A Concept for a Consumer-Centered Sustainable Last Mile Logistics

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Abstract. The amount of home deliveries of online purchased consumer goods has significantly increased in the past years. The logistics of home delivered goods is however negatively impacting the ecological environment as more packing and additional delivery tours arise. However, the environmental attitude of consumers is at the same time increasing too, which leads to a kind of dilemma of how to combine environmental consciousness with the convenience of online shopping? This paper proposes a methodological approach for designing a consumer-centered sustainable last mile logistics system and its evaluation. The suggested method combines discrete choice experiments with computer simulations which allows a feedback loop in the sustainable design of deliveries to consumers' homes.

Keywords: Sustainability · Human centered logistics · Discrete choice experiment · Simulation

1 Introduction

The share of interactive commerce in Germany is steadily increasing and achieves up to date far a market share of more than 10% of total retail sales (Statista). The sales volumes grew from 1.1 billion € in 1999 to more than 50 billion € in 2018, whereby the main hare of online sold product categories refer to cloths, shoes, tickets for events or books. While these categories show order rates of at least 35%, grocery items are so far not that often ordered online, as the order rates are below 8%. However, the importance of electronic commerce in the area of fast moving consumer goods is increasing and the deliveries of such products (also known as last mile) is going to challenge retailers as well as end users. While retailers try to find a trade-off between convenience and costs, more and more end users are expecting basically an immediate delivery of their online ordered goods, often at the same day.

This trend leads to more and more transport processes while simultaneously decreasing the utilization of the transport means (see Schnedlitz et al. 2013). Besides that, more transport results also in more CO2-emissions and last-mile-logistics requires additional packaging due to individualized preferences for picking and packing. Taking the current climate change discussions into account as well as environmental pollution

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due to plastic waste, we observe however a changing pattern in consumer behavior as more and more consumers tend to buy regional products and tend to reduce product packaging while shopping.

Consequently, consumer face the dilemma of using the advantages and conveniences offered by mobile/electronic commerce and protecting the environment by making a personal contribution for the minimization of CO2-emissions and plastic waste. However, it is nearly impossible for end users to recognize directly the effects of changing consumer behavior on the environment or to even influence it. Normally, end users can opt a lot when it comes to product choices, but nearly nothing when it comes to the selection of sustainable home delivery options. They are mainly able to determine the payment choices as well as the delivery time in terms of standard or express deliveries. When ordering online, retailers are not showing the consequences of increased CO2-emissions due to express deliveries or the costs for additional packaging. Up to date, online consumers do have no transparency when it comes to the visibility of the transport modes that are used for delivering their products. This is very surprising as a current study by PcW (2018) shows that 3 out of 4 grocery shoppers advocate less packaging waste and would prefer returnable packaging.

Taking this into account, it is the goal of this paper to present the conceptual ideas of a method that is able to design and to evaluate tailored sustainable consumer logistics options as well as their development potential. The use of this method shall allow consumers to determine their personal preferences in regards to emissions, plastic packaging, delivery times and dates for online ordered groceries in order to get a sustainable tailored home delivery.

2 Current Stage of Consumer-Centered Sustainable Logistics

Our understanding of a consumer-centered sustainable last mile logistics concept is embedded within the areas of green/sustainable logistics, consumer/city-logistics as well as food logistics/packaging. In the following we present a current state of the art of the research within these domains.

2.1 Green/Sustainable City Logistics

According to McKinnon et al. (2010), green logistics deals with the following areas: reduction of the externalities through transports, city logistics, consideration of green logistics in business strategy, reverse logistics as well as green supply chain management (SCM). Later, McKinnon et al. (2015) reduce their model of green logistics to the reduction of transport emissions. When it comes the reciprocal effects between innovative logistics concepts and customer requirements, Melkonyan et al. (2017) identify success factors for sustainable logistics systems by the application of causal loop diagrams. Their findings show that transparency in supply chain design and a distinct measurability of sustainability positively affects the conscious choice of sustainable last-mile delivery concepts.

While Clausen et al. (2016) look at specific organizational as well as technical measures for realizing green last mile logistics, Dobers et al. (2013) present resource-efficient logistics services and Athanassopoulos et al. (2016) examine the environmental effects of parcel distribution. Clausen et al. (2016) examine also the decoupling of transport for the last mile by the use of consolidation centers as well as the effects of using sustainable transport means such as E-bikes for inner-city deliveries. Hereby, they consider besides economic factors also the impact on the environment by CO2-emissions as well as the attractiveness of the concepts for suppliers and recipients. Leyerer et al. (2018) suggest the use of parcel depots for last mile distribution where mathematical optimization suggests the locations as well as the routes between a depot and an end user.

