Conceptualization of a Smart Service Platform for Last Mile Logistics

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Abstract. Digitization in logistics bears enormous potential for increased efficiency. Especially, the logistics of the last mile that causes between 13% and 75% of the overall logistics cost of parcel shipment could strongly benefit from digitization and an increased transparency. This transparency and a smart process control can be achieved with the help of a smart service platform. Such a platform connects with sensor, ID, and authentication technology in order to operate approaches, such as crowd logistics and sharing concepts with the goal of enabling an efficient, sustainable and user friendly last mile process. The contribution of this paper is a first conceptualization of the smart service platform for last mile logistics with special regards of the underlying business process management. A design science research approach is applied.

Keywords: Last mile logistics · Smart service platform · Business process management · Conceptualization · Design science research

1 Introduction

Last mile logistics describe the final delivery activities in the very last section of a supply chain. The source of the goods or parcels to be delivered is either the final warehouse or distribution center, and the destination comprises the supply chain option of the direct-to-consumer delivery [5]. Figure 1 depicts the last mile in the context of a generic supply chain from raw materials, over production facilities to warehouses or distribution centers (DC). From the DC there are two options: either delivering to retail or the direct-to-customer delivery, i.e. the last mile.

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Due to the increase in e-commerce, the last mile logistics has gain in importance in the last years. E-commerce offers customers to get products delivered directly at home. This comfort has lead to an accelerated growth in the e-commerce sector in the past and a forecast of growth from 1.3 trillion € global revenue per year in 2017 up to 2.1 trillion € in 2022 [16]. Often receivers of the parcels are not at home and changes in the social structures lead decreasing willingness of neighbors to takes parcels of the neighbors [9]. This leads to several delivery attempts of a parcel or storing of the parcel until the receiver will pick it up such that last mile logistics cause up to 75% of the complete supply chain costs [5]. Main cost drivers are non-successful first-time delivery, the resulting extra processes, and low occupancy rates of the delivery vehicles. Subsequently, traffic volume is rising and sustainability is decreased.

Some CEP (courier, express, parcels) service provider try to optimize the last mile by different means, such as parcel boxes, regarding customer preferences (location, delivery window) in order to reach a successful first-time delivery. Limited real-time information about the location and schedule of customers and parcels limit the full potential of optimization. Further, existing CEP parcel IDs are based on proprietary formats that are not open to the crowd or to other small delivery service providers. Hence, the CEP only optimize internally and statically. A sustainable last mile logistics approach [5], is based on flexibility and has to take innovative concepts into account such as crowd logistics [11] and sharing economy [14]. Further, innovative technology, such as sensors, identification and authentication, enable a smart, efficient, and user-friendly operation of last mile processes. In order to exploit the full potential of this approach standardized processes are essential to meet the challenges of the last mile.

In this work, a smart service platform with the purpose of enabling a smart last mile logistics is conceptualized. Goal of this platform is the optimization of last mile processes in terms of flexible customer oriented delivery process (time, location and means of transport), in a sustainable way (bundling parcels carrier-independent to increase occupancy rates and avoid traffic). The structure of the paper follows the design science research (DSR) process of [6]. First the topic is introduced and motivated. Related work in Sect. 2 is followed by a brief presentation of the methodological approach in Sect. 3. Section 4 discusses challenges and requirements of the last mile logistics. The main contribution,

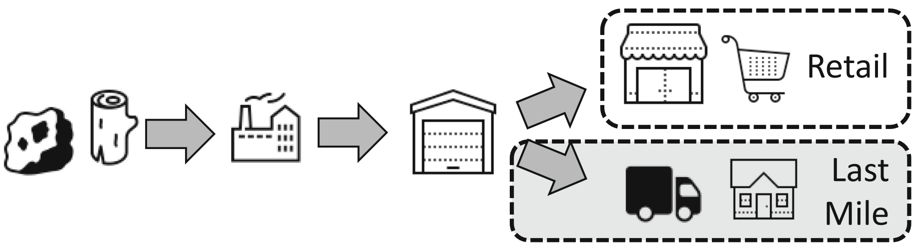

Fig. 1. Depiction of the last mile option in a supply chain, adapted from [5].

the conceptualization of the smart last mile service platform is presented and discussed in Sect. 5. The paper is concluded by Sect. 6.

2 Related Work

2.1 Literature

Literature also contains first ideas in the field of smart service platforms and last mile logistics. Publications can be divided into several categories: enhancement of physical logistics system and infrastructure, and better use of existing resources through higher transparency by software platforms.

