FACILITY DESIGN IN OMNI-CHANNEL RETAIL – A LOGISTICS POINT OF VIEW

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Abstract

Omni-channel retailing enables customers to switch seamlessly between all available sales channels of a retailer during their customer journey (pre-purchase, payment, delivery, return). This leads to vanishing boundaries between virtual and physical commerce. As retailers and their assortment become more and more interchangeable from a customers' point of view, especially delivery service and operational excellence along the supply chain represent a major foundation for creating competitive advantage. As omni-channel solutions arise from physical and virtual appearance, mostly former stationary B&M retailers face the challenges emerging from seamlessly linking multiple sales channels. From a logistics point of view, decisions need to be made if and how former distribution centers designed for "mass delivery" servicing point-of-sales (e.g. pallets, replenishment boxes) can handle single piece distance customer orders. As personal contact and physical customer proximity are major advantages over pure eCommerce retailers, the utilization of existing stores as "linking-hubs" between virtual and physical commerce is indispensable in today's markets. This leads to new logistics functions at the store level, requiring infrastructural and procedural changes in order to handle channel-independent deliveries and returns. With an analysis of the existing academic literature, this paper aims to map out results of existing publications available, regarding the question, how omni-channel retail impacts distribution facility (and process) options in retail distribution networks and which advantages and disadvantages may exist in order to achieve delivery service targets while minimizing related logistics costs. The results indicate, that the design and scope of activities in distribution centres become a key challenge and success factor in the transformation process of creating omni-channel retail. Furthermore, the integration and set-up of stores play a vital role for creating supply chain excellence and success for retailers. However, the interior design of stores to efficiently execute new logistics tasks need further investigation. Results may be used as a conceptual basis for further research in order to improve about description, analysis, improvement or (re)-design of distribution facilities within omni-channel retail environments. Practitioners may find

valuable input to improve and expand their own facilities in their omni-channel transformation process.

Key words: omni-channel retail logistics; operations facility design; distribution network; retail store; distribution centers

1. INTRODUCTION

With the rise of online commerce (=eCommerce), many traditional stationary retailers added one or more virtual sales channel into their field of action. Due to the ubiquitous possible usage of virtual information carriers (e.g. smartphones, websites, apps, etc.), today's customers are likely to switch between different sales channels. While in former times the "consumer journey" was limited to physical interaction, the internet and modern technical equipment (e.g. the use of computer tablets in stores, etc.) allowed a variety of new customer interaction points (Zhang et al., 2010). Connecting all possible interaction options for enabling customers to switch between channels seamlessly, is one major trend in retail and is referred to as "Omni-Channel Retail" (Beck & Rygl, 2015). As this heightens customer convenience, and moreover, customer satisfaction, crafting an omni-channel strategy represents a significant competitive advantage for retailers and a possibility to counteract stagnant or decreasing market positions, following the success of pure online retailers.

Numerous publications in business science discuss strategic, sales and marketing aspects, as well as social and economic implications of eCommerce and omni-channel retail. However, when it comes to logistics and supply chain management, academic publications are still limited.

As blurred boundaries between different sales channels lead to complex interrelated logistics structures, the distribution process gets more and more convolute and retailers need to find efficient ways for handling it (Hübner et al., 2015). As there are, on the one hand obvious cost, assortment and process disadvantages of former stationary retailers against pure eCommerce player, on the other hand, there are advantages when it comes to personal contact and consumer proximity. Therefore, the key challenge for maximizing profit with an omni-channel approach, from a logistics point of view, is the efficient utilization of existing facility infrastructure. This includes possible improvements and re-designing of distribution centres, stores and related distribution networks.

This paper aims to map out the impact of omni-channel retail on the functional design options of retail facilities from a logistics point of view, considering increasing delivery service level requirements and logistics cost. We focus on the following research questions:

(1) *How can a generic analysis- and evaluation framework be set-up in terms of forward and backward distribution processes, considering delivery service elements and logistics cost?*
(2) *Which facility design options already exist in retail distribution networks and how do they operate in the forward and backward distribution process?*

(3) *How can the performance of different facility design options and related networks be rated according to the outlined framework?*

The following chapter outlines our theoretical understanding of omni-channel retailing, retail distribution networks and retail facilities. Thereafter, the current academic literature is analysed to derive generic hypothesis for forward and backward distribution networks in terms of omni-channel retail. For analysing different facility design options, a description and evaluation framework is developed, deduced from the literature. This is used for analysing and evaluating the distribution processes of selected logistics networks with a focus on facility design options. As a conclusion, the answers to the presented research questions are briefly summarized and further research needs are outlined.

2. BASIC TERMINOLOGIES AND THEORETICAL BACKGROUND

2.1.1 Omni-Channel Retail

Using more than one channel for shopping a growing variety of different assortments has become a widespread practice for retail customers, driving retail companies to add new channels into their sales strategy (Zhang et al., 2010). Such a channel describes a medium (customer contact point), through which a retailer interacts with its consumers (Neslin et al., 2006). This interaction can take different forms and depends on the level at which the customer acts on the Customer Journey (pre-purchase, payment, delivery and return) (Saghiri et al., 2017).

The term "Omni" describes in this context that not only several channels are operated by one dealer, but that these are linked to each other, enabling the customer to switch seamlessly during their customer journey (cf. Beck & Rygl, 2015). Omni-channel retail therefore may be developed based upon a multi-channel retail concept, where a retailer merely operates several channels in parallel. In this context, Beck and Rygl (2015) point out the inconsistent use of the terminologies "multi-channel", "cross-channel" and "omni-channel". According to this work, the dimension of channel integration from the customers' and retailers' point of view, as well as the dimension of the number of channels, should be considered when differentiating between the different concepts. In our understanding, omni-channel retail is present, if either the retailer offers the customer all available channels and the customer can trigger full integration and/or the retailer controls full integration of all channels.

2.1.2 Retail Distribution Networks

As distribution describes "the steps taken to move and store a product from the supplier stage to a customer stage" (Chopra & Meindl, 2016, p. 81), designing a distribution network means to establish facilities and supporting transportation services to achieve efficient distribution (cf. Coyle et al., 2013). Over the last decades, in context of the rising emergence of retailers, as well as the trend towards retail consolidation, retail firms are no more just anticipators for demand, but the active designers of product supply (Fernie et al., 2015). Associated dynamics and rapidity, require flexible networks, quickly adapting short- and long-term changes.

As a logistics system is always designed from the perspective of efficiency, a distribution system needs to be evaluated accordingly (Chopra & Meindl, 2016). In detail, value for the customer needs to be created while trying to decrease cost for meeting customer requirements. From a logistics perspective, customer value is created with delivery service, regarding the four overarching key elements "delivery time", "delivery reliability", "delivery quality" and "delivery flexibility" (Pfohl, 2018, p. 38).

Costs on the other hand can be derived from operating the distribution network, allocated in the five key logistics functions, namely "transport", "inventory management", "warehousing", "order processing" and "packaging" (Pfohl, 2018, p. 20).

