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SMARTPHONE USE AS TRANSPARENCY IMPROVEMENT TOOL IN THE SUPPLY CHAIN EXECUTION

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Abstract As Supply Chain Transparency is a key success factor for effective *Supply Chain Event Management* (SCEM), many companies want to track & trace their individual orders. A new SCEM concept uses proven internet-based technologies and the *Global Positioning System* (GPS) on smartphones to overcome given media breaks of proprietory IT systems and addresses existing obstacles, especially in the fields of intermodal transports. With the integration of common smartphone technologies and transformation of social network principles into the professional field of logistics, a state-of-the-art toolkit is being developed for complex supply networks. Researched benefits result in a quick and interactive information flow with regards to the transparency of transports and shipped items. Gathered information can be published quickly to all relevant stakeholders in real time (like the sender, the shipper or the receiver of a load).

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1. INTRODUCTION

This paper describes how shipment information can theoretically be made transparent to stakeholders, with the joint appliance of location based systems and tracking technologies. In the telecom market there is a strong trend towards smartphones with permanent internet access and integrated *Global Positioning System* (GPS) functions. This trend could be used for a solution of existing supply chain management problems.

In addition to the navigation signal reception, smartphones do also have, depending on the coverage, constant connection to a cellular network. Hence, there is a bi-directional communication possible, which eases the possibility not only to receive satellite signals, but also to send and download information to and from internet applications. Due to the accurate positioning by GPS and cellular network, the user permanently can be tracked and served with location related information. Currently available mobile location-based communication services enable their users to consume categorized spatial information containing text, images, sound or video. The categorization of information can be made both passively – a user receives automated and predefined information – and actively – the user requests information individually.

1.1. The research outline

This research paper states that geo-tracking functionalities can be used not only for vehicles, but also for the tracking of their individual loads. In addition, accurate load data can be published in real time to all relevant stakeholders (like the sender, the shipper or the receiver of a load) via the internet. Forecasts of estimated arriving times can efficiently support the supply chain management of all partners in real time and the physical movement of material streams becomes visible.

For example, when a truck driver wants to know the cheapest petrol station close to his current route, *Location Based Services* (LBS) can provide actual information to his mobile device. Whenever the truck stops for a longer time period, the changed time of arrival can be transmitted to partners concerned. Such events can trigger, for example, a change in the production process, or a re-order in a dynamic delivery time window management system. LBS have a high potential to make a delivery process much more transparent in the future.

In having these visions in mind, the purpose of the research is to show how current and readily accessible technologies can be smartly combined, to create transparency through continuous information flow in the delivery process. The most important criteria for soon commercial use will be:

- smartphones, as they experience worldwide a high acceptance in the private as well as business sector and
- telecom fees for mobile internet, as they drop steadily all over Europe.

Thus, the low investment cost of the mobile devices and acceptable roaming fees make a cross boarder employment feasible in the near future.

1.2. The findings of the prototype

The practical findings prove that through the application of an innovative technology, both new transparency of supply chains, and also interactive communication and distribution control is possible. This was proven by a prototype system within a research project executed at the Logistikum in Steyr, Austria (Graf & Niedermayr, 2010, p. 82). This prototype uses location- and context based information for communication and enables users to post information of real locations randomly into the virtual world.

The prototype software controls and monitors not only individual trucks, but also individual delivery orders from suppliers to receivers. The purpose of such functionality is to be able to react accordingly to rush events in the supply chain, to identify and to respond with more agility to short call supply bottlenecks.

The vision of such open systems is to overcome the media break of proprietary as well as modal specific systems with a standardised internet based communication and information system.

2. PROBLEM DEFINITION – DELIVERY INEFFICIENCES CAUSED BY LACK OF REAL TIME INFORMATION

If enterprises can handle environmental dynamics, they will be successful. If they react inappropriately, it will negatively influence the operating performance (Wallenburg & Weber, 2005, pp.45-48). Beside a high environmental dynamic, the surrounding of supply chains is often non-transparent. The problem is a lack of trust between supply chain partners. Enterprises both lead to information barriers that hamper the communication and coordination within the supply chain substantially. Due to the insufficient transparency, processes along the supply chain and the existing environmental dynamic, get more and more non-transparent and are subject to disorders (Heusler, Stölzle & Bachmann, 2006, p. 20).