Already in the late 1990s, Berg (1999) suggests the so-called Munich model that refers to strategies for traffic reduction, traffic shifts as well as a more environmental-compatible traffic design. Lohre et al. (2011) suggest hereby the Utrecht cargo-hopper as a positive example for traffic reduction by cooperation. Auffermann (2017) as well as Schönberg and Auffermann (2017) study sustainable urban supplies and the traffic development and Raiber et al. (2014) examined the consequences of electrical drive technology for heavy weight loads and freight goods transport in cities.

Bode (2016) presents a city logistics concept that includes an inner-city distribution hub out of which trams are delivering the goods. This has also been already suggested by Lütjen and Piotrowski (2012). Recently, Elbert and Friedrich (2018) present an agent-based simulation which examines the effects of cooperation between logistics service providers for the inner-city freight goods transport. Other approaches for an improved utilization of resources and environmental compatibility within the frame of reference of green logistics and city logistics is presented by Deckert (2016).

2.2 Food Logistics from the Consumer's Perspective

Nitsche et al. (2016) present future trends in food logistics and show that more and more consumers request larger transparency along the supply chain and increasingly demand sustainable products and sustainable delivery options. Kille et al. (2015) presents the need for alternative sustainable delivery possibilities for online-grocery retailers as Bloemhof et al. (2015) also show the significant impact of food and transport packaging on the sustainability of food logistics. Buchner (2012) focuses on the challenges of food packaging and develops solutions, which include economic, environmental as well as qualitative aspects. Singh et al. (2017) also research in the area of food packaging technology with a focus on plastic and active packaging possibilities. Thereby Trapp et al. (2017) were able to identify – based on environmental accounting/life cycle analysis – that Styrofoam packaging for frozen goods delivered by parcel distributors have the same level of CO2 emissions as a private shopping tour with a car. Both alternatives however emit less CO2 than a consolidated delivery with small deep-freeze vehicles.

Meyer and Kotzab (2017) present a current state of consumer logistics research from a distribution channel point of view. Overall, consumer logistics focuses on the analysis of logistics processes from an end-user perspective starting with planning of a shopping trip to the instore processes executed by the consumer and ends with the

delivery of the products by the end-users to their homes (e.g. Bahn et al. 2015; Meyer et al. 2016, 2017; Teller et al. 2012). Thereby, Galiopoglu et al. (2015) show the consequences for such processes by the use of smart phones which allows nowadays the coupling of individualized shopping behavior with geographical information. These possibilities are summarized under the construct of social, local and mobile (SO-LO-MO) commerce. When it comes to individualization, Hüseynioglu et al. (2017) show that this is so far only applied in the acquisition potential of distribution (see Schögel 2012) and when it comes to logistics it is limited to delivery options and delivery windows.

2.3 Critical Reflection on Current State of Research

Overall, we were not able to identify any detailed observation and analysis of individualization possibilities for a sustainable last mile delivery option. Research as well as empirical evidence shows an increased interest as well as demand of consumers for sustainable solutions, however the presently offered possibilities are limited.

3 Method Development

3.1 Objective and Boundary Conditions

The goal of this paper is to present a suggestion for an interdisciplinary tool that allows a tailored design and evaluation of a sustainable tailored consumer logistics system. For this purpose, we define consumer logistics as the logistics of the last mile (see Meyer and Kotzab 2017). This contains online orders, commissioning, packaging and loading of merchandise at the retail store or in a fulfillment center as well as the delivery of the goods by a logistics service provider or the pick-up by the consumer in the store. Another additional option can be seen in a pick-up locker outside a retail store where consumers can get their products also outside the opening hours. We focus on the product category of food as this product category is regularly demanded as well as this category requires additional requirements on packaging and transport.

Sustainability is hereby considered as minimization of CO2 emissions as well as minimization of plastic for packaging, loading, transport and delivery as well as for commissioning processes. CO2 emissions result basically from the choice of the transport means for deliveries by logistics service providers as well as from self-pick-up by consumers. Furthermore, the production and recycling as well as thermal recycling of packaging leads to CO2 emissions.

A tailored design of consumer logistics is understood as the individual selection of a particular logistics option out of a set of options. This set contains the selection of the source and the sink for the transport, the selection of the logistics service provider, the transport means as well as the transport distance. The evaluation of the chosen option is based on key performance indicators including CO2 footprint, type of packaging and share of plastic, delivery time, delivery date, delivery/deposit location and shipping cost.