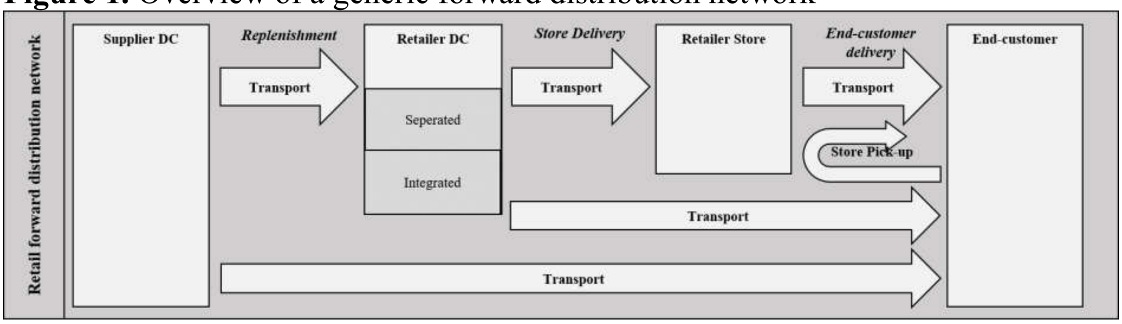
2.1.3. Retail Facilities

Facilities in a distribution network serve as buffers between demand and supply. Basically, inventory is held for supplying customers' orders (Mangan et al., 2011). The main difference arises from the questions, how the inventory is stored and how customers are supplied. Regarding retail facilities, we consider locations, operated by retail firms, which are able to fulfil (distance or stationary) customer orders. Such can be subdivided into the groups of "distribution centers" and "stores" (Hübner et al., 2016a). When considering the long-tail concept, retailers nowadays tend to carry assortment in their virtual shelf. However, physical products remain at the suppliers' warehouse until a customer order arrives. The supplier then is responsible for the actual distribution (Ishfaq et al., 2016). This specific delivery option is excluded from our analysis.

2.2. Hypothesis for Omni-Channel Retail from A Logistics Point of View

A complete analysis of the related literature would exceed the scope of this paper. Nevertheless, to provide a theoretical background, relevant hypothesis for setting up forward and backward distribution systems in omni-channel retail are derived from the analysed literature. At first, fig.1 and fig. 2 outline a generic set-up of forward and backward distribution networks, representing typical supply chain constellations in retail logistics.

Figure 1. Overview of a generic forward distribution network



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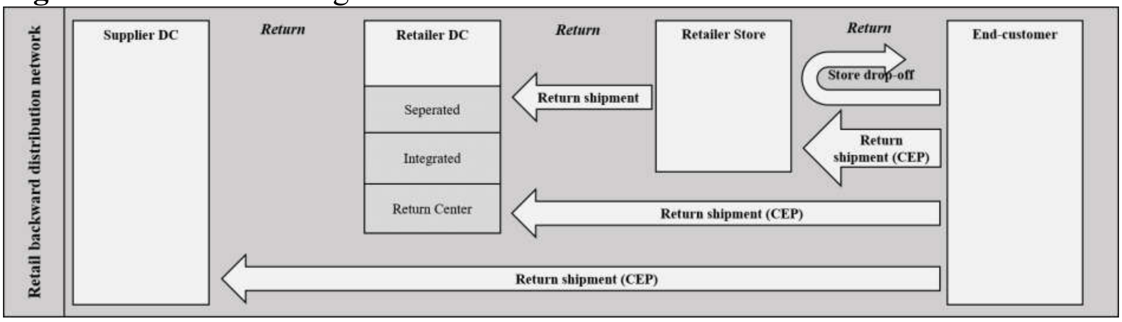
In terms of forward distribution, it is vital to understand the possibilities arising from combining different facilities within the distribution network for fulfilment. In the context of increasing customer demands, fitting distribution paths need to be developed and aligned with the existing infrastructure. The arising challenges for forward distribution networks can be summarized into the research streams:

- channel integration vs. channel seperation from a logistics perspective in terms of inventory, facilities and operations, and
- centralization vs. decentralization of distance order fulfilment.

Figure 2. Overview of a generic backward distribution network



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Return rates of more than 20 % (depending on the product type) (Asdecker, 2018) are common in retail. Convenient returns are one major selection criterion when choosing a retail from a customers' point of view (ebay, 2016). Efficient and convenient return processes are of high relevance for retail firms. The literature indicates following two research streams for backward distribution in omni-channel retail:

- usage of stores as return locations, and
- selection of best fitting return processing locations.

2.2.1. Forward Distribution

In order to provide answers to the "integrated vs. separated channels" debate, especially the preconditions for integration need to be considered: In particular, existing know-how, infrastructure and the requirements for picking (Hübner et al., 2015). Moreover, the advantages of inventory pooling need to be taken into account (Agatz et al., 2008). Furthermore, a decrease in total distribution cost due to economies of scale in transport and order quantities may be considered (Vaccaro and Iyer, 2005). Retailers operate quite different in terms of these preconditions. Advantages and disadvantages of integration need to be evaluated in consideration of specific configuration factors (Metters & Walton, 2007). Especially younger works (Ishfaq et al., 2016 / Hübner et al., 2015/2016ab) indicate as a hypothesis:

"Integration of the forward distribution system is the favoured option when evolving to an omni-channel retailer in terms of facility infrastructures, inventory and related processes"

The "centralized vs. decentralized distribution" debate is concerned with the utilization of the store network as dispatch location for distance orders. Such a concept may hold advantages in terms of less investments in necessary infrastructure (Lang & Bressoles, 2013), relieve of upstream DC-processes (Scott & Scott, 2006) and higher delivery service (Hausmann et al., 2014). On the contrary, stores in most cases are not aligned mainly for the purpose of efficient order picking. There is a threat of increased out of stock situations, as well as in-store customers may be disturbed by pickers (Durand & Gonzales-Feliu, 2012). Bendoly et al. (2007) detected a certain threshold in distance order quantities. Below this, complete decentralization is more efficient and vice versa. Ishfaq et al. (2016) mention that knowing about the cost for fulfilment from each point in the network may lead to most efficient distribution, as orders are allocated to the "best fitting" dispatch location.

Besides the dispatch process perspective, utilization of stores in the fulfilment process adds the possibility of pick-ups for distance orders. This increases customer satisfaction (Kumar et al., 2012). Furthermore, the "last-mile" deliveries can be taken over by the customers. In addition, it may increase cross-selling potential (Agatz et al., 2008) and stationary customers may experience the wider assortment of the distance channel (Zhang et al., 2010). As there is no clear statement to this debate, following hypothesis applies:

"All dispatch locations have their particular advantages and disadvantages in terms of service and cost aspects, retailers must carefully consider a specific mix, depending on requirements from both sides."

A generic overview of possible retail forward distribution networks is outlined in fig. 1.