Enterprises are therefore encouraged to react flexibly to changes in their environment without reducing the efficiency. How flexible an enterprise can react is shown by its ability to tackle unexpected events. Events are based on status reports, and changes in a process that can be positive and negative. They can trigger further processes or be recognized as mistakes and signal a deviation of plans.

2.1. Limitations and flexibility of cooperating tiers

Articles and other gender related subjects are meant to be gender neutral. The renunciations of a gendered differentiation shell improve the readability. This ability is often limited by coordination problems between planning tiers. If an event occurs, under certain restrictions, the responsible planning tier must be evaluated. Due to the high number of events there is a high probability of coordination problems which results in an overload of tiers, nervousness in the business and a belated reaction to events and disorders.

The flexibility is therefore limited through the planning tiers in enterprises. Actually, these tiers couldn´t be easily waived as in fact some decisions are made by others and planning tasks are distributed between various decision making bodies. Thus, the increase of logistical performance of planning tiers can have a positive effect on the handling ability to unexpected events. In a dynamic environment, it is important not only to have reliable plans but in case of events, to also react accordingly and if necessary, with the right tools. Disturbances in the supply chain often cause changes in the system and deteriorate the overall performance.

2.2. Proprietary ERP-Tools biased towards non-transparency

The supply network of producing companies consists of many suppliers and transport service providers. Changes in the system trigger coordination processes which get unmanageable and non-transparent to all participants very soon. In fact, sudden changes happen not only due to changes in environment, but from customer's side. Therefore, this factum is hardly predictable. The rising non-transparency makes companies react intuitively and triggers uncertainty. The uncertainty mostly occurrs due to fluctuations in demand, procurement shortages, new suppliers or a simple shift in demand, but its consequences are always costly (e.g. additional shifts, extra miles etc.). Companies have often established safety stocks to come to grips with the planning deviations and therefore have a high capital lock-up.

An easy way to increase the reactivity is to optimize the information exchange between participating members in the supply chain. Through the fluent flow of information, the reaction time to events can significantly be decreased. Nevertheless, appropriate measures to enhance the quality of decision making are detailed forecasts to have a basis to counteract quickly and appropriately to events. Despite the detailed planning of many companies, there are many occurrences that are not

predictable. Some examples are traffic jams, accidents, breakdowns of a mode of transport, delays or troubles due to language problems.

To understand later remarks about previously and currently applied supply chain management software, the author wants to give a brief overview of the development and the functions of the tools (Contentually based on Kuhn, 2002, p.127).

For decades, companies try to increase their flexibility and reactivity to realise time advantages with software systems and at the same time improve their quality. In early stages, material handling was controlled and the material demand could be forecasted. The information feedback was poor and thus that the actuality of data insufficient.