3.2 Suggested Approach

We suggest a tool which combines the socio-scientific method of discrete choice experiments for the optimal selection for a tailored sustainable consumer logistics option based on the individual consumer preferences with the engineering method of discrete-event simulation for quantifying the chosen option and offering of a feedback possibility based on the quantitative simulation results. With this approach, a consumer gets the opportunity to rethink the beforehand choice and potentially change the logistics option. The basic idea is portrayed in Fig. 1.

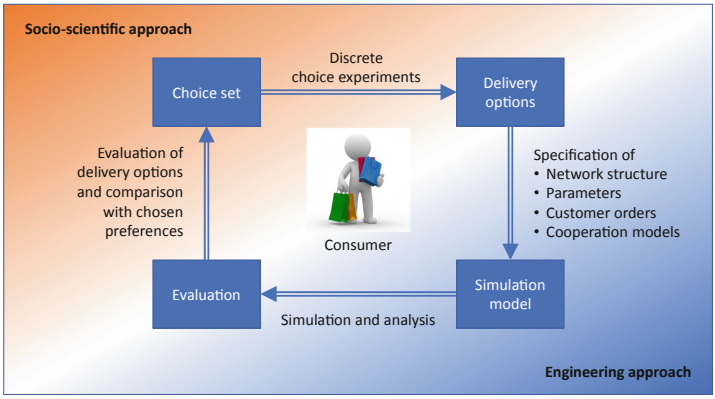

Fig. 1. Interdisciplinary method for designing and evaluating consumer-centered sustainable last mile logistics systems

The socio-scientific perspective shall identify the individual consumer preferences towards indirect logistics costs (CO2 emissions, plastic waste), direct logistics costs (shipping costs) and logistics services (delivery time, time windows, etc.) by utilizing discrete choice experiments. The combinations of these preferences result in a tailored logistics option (retailer, packaging, transport means, transport route, delivery). We suggest examining different customer groups based on a consumer life cycle and household types as suggested by Müller-Hagedorn (1984).

From the engineering perspective, these preferred logistics options will be applied to a exemplified logistics network. The results of the individual discrete choice experiments refer to typical customer profiles which will be reproduced until the simulation model has achieved an adequate number of differentiable customers. The model parameters refer thereby to the number of consumers and orders as well as to different cooperation models of the logistics service providers. The customer orders will be processed during the simulation based on the preferred logistics option. This shall identify the impact as well as the dependencies of different consumers with different logistics preferences.

The simulation results will show the respondents their CO2 footprint, share of packaging and plastic waste as well as shipping costs, delivery times and delivery dates for all orders during a simulation period. With this, the consumers receive a measurable

feedback to their preferred logistics option and with this quantification they may be able to rethink their previous decision and to potentially adapt their preferences for a second or even third simulation round. The incremental changes are going to be documented. This simulation-based feedback possibility represents the methodological enhancement of the traditional discrete choice experiment.

4 Conclusion and Outlook

This paper suggests an innovative methodological approach for measuring the preferences for tailored sustainable consumer logistics by combining discrete choice experiments with computer-based simulation. Furthermore, the approach includes a feedback possibility in order to give consumers a chance to rethink a previous decision. The simulation model allows a measurable result of a consumer decision in regards to a preferred logistics option and allows an adaption towards increased sustainability by keeping a high degree on individualization. The presented approach is an extension of existing discrete choice experiment approaches by combining computer-based simulation. So far, discrete choice experiments would allow only qualitative statements on a desired last-mile logistics while the pure modelling and simulation of logistics options would be based on theoretical considerations only. Our suggestion allows an inclusion of real consumer preferences as well as a critical reflection and further adaptation of logistics systems on the other side.

Of course, there are still some limitations which need to be considered when continuing this research endeavor. First, we need to identify the specific practical requirements as well as challenges which are related with the scale-up of the suggested approach. Second, it is necessary to specify the specific transport means as well as environmental boundary conditions that go into the decision-making process. From a supply chain perspective, it is necessary to further consider – based on the outcomes of the discrete choice experiments – the consequences of consumer-centered sustainable last mile logistics solutions for the demand management processes of the involved retailers and manufacturers as well as logistics service providers. In order to keep the decision sets as simple as possible, our suggestions do not include the basic notions of price elasticity as we consider changing delivery fees not as a part of the product price. Nevertheless, there might be an effect of changing fees on the overall buying behavior.

Finally, it is also necessary to expand the notion of sustainability to more than only carbon emissions and packaging waste. The choice sets may also include e.g. decision possibilities towards compensation programs.

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