2.2.2. Backward Distribution

Customers nowadays expect convenient return possibilities, which meanwhile express a selection criterion for purchasing. Hübner et al. (2016b) indicate that in the transition to omni-channel retail, customers can return products independent from their purchasing channel. Bernon et al. (2016) elucidate, that in omni-channel retail, the integration of multiple return locations is key for creating customer satisfaction and propose to collaborate with LSPs (=Logistics Service Providers) and sibling companies to have a brought return network. They further explain that having convenient return options increases customer likeliness to purchase goods. Zhang et al. (2010) conclude, that stores should be leverage as return location for having additional customer interaction points, as well as it increases customer satisfaction. In general, following hypothesis can be derived from the literature (e.g. Hübner et al., 2015/2016a / Bernon et al., 2016):

"In omni-channel retail, return accessibility present a significant competitive advantage and firms should develop fitting solutions in their distribution networks, depending on consumers' preferences and independent from the purchasing channel."

As stores, DCs and RCs are possible return locations, the question of where to process returns arises. Evaluating criteria in the return process can be summarized as overall process efficiency, inventory re-integration time, transportation cost, IT requirements and workforce pooling (Hübner et al., 2016a / Ishfaq et al., 2016). Bernon et al. (2016) indicate that with multiple channels, return complexity increases and integration is lacking in terms of processes and inventory. While return processing in upstream DCs is more efficient in terms of processing, Lang and Bressolles (2013) indicate, that using stores as return location lower the cost of the (backward) last mile. On the contrary, stores need to be adjust to process returns, as well as inventory (re-) balancing inside the store network is a major challenge. Mahar et al. (2014) analysed returns in store, deducing that not all stores should be leveraged as return processing location. The literature indicates following hypothesis (e.g. Hübner et al., 2016a / Bernon et al., 2016):

"Retailers need to carefully evaluate different processing locations for returns, as each have specific advantages and disadvantages in terms of processing speed, return efficiency and inventory rebalancing."

Possible backward distribution networks configurations are outlined as a generic overview in fig. 2.

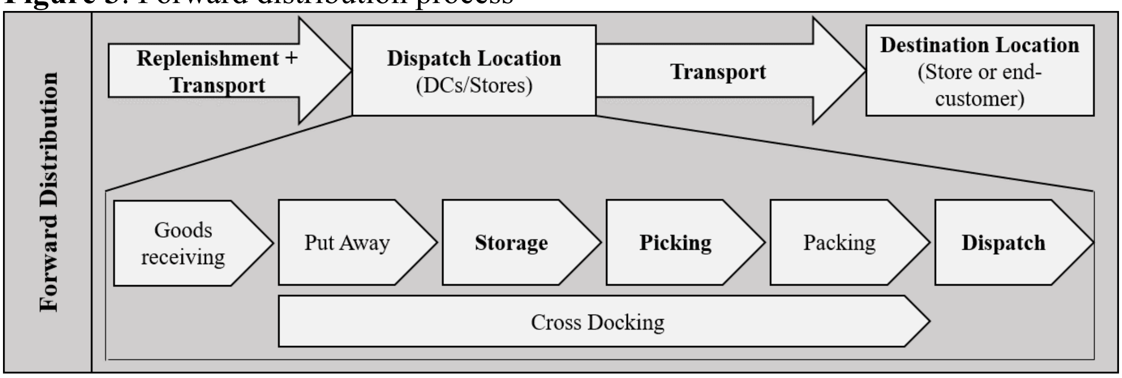
3. DEVELOPING AN ANALYSIS FRAMEWORK FOR OMNI-CHANNEL FACILITY DESIGN OPTIONS

For analysing facility design options in omni-channel retail from a logistics point of view, a comprehensive analysis framework is required. On the one hand this should include aspects for describing the facilities regarding the specific role in the distribution network. On the other hand, evaluation criteria for analysing each in terms of delivery service and logistical efficiency need to be considered. Our framework is set-up according the following two aspects:

- to provide a generic overview of ***forward and backward distribution processes***, as a basis for describing the outlined facilities, and
- to map out ***cost***, necessary for the distribution process in order to meet relevant ***delivery service aspects***.

3.1. Processes in Forward and Backward Distribution

Figure 3. Forward distribution process



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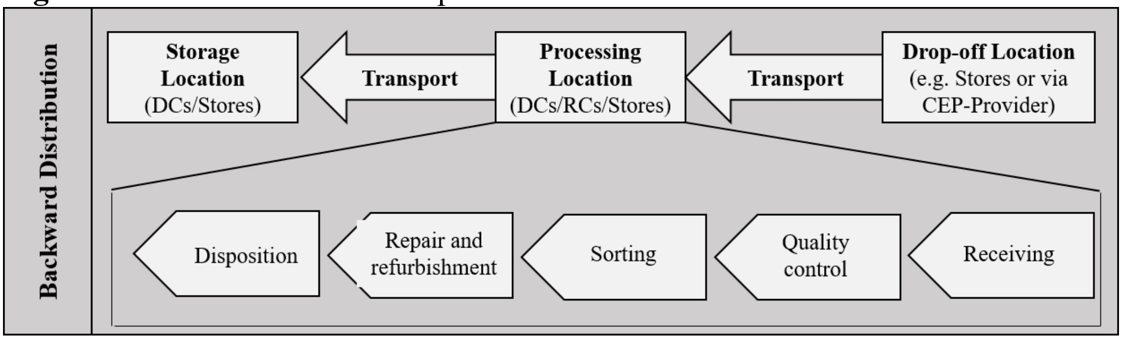
In general, "the forward distribution system is usually characterized by its sources (=**dispatch locations**), the **destinations** (=points of reception) and the associated links" (Hübner et al., 2016a, p. 259). In case of retail firms, DCs as well as stores can serve as dispatch location (cf. chap. 2), destinations can be stores or end-customers' homes. The associated links, connecting both, are **transport** processes. Further, **replenishment** of stock keeping sources with inventory needs to be considered. This article focuses on facility design options, accordingly, the distribution processes in a dispatch location need further investigation. Pfohl (2018) distinguish the processes in warehouses into the categories "goods receiving", "put away", "storage", "picking", packing" and "dispatch". "Cross docking" is another possible option (Kuhn & Sternbeck, 2013) (Figure 3).

Figure 4. Backward distribution process



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In conformity with the outlined forward distribution system and derived from the literature (e.g. Bernon et al, 2016 / Hübner et al, 2016a), the backward distribution system is characterized by the **drop-off location**, the **processing location**, the final **storage location** and associated links. Drop-off locations can be the store network or customer homes via CEP-Provider (=Providers of Courier, Express and Parcel Services), shipping the returns up the supply chain. Other (e.g. LSP-network, affiliate companies, etc.) will be excluded in this paper. Processing location can be stores, upstream DCs or further return centers (Hübner et al., 2016a). The final storage location is necessary to include, as inventory re-balancing within the whole network might be necessary (Bernon et al., 2016). Connecting elements are **transport** processes as well. From high concern are processes, necessary for return handling, executed in the processing location. They can be subdivided into the categories "receiving", "quality control", "sorting", "repair and refurbishment" and "disposition" (derived and slightly modified from Bernon et al., 2016) (Figure 4).