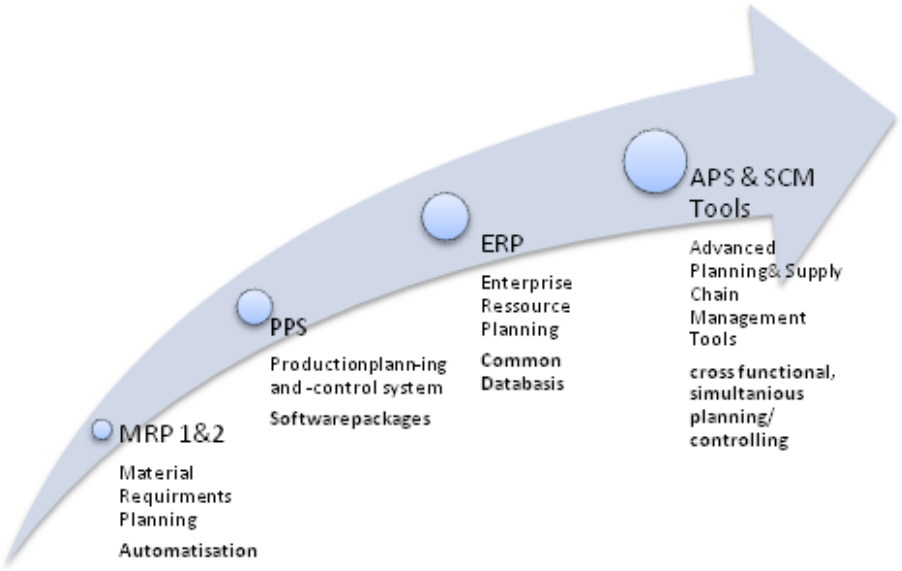

Fig. 1 Stages of development of software systems

Later systems like PPS included program and capacity planning, order management and order monitoring. The problem was the inflexibility in demand changes and no information of the supply chain was picked up and processed (Kuhn & Hellingrath, 2002, p.127). Current *Electronic Resource Planning* (ERP) [ERP Systems are integrated economical standard software applications, that support almost all tasks and processes (e.g. production, controlling, human resources, distribution, procurement) of an enterprise.] systems are able to integrate external systems and therefore increase the quality of data. The disadvantage of all conventional systems is the static planning. Advanced Planning Systems have dynamic planning features; hence this comprises various influencing factors and dynamical-

ly reacts to changes. The result is that safety stock can be decreased, lead times shortened and delivery times determined further in advance.

The development of technologies is constant and the implementation of systems is costly but necessary to compete in the market. Nowadays, information systems are used as decision- and planning support of a supply chain and are becoming more complex. Through their deployment, the transparency along the material flow should be improved. Furthermore, these systems should enable quick demand forecasts and planning, as well as process controlling and exceptional handling.

2.3. Transparency needs in the material handling process along the supply chain execution

The transparency in the supply chain execution has high priority for producers. Especially companies in the production and transport handling have a high demand in knowing details of incoming goods, changes in planned processes, forecast information of suppliers, feedback of customers and exact details on current statuses of trucks of their contracted transport service providers. To manage all this information in one system, there has been a disadvantage of all present proprietary IT-Systems. The central problems laid in media breaks that arise when various software solutions shall collaborate but are not actually able to do so. Reasons may be their diversity in advancement, structure, licensing agreements with developers, special requirements of the company and so forth.

Many steps in past administration processes need to be handled manually where a lot of information apparently gets stuck. Email, fax and the telephone are the most trusted and worldwide established technologies bridging media gaps. Thus, only a technological innovation that fulfils the requirement to be open, easy to be integrated with present systems, beneficial to all supply chain partners and convenient to implement, has enough potential to close the information gaps.

In the delivery process, technological achievements have been invented, that boosted the transparency in the delivery process and customer value, likewise. One technology is the tracking and tracing of vehicles and/or processes. Only two decades ago, the *Global Positioning System* was made available for public use and enabled in-car navigation and the tracking of vehicles. Navigation systems have become cheap, standard equipment in private and commercial vehicles enable an efficient routing, tracking, tracing for carriers and spawn a higher level of transparency.

2.4. Live tracking of individual loads as controlling tool towards delivery efficiency

Although a great leap forward has been achieved and vehicle tracking is a current standard, there is still a lack of real time order tracking. *Live tracking* is an upcoming feature that can be done with conventional tracking devices like GPS

boxes that are constantly sending out their current coordinates and can easily be attached to containers, parcels, palettes and in vehicles. The problem is that these senders are costly and must be returned somehow after use and additionally, can hardly be attached to smaller loading units. This example shows, that there is a system gap that hasn´t been solved so far.

An efficient delivery is a very dynamic process and should be considered in production planning. The problem does not only arise in the very transport of a logistical object, but also at the pick-up on the suppliers premise. The supplier may not know when the carrier arrives and has possibly not yet prepared the order. In this case, there is a high chance that the freight will experience a first delay.

GPS-based tracking and tracing of vehicles is state-of-the art for a lot of proprietary fleet management systems. Conventional tracking systems are rather rigid and provide only time stamps when a logistical object has passed a point where it was scanned and recognized (e.g. by an ERP system). Additionally, they usually do not consider delays (events), idle and resting times of vehicles and drivers and therefore cannot provide a supplier or recipient with an actual estimated time of arrival of a carrier.