The first category about physical systems and infrastructure of the last mile contains papers, such as [3], discussing different forms and locations of transshipment areas for a reduced traffic between the depot and remote areas of distribution as well as a modular box system in order to increase drop rate on the first attempt. Even though, an improved infrastructure can tremendously improve the situation by making every first drop attempt successful, this kind of infrastructure with modular parcel boxes is very expensive and thus a widespread roll out appears to be a rather strategic goal for future infrastructure planning. Nevertheless, this approach shows the effectiveness of a dense net of drop locations. The idea of urban consolidation centers (UCC) is picked up by [7]. The UCC could be operated by governments' initiatives [12] or company alliances, and function as a cross docking point for re-ordering shipments provider-independent concerning destination area. The authors tried to optimize the profit of the UCCs by auction mechanism.

The second category focuses more on an advanced matching and synchronization of existing resources on the base of an increased flow of information. The article of [10] proposes a freight-pooling service in order to reduce traffic and increase occupancy rates. The authors of [13] suggest an advanced interactive end-to-end communication between service providers and customers in order to increase delivery quality. They also emphasize the need of integrating the information of all stakeholders, i.e. senders and recipients. Further, they interestingly outline a shift from location-oriented to person-oriented services in the last mile sector. As a conclusion of their paper [15], the authors raise questions for future development effort. This comprises collaboration of multiple stakeholders (such as shippers, LSP, and customers) via a common platform, as well as the demand for a common framework and possibilities of visualization and real time data availability. The article of [17] demonstrates the feasibility and increased efficiency of an intelligent last mile approach enabled by a mobile ICT platform providing real-time communication and thus an enhanced transparency. The authors state a main challenge is the amount and distribution of central pickup locations. Further research directions comprise the creation of individual recipient networks in order to increase efficiency of the crowd approach as well s the integration of alternative transportation technologies. The smart service platform of [19] focuses on the logistics of retailers and an intelligent replenishment in order to not lose revenue due to an out-of-stock situation. The efficient use of the crowd as a transport resource is not focus.

Further, approaches of mobile crowd sourcing are related to the topic of sustainable last mile logistics, e.g. see [18] or the participation of citizens in an urban context of smart cities in [1] and [2].

2.2 Research Projects

There are several research projects that focus on modern last mile logistics concepts. The project SMILE[1] represents rather an overarching initiative of the city of Hamburg in order to bundle research activities concerning mobility in an urban context. Projects from the topics of last mile and smart city are interweaved. The research project Guided AL[2] focuses on authentication approaches in a smart city context, which could be interesting for delivery to flexible but restricted location, such as private car or apartment.

2.3 Findings

The result of the related work analysis shows several important points and challenges that are to be taken into account when tackling problems of the last mile logistics field. On the one hand there is a need for improvement of the physical infrastructure, in terms of a *dense net of hubs* for pick up that are *carrier-independent*. On the other hand there are several points to increase the efficiency in the use of existing resources by advanced information systems for a higher transparency. This comprises a collaborative approach with the *pooling of resources* as well as the *integration of information* and collaboration of several stakeholders, i.e. carriers, CEP, LSP, and recipients. This can be realized via a *platform* that is ideally operated by an independent third party to avoid discrimination. Especially, the integration of the *crowd and flexible recipients' networks* will foster sustainability and acceptance.

3 Method

The paper follows the DSR paradigm as the leading methodology with its proactive characteristics and a focus on the creation of new IS (information systems) artifacts [8]. This comprises the incorporation of business needs in order to shape research goals (relevance) that are reached with the help of the scientific knowledge base (rigor). Goal is to build artifacts that extend the current knowledge base and can be applied in the appropriate environment. The presentation of DSR artifacts follows seven steps [6] described in the introduction and reflected by the structure of the paper.

Main method is the conceptual modeling [4] that is about describing the semantics of software applications at a high level of abstraction in terms of

[1] http://www.hamburg.de/pressearchiv-fhh/7495190/2016-11-25-bwvi-smile/.
[2] http://guided-al.de/.

structure, behavior, and user interaction. The developed model is nascent design theory and thus on the second level of DSR contribution types [6] and extends the knowledge base of the prescriptive lamda knowledge in the field of last mile logistics. As smart service platforms already exist in other fields, the artifact of this paper can be located in the field of exaptations in the DSR knowledge contribution framework [6], which implies the extension of known solutions to new problems and new fields of application, i.e. last mile logistics.