3.2. Evaluation Indicators

In order to achieve logistical efficiency, relevant customer service elements should be met while reducing cost for fulfilment (Pfohl, 2018). Hence, cost and service aspects need to be taken into account when setting-up an evaluation framework. A variety of performance indicators exist in the literature, which all may have their justification in the distribution process. We focus on frequently mentioned performance criteria and service elements in analysed publications, which therefore are considered as relevant for omni-channel retail. Note, that this is a selected range of performance indicators, not including every process step and logistics key function. Further deep-analysis may be an interesting field of research.

Logistics service criteria for customers in the context of current retailing, which can be influenced by the "facility", can be summarized as follows:

(1) short lead times (e.g. Lang & Bressolles, 2013 / Murfield et al., 2017 / Fransoo & Wullms, 2016),
(2) high product availability (e.g. Martino, 2013, Xing et al., 2011 / Rabinovich & Bailey, 2004),
(3) multiple delivery options (e.g. Fransoo & Wullms, 2016),
(4) large article assortment (e.g. Kumar et al., 2012 / Ishfaq et al., 2016 / Agatz et al., 2008), and
(5) convenient return-processes (e.g. Bernon et al., 2015 / Lang & Bressolles, 2013).

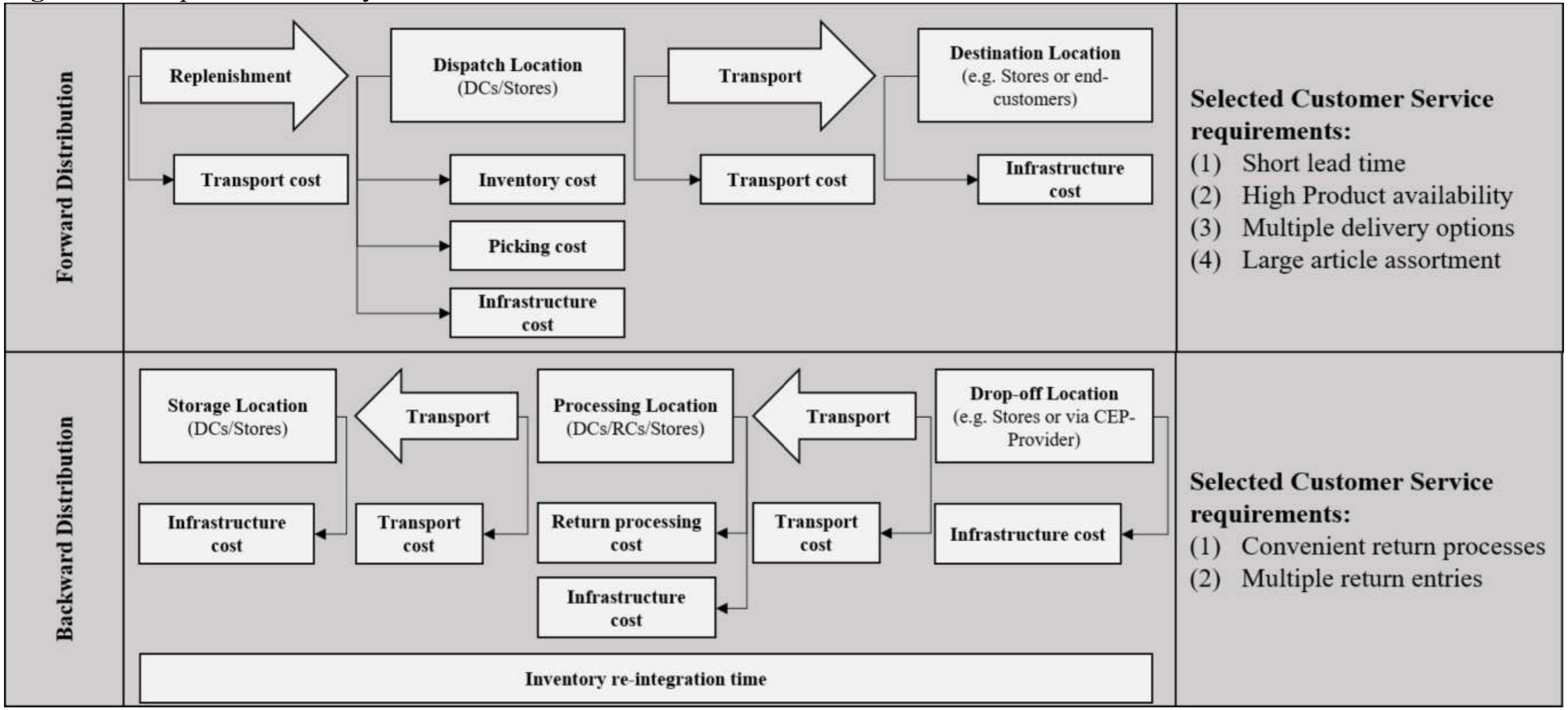
Key cost criteria mentioned are:

(1) transport cost (e.g. Mahar et al., 2014 / Bendoly et al., 2007 / de Koster; 2002),
(2) inventory cost (e.g. Afzar et al., 2014 / Bendoly et al., 2007),
(3) picking cost (e.g. Agatz et al., 2008),
(4) infrastructure cost (e.g. Lang & Bressolles; 2013),
(5) return processing cost (e.g. Bernon et al., 2015 / Hübner et al., 2016a), and
(6) inventory re-integration time for returns (e.g. Hübner et al., 2016a / Bernon et al., 2016).

3.3. Merging a Comprehensive Analysis Framework

The interplay of dispatch/processing location and destination/drop-off location, representing the distribution system, is primarily responsible for meeting customer service requirements while minimizing cost. Including both, we merge selected forward and backward distribution processes (chap. 3.1) with related (selected) logistics cost and delivery service elements (chap. 3.2). Fig. 5 presents the amalgamated analysis framework.

Figure 5. Comprehensive analysis framework



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4. ANALYSING SELECTED FACILITY DESIGN OPTIONS

4.1. Retail Facility Design Options in Omni-Channel Retail

Retailers can operate distribution centers (=DCs) and stores in various designs. In the analysed literature, seven main design configurations at the store level and four distribution center configurations have been identified. Along the supply chain, there are facilities at suppliers and LSPs, excluded in this paper, as mentioned.

Regarding distribution centers, the literature indicates four upstream facility options, handling forward and backward distribution. Triggering questions for differentiation are:

(1) "Should distance and store orders be prepared in separate or integrated into one distribution center?"

(2) "Which facilities should best serve the purpose of return handling?".

If total separation of distance and stationary channels is used, there is the need for a ***separate B&M DC*** and/or retailers set up ***separate eCommerce DCs*** for only processing distance orders. In case the integration of channels is chosen, DCs are integrated (***=integrated DCs***), capable for processing both, stationary and distance orders. Other DC types are only capable of processing returns and further inventory rebalancing (=***return centers (RCs)***).

