution efficiency* objective determining a reduction of emissions of e.g. greenhouse gases or other pollutants in relation to logistics service outputs.

A *logistics perspective* (Bowen et al., 2001; Fleischmann et al., 1997; Tate, 1996) is underpinned by the following three important factors:

- *Availability* objective describing the basic function of logistics to ensure availability of the right goods at the right place and on time.
- *Quality* objective addressing the need for unharmed goods transport and smoothness of logistics *services* (service orientation, security awareness).
- *Transparency* objective in logistics depicting the aim to provide accurate and real-time information about transport, goods status and overall logistics performance for customers and other partners in the supply chain.

The *customer perspective* (Christopher et al., 2004; Giunipero et al., 2004) is described further by the following three objectives:

- *Value* objective addressing the ratio of costs and *product* quality in purchasing to be guarded and improved.
- *Risk* objective defining an overall risk management approach in order to avoid situations threatening company existence.
- *Process efficiency* objective determining the process time and internal process costs to be reduced in supply management e.g. by E-Procurement.

The *event and flexibility perspective* (Wagner et al., 2006; Wang et al., 2007) is outlined by the following three factors:

- *Speed* objective according to standard events in supply chains as usually disruptions in the transport chain create a need for higher speed.
- *Acceptance* objective mentioning that with increasing technology impact on all steps, persons and companies in a supply chain there has to be more emphasizing of acceptance.
- *Implementation* objective determining the fact that future technologies will need even more education and training efforts in order to fledge their full potential in supply chain event management (*implementation hurdle*).

All these factors together build an integrated view and might enable an integrated information modeling for logistics decisions – for the first time including sustainable decision facts. This could lead to more sustainable operational logistics decisions e.g. in transport modes and event reactions.

But still this model is missing quantitative measurement, simulation and controlling data. Therefore the authors developed in a logistics research project the following scorecard (figure 2), drafting operational measurement criteria for all the four perspectives of operational sustainable logistics management for the first time.

customer perspective		
objectives	measures	targets
process	customer satisfaction	school grade using survey better than 2,0
risk	% of all 'events'	< 5 %
cost	% cost overrun in LSP-responsibility	< 25 %

event & flexibility perspective		
objectives	measures	targets
speed	% on time in face of event	despite event on schedule > 50 %
implementation	total cost of all events in ratio to returns of all events	< 150 %
acceptance	average response time upon events	minimize, e.g. 23 h today => 21,5 h in future

logistics perspective		
objectives	measures	targets
quality	% on time of all	> 95 %
	low damage share	< 2 %
transparency	% of parcels in T+T-and/or SCEM-system	> 80 %
availibility	delivery time	e.g. 24 h run-time in germany / 48 h europe / 72 h worldwide

green perspective		
objectives	measures	targets
pollution	reduction absolute	minimize
	reduction below average	below 80 g (road transport)
output	certificate	ISO 14001, etc.
safty	net worth of all damages: damage costs / total turnover (alternative: per tkm)	< 1%

Figure 2: Operative Sustainable Logistics Management Scorecard

4. OPERATIVE DATA SIMULATION

The following operative transport data are used as an example in order to show an aggregated view as indicated on the OLSM model and scorecard draft above. The presented data are operational transport data from DACHSER in July 2010 concerning transports in Germany and Europe, usually consumer goods as e.g. coffee products or cosmetics. Interestingly the event descriptions provide a wide range of simulation and controlling requirements, e.g. from missing parts to consignees denying reception of goods. Today these events are handled on a single event "get it done" basis – but this should be changed by simulation and information systems as the scorecard drafted above in order to enable logistics management to react on a strategic level though operational transports are concerned. This could increase economic and sustainability gains in the supply chain.