Estimated times of arrival are important for production planning and express parts. However, regular deliveries are usually scheduled according to time window regulation that can be predetermined (e.g. in 1,5hrs intervals) or dynamically (e.g. an unloading point is booked for a period in a certain time in advanced). A time window regulation seems evident for a higher number of daily deliveries to avoid queues in front of a ramp, too much traffic on the premises and a clear sequence of unloading (e.g. in case of late arrivals, no shows etc.).

2.5. Efficient IT systems as driver for inefficiencies?

There are professional delivery-time window management systems on the market, interlinked with existing ERP systems that centrally record transport and production data (e.g. number of pallets produced; number of bags and cartons of a specific SKU, etc.). The question arises, whether these systems can really be effective?

The downside of all these already complex systems is that there is only little information exchange with external tracking and tracing systems. Live tracking is therefore not a conventional tool and also not integrated in ERP systems. Logistical objects need, as already mentioned, GPS tracking, an interface with fleet management software or an interface with the on-board navigation system of the vehicle. Both options are costly and many ERP systems do insufficiently cooperate with third party software.

Due to the amount of transport modalities and the diversity of logistic technologies, this paper is focused on the transparency of transportation modalities through the appliance of location related services on mobile devices. The challenges of

perspective technologies are not only to create faster responding and accurate data transmission, but to stronger interlink and integrate existing systems. Every supply chain partner has a strong interest to design his own processes more efficiently. Proprietary management systems of companies are highly complex but constantly reach their limit of performance when it comes to information exchange. Information on an improved transparency along the material flow gives process owners a clearer and reliable basis for decision making.

The ubiquitousness of internet access, smartphones and increasingly powerful microchips and a pervasive monitoring of logistical objects is just a question of time. Technology leading companies have already invented micro chips that can autonomously gather data of their environment which heralds a new era of logistic technology.

3. SUPPLY CHAIN AGILITY BY REAL TIME TRANSPARENCY

The applied technologies use integrated location and context based information and communication systems. The developed prototype is foreseen to record, to monitor and to control the whole delivery process in order to react appropriately to any irregular situation. Furthermore, it promotes the agility of companies and its adaptability in the operative supply chain through the re-grouping of unloading sequences. The system is to help adapting complex processes to current frameworks in real time and therefore speed up processes in the supply chain network. The aim of this research is the employment of *real time transparency* in the whole delivery chain from the ramp of the supplier to the physical receipt of goods at the receiver. There are general theoretical outcomes that improve the information flow and enhance many processes of all participants. The following table gives an overview of the defined goals.

Table 1 Theoretical transparency improvements of smartphone use in a delivery process

	Theoretical transparency improvements through smart phone use		
	Receiver	Transport Service Provider	Supplier
Optimization of in-plant material and information flow control through embedding in the control centre)	Increase of information quality for expeditiors	Shorter stops in the plant and accelerated dispatch; hence quicker availability of transport capacities	
	New basis for decision making for unloading sequences	Faster truck rotation – lower idle time	Faster truck rotation, less blocking of plant space
	Efficiency increase at unloading points and destress of drivers	Reduction of costs and CO_2 emissions	
	Reduction of throughput time and acceleration f truck rotation (because of less track on the factory	Better prediction when truck is available again	

	grunds, overview of waiting trucks)		
	Truck navigation to the predefined unloading points on the premise of the receiver		Truck navigation to the predefined unloading points
	Automation of manual processes (documentation, bilding, registration, etc.)	Fewer responsibilities for the driver through automation of manual process (documentation, registration, customs paperwork, etc.)	
	Planning of capacities of loading- and unloading points		Planning of capacities of loading- and unloading points
Optimization of delivery control	Earlier recognition of when an object becomes an express or high priority part	Quicker unloading and a administration	Due to ETA – quicker preparation of goods (destressing)
	Flexibility in the unloading sequence (less queues befor the ramps)	Therefore faster truck rotation and usage of transport capacities	Response time is lower when a part is currently not available
	Quick information forwarding to the receiving ramp		
	Perception of the status and position of delivery with an as exact as possible estimated time of arrival at the receiver's gate	Avoiding waiting time and pressing the driver for time. However, it is also an improved exploitation of the transport fleet trough accelerated discharge	Is receiving an estimated time of arrival of the transport service provider; reduces waiting time of trucks on the premise
	Exact documentation of the delivery process as bilding basis	Has evidence of actual transportation time, route and idle time	