For differentiating stores, particular functions in forward and backward distribution need to be taken into account. On the one hand, stores can serve as a pick-up location for stationary orders (***traditional B&M function***) and distance orders (***pick-up in store function***). On the other hand, stores may only hold exhibit assortment, the actual order distribution is executed from upstream DCs (***showroom function***). Stores also can serve as distance-order preparation facilities. Accordingly, stores may be considered as „local distribution centres" themselves (***pick-in store function*** and ***dark store***). Considering backward distribution, customer returns, independent from the buying location, can be received at store level and either be routed to upstream DCs for further processing (***store return hub***) or processed directly at store level (***store return center***). Consequently, store design options in forward distribution can be differentiated by the following two questions:

(1) "Where does the customer decides to perchuse a product?"

(2) "Who is responsible for the last mile delivery?".

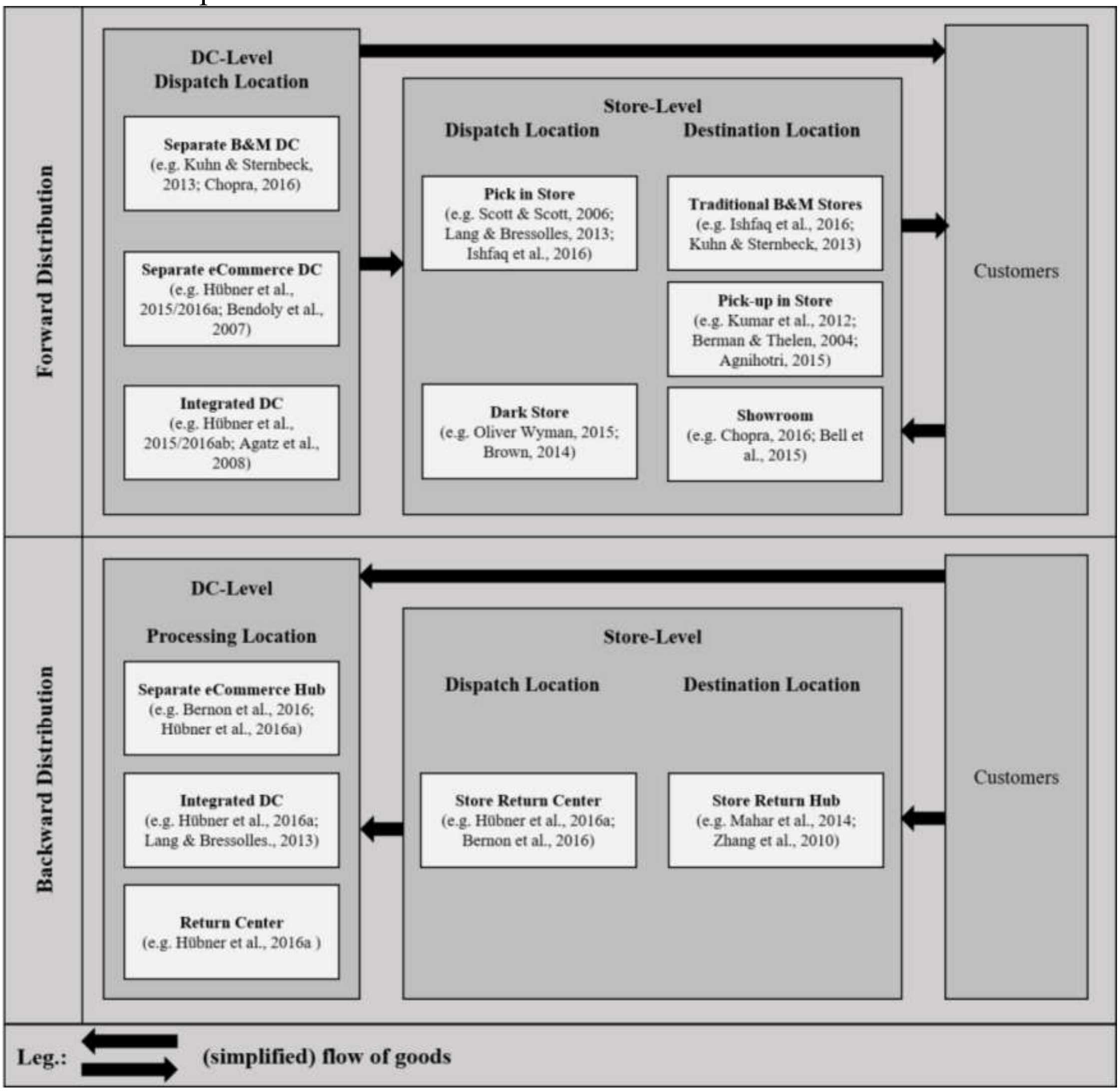
In terms of backward distribution, a differentiation can be made by asking the questions:

(1) "Where can the order be returned?"

(2) „Where is the order processed?"

In fig. 6, different facility design options are outlined and respective literature is listed. For basic clustering, the design options chosen are structured according to their network function, either serving as dispatch locations, or, as destination locations for stationary and distance orders. Note, that facilities may interplay with each other (e.g. integrated DC-delivery with pick up in store) or serve in multiple functions (e.g. pick in store with pick up possibility).

Figure 6. Selected facility design options in omni-channel retail and related literature examples



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A complete analysis of all various facility design and related logistics channel options would exceed the scope of this paper. We concentrate on a selected range of recently and mostly discussed configurations:

(1) "Pick-in Store" concept in combination with "pick-from store" and "direct home delivery";
(2) "Integrated Distribution Center" concept in the interplay with "direct home delivery" and "store delivery" for distance orders; and
(3) "Store Return Center" concept with regards to further inventory re-balancing processes.

4.2. "Pick-in Store" Concept

The pick-in store concept enables to process distance orders from the stores, while the buying process is performed via the distance channel. The order is then routed to the nearest store with the capability of processing in-store picking. Inventory availability and inventory accuracy is of major importance for the concept (Capgemini, 2016). Quick ramp-up and limited invest are advantages, leading retailers to test and scale-up related sales and logistics processes (Hübner et al., 2016b). Besides that, advanced omni-channel retailers utilize this concept, as it enables short delivery time (even same day) to the local customer base (Hausmann et al., 2014).

4.2.1. Distribution Process

In this concept, distance orders and stationary customers are supplied from stores. Aligned inventory policies are a pre-requisite. In particular, either the quantity or the frequency of ***replenishment*** cycles need to be adjust.

At store level, besides daily stationary retail business, store associates usually would perform ***picking and packing processes*** of distance orders from in-store shelves, holding the inventory for both channels (Hübner et al., 2016c).

Further ***dispatch*** is executed either as customer pick-up in stores or as home delivery. In case of home delivery, facilities require further alignment for package and dispatch processes (Hübner et al., 2016c).

The last mile is then processed either by CEP-Providers or specialized LSPs (Hausmann et al., 2014).