ActiveReport DACHSER

Type Report Event	Origin of report		Division	Product	Consignee			Consignor				Order date	Quantity packaging	External remarks
	Date	Time			NC	ZIP	City	Name	NC	ZIP	City			
refusal of acceptance	19.7.10	12:19	Food Logistics	targospeed 12	D	81829	MUENCHEN	LAVAZZA LUIGI DEUTSCHLAND GMBH	D	60598	FRANKFURT	16.7.10	1 euro pallet	One CC was refused cause wrong goods has been delivered. A subsequent good will be delivered on the 21 of july till 9 o´clock a.m
New deadline arranged	20.7.10	12:00	Food Logistics	classicline	D	92355	VELBURG	LAVAZZA LUIGI DEUTSCHLAND GMBH	D	60598	FRANKFURT	19.7.10	49 carton	The consignee wishes the delivery on the 22 of july
Partial delivery	20.7.10	11:46	Food Logistics	targospeed 12	D	87534	OBERSTAUFEN	LAVAZZA LUIGI DEUTSCHLAND GMBH	D	60598	FRANKFURT	16.7.10	21 carton	One Item has not been delivered cause of a mistake by the Order Picking. We will deliver the item on the 17 th of july at the arranged time slot of the consignee
Consignment does not have any cartage note status	21.7.10	10:04	European Logistics	targospeed	D	21339	LUENEBURG	NORA SYSTEMS GMBH	D	69469	WEINHEIM	20.7.10	1 one way pallet	Shipment will be delivered in the afternoon
Complete deficiency	21.7.10	10:53	European Logistics	targospeed	D	35091	COELBE	NORA SYSTEMS GMBH	D	69469	WEINHEIM	20.7.10	1 one way pallet	When would you send us the shipment- Or should we cancel this Order? Many thanks for your soon reply in advance
Booking in (Avis)	21.7.10	02:23	European Logistics	targospeed	D	45770	MARL	NORA SYSTEMS GMBH	D	69469	WEINHEIM	20.7.10	1 one way pallet	The shipment arrived too late in our branch for the delivery in time. We would like to book in the shipment for the delivery today by an express to our charge or for the delivery tomorrow in the morning.

Figure 3: Operative Sustainable Logistics Data

ActiveReport is developed by Dachser and it is among to an innovative quality tool. This supply chain event management instrument is used in the practical experience to show and report proactively and directly every irregularity in the transport and logistic process; thereby the quality in logistic chains will be increased.
In fact each shipment is monitored continuously during the whole transport process. In the case of any difference for ex. Refusal of delivery, incorrect quantities or wrong delivery address, the Active Report tool automatically create a report about the deviation in real time, so that the shipper and Dachser staff can take corrective measures immediately. The Advantages for the customer with ActiveReport are:

- It increases the quality entire the logistic chain
- All the shipments are continuously monitored
- Transparence during the process chain
- Corrective measures can be taken immediately
- The customer can define precisely at the product level which information are relevant for them.

Example 1 (shipment for Marl; the latter in the table)**:** on 20 July the transmission fetched from the sender for the feed to 21.07. (in Marl). To 21.07. around 2:23 a ActiveReport originated in, since the vehicle did not arrive in the receipt address at 2 o'clock. (The feed is endangered). The Dachser coworker (the nightshift) examine, when the vehicle in the receipt address arrives and these inform. In this case the vehicle arrived after 8 o'clock. The feed cannot be accomplished. The outlet address informs the sender about the forthcoming run time excess and offers to the customer the further setting possibilities, like feed by special trip on the same day or feed on the next day for beginning of work. (This is the service of the Dachser). The sender examines, as hasty the transmission is and communicates his decision to the Dachser coworker.

Example 2: A shipment for Hamm could not be delivered, since the address is not correct. The driver enters this difference locally and transmits the data by GPRS to Dachser. At this moment a ActiveReport is provided automatically. The receipt address examines whether it the address via Internet or local directory. Directories to determine can order and the second feed. If the new address in the proximity is and the route is assigned. In this case was the address in another geographical place. The outlet address informed the sender about the setting difference and asked for further order. On the same day the new address was conveyed. These instructions were conveyed to the receipt address. This arranged the forwarding of the transmission to the responsible receipt address on the same day. The feed took place on the subsequent day.

5. OUTLOOK AND FUTURE DEVELOPMENT

The described OSLM simulation research brought the following main results:

- A concise management model for operational sustainable logistics is necessary and drafted in this article.
- The general model needs an outline in quantitative measurement data in order to be of value to logistics management and decisionmakers.
- Operational data from the logistics service provider DACHSER showed the wide range of events in operational transports and therefore the dire need to aggregate these information into management information, simulation and decision systems.

There may be several options for further research e.g. testing the suggested objective data in the OSLM model perspectives regarding their operational value in practice. Some parameters may have to be change to to company context, specific business area or even country and regional location and position in the supply chain (e.g. OEMs as Volkswagen: Koplin et al., 2007).

Further research may also extend the view of the four provided perspectives and the three objective areas within the perspectives if necessary.

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