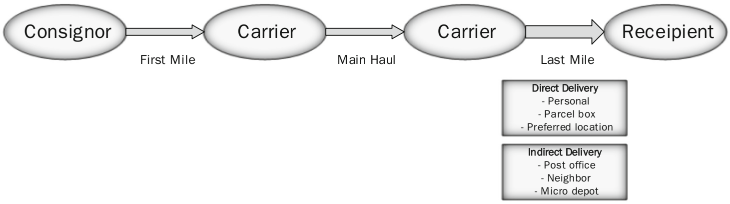

Fig. 2. Parcel delivery process

4 Challenges and Requirements

Next to the analysis of literature, interviews with experts from the CEP industry and related fields are conducted. Represented by the German Federal Association of Courier-Express-Post (BdKEP)[3] their views created insights in the current state of last mile logistics and current challenges. This section first presents the delivery process of parcels in general and will then present current challenges in the last mile delivery. Based on the identified challenges, requirements for a smart service platform supporting and improving the last mile logistic is presented.

When analyzing the issues and challenges in the last mile delivery, the complete process of the parcel delivery has to be considered which is shown in Fig. 2. When a consignor wants to send a parcel, a carrier is selected. In the first step, the *first mile*, the parcel is transferred from the consignor to the carrier's pickup point which can be done by the consignor, the carrier, or another service provider. Thereby, information about the parcel (e.g. size, weight) and the recipient (e.g. name, address) are provided to the carrier. The carrier then tags the parcel with an individual ID and encrypted information about the consignor and recipient. In the next step, the *main haul*, the carrier transports this parcel consolidated with other parcels of the same main direction to a hub near by the recipient where the last mile starts.

The main goal for the carrier on the last mile is to deliver the parcel in at first attempt to the recipient. However, the *not-at-home* problem leads often to high delivery failures. Another challenge is that in certain areas, especially in rural areas, the critical mass is not reached which leads to financial loss by

[3] https://bdkep.de/.

the carrier. The CEP service provider tries to increase their success rate in the first-attempt-delivery with different means of direct delivery to the recipient, e.g. private parcel box or a (static) preferred location, as depicted in Fig. 2. Additional to the personal delivery, some of the CEP also provide the delivery to a private parcel box of the recipient or a preferred location, such as a garage, if the recipient has given an approval. If a direct delivery is not possible, in a second step, the parcel is dropped as near as possible to the recipient, i.e. in a post office, at a neighbor's apartment, or at a micro depot. The micro depot today could be something like a public parcel box (e.g. DHL Packstation[4], parcel service integrated in a Kiosk or retail location). Still, the following issues remain:

1. *Distributed storage*: Several parcels for one recipient are sent via different carriers and in case of non-successful delivery attempt they end up at different locations, e.g. parcel 1 at the post office, parcel 2 at the charmeless neighbor X, and parcel 3 at the retail shop down the road. Thus a high effort has to be invested by the recipient to get all the shipments.
2. *Low density of possible drop locations and dependency on physical infrastructure*: As CEP currently only drop packages at their proprietary drop locations in case of non-successful delivery attempt, customers might have to cover a long distance in order to get their parcels.
3. *Low occupancy rates in certain areas*: All CEP have to deliver to all locations and city districts as well as to all rural areas. This leads to low occupancy rates of the delivery vans.
4. *Proprietary shipment information*: CEPs' parcel IDs are based on carrier-proprietary formats that are not available to other CEP.
5. *Static preferences*: Even with recipient-approved drop locations in case of being not-at-home, CEP miss the chance of reacting to flexible preferences and adapted scheduling depending on the current life or work situation of the recipient.
6. *Omission of crowd potentials*: Appropriate concepts and IT systems are missing to unlock the potential of the crowd to make the last mile more sustainable. In terms of a high sustainability, the involvement of the crowd is absolutely essential.

The results of the interviews reflect the issues and challenges found in literature. Thus the following requirements can be derived that lead the conceptualization of the smart service platform for last mile logistics:

1. *white label micro hubs* where parcels of all carriers can be dropped and later on collectively gathered by the recipient.
2. *new micro hubs* have to be created easily and virtually in order to increase density of the drop locations. This comprises the creation and management of virtual micro hubs for flexible last mile infrastructure.

[4] https://www.dhl.de/content/de/en/privatkunden/pakete-empfangen/an-einem-abholort-empfangen/packstation-empfang.html.

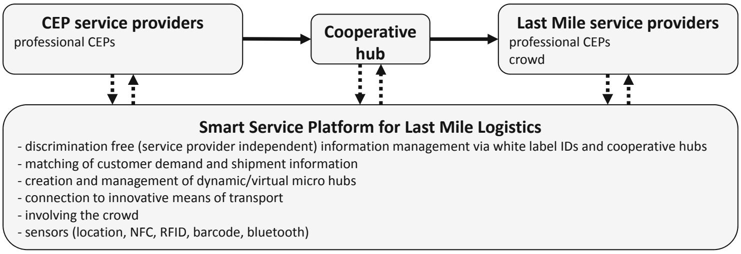

Fig. 3. First draft of the Smart Service Platform (solid arrows presenting the physical flow of goods, dashed ones representing the flow of information).