4*.2.2. Evaluation*

From the customers' point of view, (possible) ***shorter lead times***, for local customers even same day (Hausmann et al., 2014) and an ***additional delivery option*** (if in-store pick-up is enabled), may increase customer satisfaction.

By using the complete store network with related inventory as one "virtual common inventory" for fulfilling distance orders, online customers may experience ***higher product availability***, as an order can be routed to a destination with guaranteed delivery capability (Martino, 2013). In contrast, ***product availability*** for stationary customers may be decreasing in case limited inventory would lower shelve availability for store customers.

Regarding additional assortment, as stores are limited in space***, possibilities of storing additional assortment***, not available for the stationary channel, ***are limited*** (Metters & Walton, 2007).

Distance orders can be collected by customers directly in stores, ***decreasing last-mile transport cost***. Aligned replenishment cycles in terms of quantity or frequency need to be taken into account. This might outweigh the decreased last-mile cost, especially in out-of-stock situations as backorders from upstream DCs may arise, inflicting both, ***delivery time and cost*** (Bendoly et al., 2007).

Due to the decentral stock allocation at store level, advantages of inventory pooling cannot be achieved, leading to ***lower inventory efficiency***, compared to centralized distribution from DCs (Agatz et al., 2008).

In case pick in-store is used as the only option for distance order fulfilment, ***infrastructure cost can be considered lower***, since upstream DCs are not involved in the fulfilment processes and the store network only needs slight adjustments. (Lang & Bressolles, 2013).

Typically, stores are not specifically designed for efficient picking, but aiming towards creating a positive shopping experience. Articles are placed on shelves by size, shape, brand or other sales and marketing aspects. Logistics criteria (e.g. shelve numbering, movement category, etc.) are hardly considered. In addition, stationary customers moving inside the facility, may disturb efficient picking for distance orders during opening hours and vice versa. In contrast to DCs, ***picking efficiency*** can therefore be considered ***lower***.

4.3. "Integrated Distribution Center" Concept

While process and delivery time advantages are major arguments for dedicated DCs, integrated solutions show advantages in inventory pooling, product availability, lower inventory cost and bundling effects for inbound logistics, while processes are more complex (Chopra, 2012 / Vaccaro & Iyer, 2006 / Hübner et al., 2015). In particular, higher complexity arises from differences between stationary and distance order fulfilment processes in terms of storage, picking and dispatch (Metters & Walton, 2007 / Hübner et al., 2016a). In the integrated DC concept, either a strict spatial separation is used, or the picking process needs to be adjusted in order to operate both channels from one common inventory base (Metters & Walton, 2007 / Hübner et al., 2016b).

4.3.1. Distribution Process

Distribution centers are ***replenished*** by upstream suppliers or further facilities, operated by retailers, typically in pallets or, large reusable boxes (Kuhn & Sternbeck, 2013).

DCs operated by former B&M retailers are designed for store order fulfilment. S***torage*** arrangement is therefore often based on the store layout in quantity and picking sequence (Kuhn & Sternbeck, 2013).

The ***picking*** system is a major challenge in the integrated DC concept. Small quantities of different products, individually picked for one specific customer order, need to be aligned with large volume order picking on pallets for store replenishment. Retailers with small stores and high replenishment frequency use the integrated approach more often, as both distribution processes have similarities (Hübner et al., 2015). Usually boutique-style stores are supplied via DCs just-in-time with high frequency in a sell-one/replenish-one mod, even using parcel services. In order to overcome the challenges of different picking systems, retailers may use for instance common picking zones, distinguished according to the order article movement category or channel-specific picking sequences (Hübner et al., 2015).

After picking, delivery for distance orders is usually executed via CEP-providers, store replenishment via (internal or external) general cargo services. In case store pick-up is used for the distance orders, transport for both, distance and store, may be consolidated (Agatz et al., 2008 / Ishfaq et al., 2016).

4.3.2. Evaluation

From a customer's point of view, compared to the other concepts, ***lead times*** may be longer due to the centralization and integration of fulfilment processes with longer transport distances for both, store and customer orders (Hübner et al., 2016a). Orders for both channels need to be picked from the same inventory, leading to higher operational complexity, potentially creating longer lead times.

Inventory for both channels is pooled centrally. Increase ***product availability*** may be the result (Hübner et al., 2016a).

The integrated DC approach does not influence offering ***multiple delivery options***, but using "pick-up in store" as delivery mode may decrease transport cost, as both order flows can be consolidated (Agatz et al., 2008 / Ishfaq et al., 2016).

Due to the pooled inventory of distance and stationary channels in one DC, the (typically wider (Kumar et al., 2012)) ***assortment*** of the distance channel is included in both. When combining the distance channel with the stationary channel at the stationary front end (e.g. with tablets in store), the additional assortment of the distance channel can be offered in the stationary channel at the same time.

In this concept, only centralized DCs needs to be supplied by upstream suppliers, so ***transports*** can be concentrated and consolidated, lowering cost. When using store pick-up as "destination location", the share of distance orders, shipped via CEP providers, may decrease, lowering the ***cost for the "last mile"*** in distance order fulfilment.

Store replenishment orders and distance orders are ***picked and packed*** from one common inventory. Both fulfilment types are typically different in processes (pallet picking vs single order picking), increasing the complexity of order preparation (Hübner et al., 2016a). ***Picking cost*** consequently increase.

Operating (one or multiple) integrated DC(s) for stationary and distance order fulfilment lowers ***infrastructure cost,*** compared to seperated structures, as consequently less facilities are needed. In contrast, the integrated DC needs more space to carry out both fulfilment methods and higher inventory levels (Hübner et al., 2016a). However, considering typical investments for setting up a new DC compared with investments for infrastructure extension, the infrastructure cost for the integrated DC concept is hypothetically lower.

Distance and stationary channels are picked from one common inventory pool in this concept, therefore lower inventory levels are required (=Inventory pooling). This lowers ***cost for inventory***, stating one major argument for setting up an integrated DC.

4.4. "Store Return Center" Concept

Customers handing in returns to stores can be considered as an additional customer touchpoint, offering additional sales possibilities. Furthermore, customers prefer retailers with multiple access return options (Zhang et al., 2010). In-Store returns are cheaper than returns via postal service in terms of transport cost (Chopra, 2016). In contrast, questions concerning inventory, infrastructure and processing occur (Bernon et al., 2016). Stores act as return centers themselves, in case returns are processed inside.

4.4.1. Distribution Process

When using the store as a return center, the ***drop-off location*** can either be the store itself (=return to store). Alternatively, LSPs / CEP-Providers are engaged for drop-off and further delivery to the store.

At the store level, return shipments are received, ***sorted*** according the condition and (if necessary) ***refurbished*** or scrapped.

The „ready for re-sell" products then get ***stored*** in the store inventory. Products needed in another facility are further re-balanced. This can be executed either via CEP-Providers or vehicles, used for store-replenishment according to the replenishment cycle.