3. CONCLUSION

In a dynamic and complex environment, companies constantly transform and must adapt to new frameworks. New systems and technologies get room for improvement in the adaptability and automating of operations. Nevertheless, the development process is crucial, as experiences and data of common events and their problem solution processes can be saved and later used for a further development step. The outcome will be a knowledge base that can be used to improve the management process of future events and technical communication problems can be effectively counteracted. With this procedure, a learning supply chain event- and information management can be developed.

The priority is not solely the exchange of data, but the active involvement of all supply chain partners in the planning of distribution, production and resources.

Due to the soon to be introduced inter-mobile device and car-to-car communication, perspective location based tracking systems will increase the spectrum by the following functions (Popescu-Zeletin, Radusch & Rigani; p. 6ff):

- Additional spatial information of public and private premises like train stations, airports, factory plants, etc.
- Public areas with points of interest like shops, hotels, garages, companies
- Maps of traffic signs, temporary road construction sites, time limited parking zones.

This is only a small selection of additional features that can be potentially integrated in future location related tracking systems. It is hardly appraisable what the consequences of ubiquitous computing are (Resatsch, p.15). Smart tags on logistical items that are sensitive to their environment, outline another strong trend towards location based technology. The miniaturized RFID transponders communicate wirelessly with a scanner and can be tracked accordingly.

Location based services play a major role in the transformation process towards a transparent supply chain. The research shows, with LBS there are new indicators for performance, measureable in the material handling process (Bredrup, p. 62ff). Furthermore, it enables *Supply Chain Event Management* (SCEM) to react much earlier and makes process disorders visible. Generally speaking, LBS improves the transparency of the supply chain and the controllability of processes, which is an enormous contribution to the agility of all participants.

REFERENCES

Bredrup H., (1995), "Background on Performance Measurement", A. Rolstadas (Ed.), Performance Management – a business process benchmarking approach, Chapman & Hall, London, pp. 61-88.

Graf H-Ch. & Niedermayr, (2010), "Location-Based-Services und deren Einsatzpotentiale Forschungsband des Logistikum". Research, Hgb: Staberhofer, Steyr, pp. 82-86.

Graf H.-Ch. & Tellian N., (2011), "Smartphones as enabler of Supply Chain Event Management", K. Grzybowska (Ed.), Management of Global and Regional Supply Chain – research and concepts, Publishing House of Poznan University of Technology, Poznan, pp.133-143.

Heusler K.F., Stölzle W. & Bachmann H., (2006), "Supply Chain Event Management – Grundlagen, Funktionen und potenzielle", [in:] WiSt, Vol. 35, No. 1, pp. 19-24.

Kuhn A. & Hellingrath H., (2002), Supply Chain Management – Optimierte Zusammenarbeit in der Wertschöpfungskette; Axel-Springer Verlag, Berlin.

Popescu-Zeletin, Radusch & Rigani, (2010), Vehicular-2-X Communication – State of the Art and Research in Mobile Vehicular Ad hoc Networks, Axel Springer Verlag, Heidelberg.

Resatsch F., (2010), "Ubiquitous Computing – Developing and Evaluating Near Field Communication Applications", H. Krcmar (Ed.), Informationmanagement und Computer Aided Team, Axel Springer Verlag, Heidelberg .

Wallenburg C. M. & Weber J., (2005), "Management von Produktion und Logistik bei Umweltdynamik", [in]: Industrie Management – Zeitschrift für Industrielle Geschäftsprozesse; Gito mbH Verlag für Industrielle Informationstechnik und Organisation, Berlin, Vol.21, pp. 45-48.

BIOGRAPHICAL NOTES

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