3. *white label shipment IDs* are necessary in order to make an exchange of parcels between different CEP possible. Thus, CEP could also carry shipments of other CEPs and increase their occupancy rates.
4. *Flexible last mile processes* that are able to react on re-scheduling needs induced by the recipient.
5. *Involvement of the crowd* in order to unlock the potential for a higher sustainability of last mile logistics.

5 Smart Service Platform for the Last Mile

5.1 Artifact Description

In order to meet the above mentioned requirements, a fundamental paradigm shift has to be initiated, due to incompatibility of the proprietary ID formats of shipments of different CEP service providers. This paradigm shift consists of white label approach of shipment IDs and white label approach for micro hubs, both managed by independent third parties in order to grant a non-discriminating access to the market for all CEP and the crowd as well. With such a shift, the exchange of parcels from different CEP to other CEP or the crowd is enabled. Further, with a independent smart service platform, cooperative hubs can be opened, managed and retired flexibly. The option of creating virtual micro hubs is an important functionality.

As depicted in Fig. 3 this paradigm shift is bound to a strict separation between the main haul that is operated by a standard professional CEP and the last mile that is to be operated by some kind of a last mile service provider. The latter one could be a professional CEP but also a member of the crowd or maybe even an alternative option of transportation (such as transportation robot, drone, bike courier, cargo bike or cargo tram).

The physical flow of goods is realized from the main haul CEP to the cooperative hub which could also be a virtual location as a central drop location. After the parcel has been dropped at the hub, the recipient is able to choose from a variety of options in order to finally receive its shipment. Next to a preferred location and a preferred time it is also imaginable to offer a preferred means of transport, in case the recipient would like to choose the most sustainable or the fastest option for the last mile.

The informational flow is more complex in order to gather as much data as needed for a flexible and sustainable last mile logistics. The smart service platform acts as an intermediary between the both sides of the consignor and main haul CEP on the one side and the last mil process and the recipient on the other. Therefore, a white label approach is absolutely essential. This comprises (1) the creation and management of shipment ID and information under a white label approach and (2) the operation of the cooperative hub under a white label approach. With this a discrimination free proceeding of the process can be granted and a emancipated access to the last mile market for either professional CEP (global players but also small and medium sized) as well as for crowd participants. Important functionality comprises the matching of stored shipments at the cooperative hub and the (daily) routes of the participating crowd members in order to give push notifications of participation possibilities. Especially, in the context of new technologies such as the Internet of Things (IoT) and the requirement of real-time data processing the connection to new technologies gathers more importance. Hence, the link to sensors and identification and authentication technology is obligatory for the smart service platform.

Business model and incentives of the smart service platform could be various. For CEP the incentive is to reduce costs by not operating the last mile in the classic way. The avoidance and the inherent cost savins could be used to pay for the last mile operation in order to not pass on the costs for the system to the final recipient. Even though, it is possible to let the recipint pay for the fulfillment of special demands on the last mile, such as special location or time slot. Or, as already mentioned, the demand for special means of transport or special option such as very fast and/or very sustainable delivery on the last mile could be paid by the recipient. The incentive for the crowd participants could be realized by some kind of virtual coin system, making special options available for free in case someone of the crowds wants to use the services of the platform or also just social kindness or just ecological awareness.

5.2 Discussion

The results are high level, but still they mark an important and remarkable step in the current situation of the field of last mile logistics. By laying the foundation for a white label approach, an important step could be done towards opening up the market of the last mile logistics to small and medium logistics enterprises but also to the crowd, while unlocking a high potential for increased sustainability. With the functionality of virtual micro hubs/cooperative hubs, the infrastructure of dropping locations can be easily adapted to a change in demand. Future research directions should aim at improving the concept and adding more detail in order to realize all the functionality mentioned in the conceptualization.

6 Conclusion

The paper introduced the research field of last mile logistics. After motivating the need for a more flexible solution with the potential of a higher sustainability, related work from literature and current research projects was presented. Further, results of interviews conducted with experts from the field of CEP were presented. The synthesis of the literature findings and the results of the interviews matched and from this the requirements for the smart service platform were derived. A first conceptualization of the smart service platform was introduced and the discrimination-free white label approach for the shipment IDs and the cooperative hubs was emphasized.

The concept presents a remarkable and important paradigm shift in the field of CEP and last mile logistics as currently CEP work only on proprietary formats, making a flexible reaction to recipient demand and a participation of the crowd in a sustainable last mile logistics impossible.

Future research will focus on further detailing the concept and developing technical specifications for the approach.

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