4.4.2. Evaluation

From a customers' point of view, store return are increasing ***return convenience*** (Bernon et al., 2016). Some retailers start to partner with affiliated companies or use specialized logistics partners for offering more return locations (Bernon et al., 2016). Linking store returns with direct payment additionally increases customer satisfaction (Agnihotri, 2015). In some return cases, customers may only exchange products. When using stores as return locations, this can be carried out in one step, increasing customer satisfaction while lowering operational cost for the complete return and re-ordering process (Bernon et al., 2016).

Using stores as return locations lowers the cost for "last-mile transport" via CEP-return to a certain degree, contributing to overall ***transport cost reduction*** (Hübner et al., 2016a). On the contrary, further inventory re-balancing to other facilities later on leads to additional transports.

Considering ***infrastructure*** and related ***inventory cost***, using stores as return processing locations increase inventory re-integration time while more space is needed for the actual return processing (Hübner et al., 2016a). In general, due to faster re-integration time, using stores as return processing locations lower capital cost, tied-up in inventory. In contrast, higher infrastructure cost may arise, especially when considering personnel cost.

Return processes at a centralized facility may be considered more efficient than return processes at store level (Bernon et al., 2016). However, an advantage may be (depending on return-goodwill of a retailer), that a first check in terms of the return condition can be performed while the customer is still present. This leads to a first classification and decrease in overall returns, as products, obviously already used by customers are not accepted (Bernon et al., 2016).

4.5. Evaluation Overview

A qualitative evaluation of the different facility design options is summarized in the light of the outlined performance and service indicators (Figure 7). We indicate an above average performance with a "+" and a beneath average performance with a "-". If a performance indicator can be considered as relatively higher or lower than "+" or "-", we indicate "++" or "- -". When a criterion is not influenced by the network setting, we indicate "x". The assessment is based upon findings in the literature and is qualitatively explained in the chapters above.

Figure 7. Qualitative assessment of the evaluated facilities and related network configurations

	Processing location	In-Store Picking		Integrated DC		Store Return Center	
	Dispatch/Storage Location	pick-from store	home delivery	pick-from store	home delivery	In-Store Storage	Other facility
Customer Perspective	Lead time	++	+	+	-		
	High product availability	-	+	++	++		
	Multiple delivery options	+	x	+	x		
	Large article assortment	-	-	++	++		
	Convenient return processes					+	+
Cost Perspective	Transport cost	++	+	+	-	+	-
	Inventory cost	-	-	++	++	++	+
	Picking cost	-	-	-	-		
	Infrastructure cost	+	+	+	+	-	-
	Inventory re-integration time					++	+
	Return processing cost					-	-

Source: Own figure

5. CONCLUSIONS AND OUTLOOK

In order to analyse the impact of omni-channel retail on facility design options, we developed a generic description and evaluation framework. In this, typical (sub-)processes in forward and backward distribution were amalgamated with delivery service criteria and logistics cost, derived from a literature analysis. In addition, several facility design options were outlined, executing various functionalities in retail distribution networks. Selected ones were further analysed according the developed framework.

In conclusion, significant advantages in terms of shorter lead times, transport cost and infrastructure cost occur when using stores as distance order processing locations, especially when linking them with in-store pick up. Utilization of stores in backward distribution decrease cost for infrastructure and inventory. In contrast, stores are less efficient in terms of picking and inventory. Assortment extension is harder to achieve. The infrastructure itself is generally not designed for processing returns. This leads to less efficiency, compared to upstream DCs.

Integrated DCs as dispatch locations in the forward distribution process have advantages in terms of product availability, assortment extension and inventory efficiency. In contrast, the lead times may be longer and transport cost higher, compared to in-store picking. In addition, picking cost can be considered higher.

In omni-channel retail, there is not one "best-practice distribution network" due to a variety of retailer-specific preconditions (e.g. strategy, assortment, retail format, existing infrastructure, etc.). A systematic, however, qualitative assessment of the cost and benefits of different facility design functionalities may help practitioners to choose suitable distribution network configuration. Equipping facilities for several functionalities and therefore having several possible distribution paths might increase customer satisfaction while decreasing logistics cost, as the most efficient one can be chosen, depending on customer requirements.

Our work contributes for practitioners, as well as future researchers as it outlines a blue-print approach of a holistic analysis framework in omni-channel retail logistics. By providing an overview of relevant distribution processes and linking them to specific customer requirements and logistics cost, especially practitioners may find valuable information for further develop their logistics network.

Additional research, especially field tests, should further deepen the outlined framework in terms of distribution processes, customer requirements and logistics cost. The framework can be as well evolved in terms of a guideline (e.g. by using a scoring model) for omni-channel network design, supporting practitioners in their individual transformation process. Another interesting field of investigation is the actual in-store design of facilities. Especially "dark store" and "showroom" concepts may provide significant advantages for retailers, considering urbanization, the shrinking of store space (Jones & Livingstone, 2015), the increasing importance of short lead times, as well as delivery service and return convenience for the customer.

6. REFERENCES

Afzar, K., Khan, N. & Gabriel, N. (2014). Performance Measurement: A Conceptual Framework for Supply Chain Practices, *Procedia – Social and Behavioural Sciences*, 150, p.803-812.

Agatz, N., Fleischmann, M. & van Nunen, J. (2008). E-Fulfillment and Multi-Channel Distribution – A Review, *European Journal of Operational Research*, 187, p.339-356.

Agnihotri, A. (2015). Can Brick-and-Mortar retailers Successfully Become Multichannel Retailers?, *Journal of Marketing Channels*, 22(1), p.62-73.

Asdecker, B. (2018). Statistiken Retouren Deutschland [available at: http://www.retourenforschung.de/definition_statistiken-retouren-deutschland.html , access April 11, 2018]

Beck, N. & Rygl, D. (2015). Categorization of multiple channel retailing in Multi-, Cross- and Omni-Channel Retailing for retailers and retailing, *Journal of Retailing and Consumer Services*, 27, p.170-178.

Bell, D., Gallino, S. & Moreno, A. (2014). Showrooms and Information Provision in Omni-channel Retail, *Production and Operations Management*, 24(3), p. 359-368.

Bendoly, E., Blocher, D., Bretthauer, K. & Venkataramanan, M. (2006). Service and cost benefits through clicks-and-mortar integration – Implications for the centralization/decentralization debate, *European Journal of Operational Research*, 180, p.426-442.

Berman, B. & Thelen, S. (2004). A guide to developing and managing a well-integrated multi-channel retail strategy, *International Journal of Retail & Distribution Management*, 21(5), p.356-359.

Bernon, M., Cullen, J. & Gorst, J. (2016). Online retail returns management – Integration within an omni-channel distribution context, *International Journal of Physical Distribution & Logistics Management*, 46(6/7), p.584-605.

Brown, M. (2014). The dark Store and Omni-Channel Commerce [available at: http://www.pfsweb.com/blog/the-dark-store-and-omni-channel-commerce/ , access April 08, 2018]

Cao, L. (2014). Business Model Transformation in Moving to a Cross-Channel retail Strategy – A Case Study, *International Journal of Electronic Commerce*, 18(4), p.69-95.

Capgemini (2016). Online Fulfillment – Avoiding the margin squeeze [available at: https://www.capgemini.com/gb-en/wp-content/uploads/sites/3/2017/07/online_fulfillment_avoiding_the_margin_squeeze_1.pdf , access April 10, 2018].

Chopra, S. & Meindl, P. (2015*): Supply Chain Management: Strategy, Planning, and Operations*, 6th Edition, Essex: Pearson Publishing.

Chopra, S. (2015). How omni-channel can be the future of retailing, *Decision*, 43(2), p.135-144.

Coyle, J., Langley, C. J., Nowack, R.A., & Gibson, B.J. (2013). *Supply Chain Management: A Logistics Approach*, Mason: South Western Publishing

De Koster, R.B.M. (2002). Distribution structures for food home shopping, *International Journal of Physical Distribution & Logistics Management,* 32(5), p.362-380.

Ebay.de (2016). Konjunkturumfrage unter Onlinemarktplatzhändlern Q2 2016 [available at: https://de.statista.com/statistik/daten/studie/589531/umfrage/beurteilung-des-retourenmanagements-durch-onlinemarktplatzhaendler/ , access April 11, 2018]

Fernie, J., Fernie, S. & Moore, C. (2015). *Principles of Retailing*, 2nd Edition, London: Routledge

Fernie, J., Sparks, L. (2009). *Logistics and Retail Management: Emerging Issues and New Challenges in the Retail Supply Chain*, 3rd Edition, London a. o.: Kogan Page Publising

Fransoo, J. & Wullms, B. (2016). *Demand fulfilment – Logistic operations that match customer expectations*, in: van Woensel, T. & Broft A.D. (2016). *Omni-channel* *logistics – state of the art*, Technische Universiteit Eindhoven [available at: https://pure.tue.nl/ws/files/50105876/open_access_Omni_Channel_Logistics_lay_out_def.pdf , access May 02, 2018]

Hausmann, L., Herrmann, N., Krause, J. & Netzer, T. (2014). Same-day delivery: The next evolutionary step in parcel logistics [available at: https://www.mckinsey.com/industries/travel-transport-and-logistics/our-insights/same-day-delivery-the-next-evolutionary-step-in-parcel-logistics , access April 10, 2018]

Hertel, J., Zentes, J. & Schramm-Klein, H. (2011). *Supply-Chain-Management und Warenwirtschaftssysteme im Handel*, 2nd Edition, Berlin/Heidelberg: Springer

Hübner, A., Holzapfel, A. & Kuhn, H. (2015). Operations management in multi-channel retailing: an explorative study, *Operations Management Research*, 8, p.84-100.

Hübner, A., Holzapfel, A. & Kuhn; H. (2016a). Distribution systems in omni-channel retailing, *Business Research*, 9, p.255-296.

Hübner, A., Kuhn, H. & Wollenburg, J. (2016c). Last mile fulfilment and distribution in omni-channel grocery retailing, *International Journal of Retail & Distribution Management,* 44(3), p.228-247.

Hübner, A., Wollenburg, J. & Holzapfel, A. (2016b). Retail Logistics in Transition from Multi-Channel to Omni-Channel, *International Journal of Physical Distribution & Logistics Management*, 46(6/7), p.562-583.

Ishfaq, R., Defee, C., Gibson, B. & Raja, U. (2016). Realignment of the physical distribution process in omni-channel fulfilment, *International Journal of Physical Distribution & Logistics Management*, 46(6/7), p.543-561.

Jones, C. & Livingstone, N. (2015). Emerging implications of online retailing for real estate – Twenty-first century clicks and bricks*, Journal of Corporate Real Estate*, 17(3), pp.226-239.

Kuhn, H. & Sternbeck, M. (2013). Integrative retail logistics: An exploratory study, *Operations Management Research,* 6(1/2), p.2-18.

Kumar, S., Eidem, J. & Perdomo, D. (2012). Clash of the e-commerce titans – A new paradigm for consumer purchase process improvement, *International Journal of Productivity and Performance Measurement*, 61(7), p.805-830.

Lang, G. & Bressolles, G. (2013). Economic Performance and Customer Expactation in e-Fulfillment Systems – A Multi-Channel Retailer Perspective, *Supply Chain Forum*, 14(1), p.16-26.

Mahar, S., Wright, P., Bretthauer, K. & Hill, R. (2014). Optimizing marketer costs and consumer benefits across "clicks" and "bricks", *Journal of the Academy of Marketing Science*, 42, p.619-641.

Mangan, J., Lalwani, C., Butcher, T., Javadpour, R. (2011). *Global Logistics and Supply Chain Management*, 2nd Edition, Sussex: Wiley

Martino, G. (2013). *Supply Chain management in the Fashion Retail Industry – a multi-method approach for the optimisation of performances*, doctoral dissertation, University of Salerno

Metters, R. & Walton, S. (2007). Strategic supply chain choices for multi-channel Internet retailers, *Service Business*, 1, p.317-331.

Murfield, M., Boone, C., Rutner, P. & Thomas, R. (2017). Investigating logistics service quality in omni-channel retailing, *International Journal of Physical Distribution & Logistics Management*, 47(4), p.263-296.

Neslin, S., Grewal, D., Leghorn, R., Shankar, V., Teerling, M., Thomas, J. & Verhoef, P. (2006). Challenges and Opportunities in Multichannel Customer Management, *Journal of Service Research*, 9(2), p.95-112.

Oliver Wyman (2015). Omnichannel Operations: Branching out in the new retail ecosystem [available at: http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/2015/jun/OW_Omnichannel_Operations.pdf , access April 10, 2018]

Pfohl, H. (2018): *Logistiksysteme – Betriebswirtschaftliche Grundlagen*, 9th Edition, Heidelberg a. o.: Springer.

Rabinovich, E. & Bailey, J.P. (2004). Physical distribution service quality in internet retailing - service pricing, transaction attributes, and firm attributes, *Journal of Operations Management,* 21(6), p. 651-672.

Saghiri, S., Wilding, R., Mena, C. & Bourlakis, M. (2017). Towards a three-dimensional framework for omni-channel, *Journal of Business Research*, 77, p. 53-67

Scott, C. & Scott J. (2006). Efficient allocation of online grocery orders, *International Journal of Productivity and Quality Management*, 1(1/2), p. 88-102.

Vaccaro, V. & Iyer, G. (2005). Multichannel retailing and the internet: prospects, problems and strategic options, *International Journal of Internet Marketing and Advertising*, 2(3), p.168-183.

Xing, Y., Grant, B., McKinnon, A. & Fernie, J. (2011). The interface between retailers and logistics service providers in the online market, *European Journal of Marketing*, 45(3), p.334-357.

Zhang, J., Farris, P., Irvin, J., Kushwaha, T., Steenburgh, T. & Weitz, B. (2010). Crafting Integrated Multichannel Retailing Srategies, *Journal of Interactive Marketing*, 24, p.168-180.