Omnichannel Assortment Planning

Robert P. Rooderkerk and A. Gürhan Kök

> That neat, tidy and linear path [to purchase] . . . is now a convoluted maze of different channels, touch points, platforms and devices.
>
> *Doug Stephens (2017), p. 56*

Abstract In today's omnichannel environment consumers increasingly interact with assortments of the same firm across different touchpoints. To provide the seamless experience consumers are increasingly used to, firms have to engage in omnichannel assortment planning; coordinate all aspects of their assortment across different channels. This chapter outlines this process, using a combination of literature review and real-world examples. We start with the consumer perspective. How has the proliferation of information and sales channels shaped omnichannel customer journeys? And reversely, how is changing consumer behavior shaping the omnichannel evolution? Next, we describe the notion of omnichannel assortment planning, contrasting it to more traditional assortment planning per channel. Following our definition of omnichannel assortment planning we discuss the strategic, tactical, and operational challenges that arise in this process. Addressing these challenges requires an even more intimate connection between the marketing and operations functions of firms. In addition, it calls for the use of state-of-the-art technologies and data integration along the customer journey, across the firm's functions and across all relevant touchpoints. We end with a discussion in which we outline how academic research can contribute to the emerging practice of omnichannel assortment planning.

R. P. Rooderkerk (✉)
Rotterdam School of Management, Erasmus University, Rotterdam, The Netherlands
e-mail: rooderkerk@rsm.nl

A. G. Kök
Koç University, Istanbul, Turkey
e-mail: gkok@ku.edu.tr

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1 Introduction

In today's increasingly omnichannel world, firms can offer their products through many different channels. Moreover, consumers can be exposed to a firm's products on a wide array of touchpoints,[1] not all directly malleable by the firm (e.g., price comparison websites, blogs, etc.). As a consequence, there is an increasing need for firms to coordinate their assortment planning process across all relevant channels, while accounting for the movement of consumers and information across all relevant touchpoints. To address this need, we introduce the notion of omnichannel assortment planning in this chapter and describe the most pressing challenges in this domain. We summarize the most relevant findings in this nascent research domain and suggest avenues for future research.

The remainder of this chapter is organized as follows. In the next section we summarize how the omnichannel evolution has affected consumer behavior (and vice versa). Section 3 defines the process of omnichannel assortment planning and highlights the most important challenges faced by firms. Sections 4–6 discuss these strategic, tactical, and operational challenges, respectively. We end with a discussion in Sect. 7.

2 Omnichannel Consumer Behavior

The current omnichannel environment has resulted in hyper competition between firms, further increasing the need for customer-centric business models. Following this observation, we start this chapter with the perspective of the consumer. More specifically, in this section we detail how the evolution to an omnichannel world has altered consumer behavior. Reversely, we also discuss how changes in the way consumers (prefer to) shop and their interaction with technology have shaped the omnichannel evolution.

2.1 The Omnichannel Customer Journey

We refer to Fig. 1 for a visualization of omnichannel consumer behavior. This conceptual model of the omnichannel customer journey is an adaptation of Figure 1

[1] A touchpoint is any consumer interaction with a firm or its offerings; for example, writing a review. Every touchpoint is associated with a given channel, for example, the firm website or a blog in case of a review. However, a channel is typically not uniquely associated with a given touchpoint; a website may also be a place where a consumer can buy a product besides leaving a review. It is important to note that not all channels may be under (full) control of the firm.

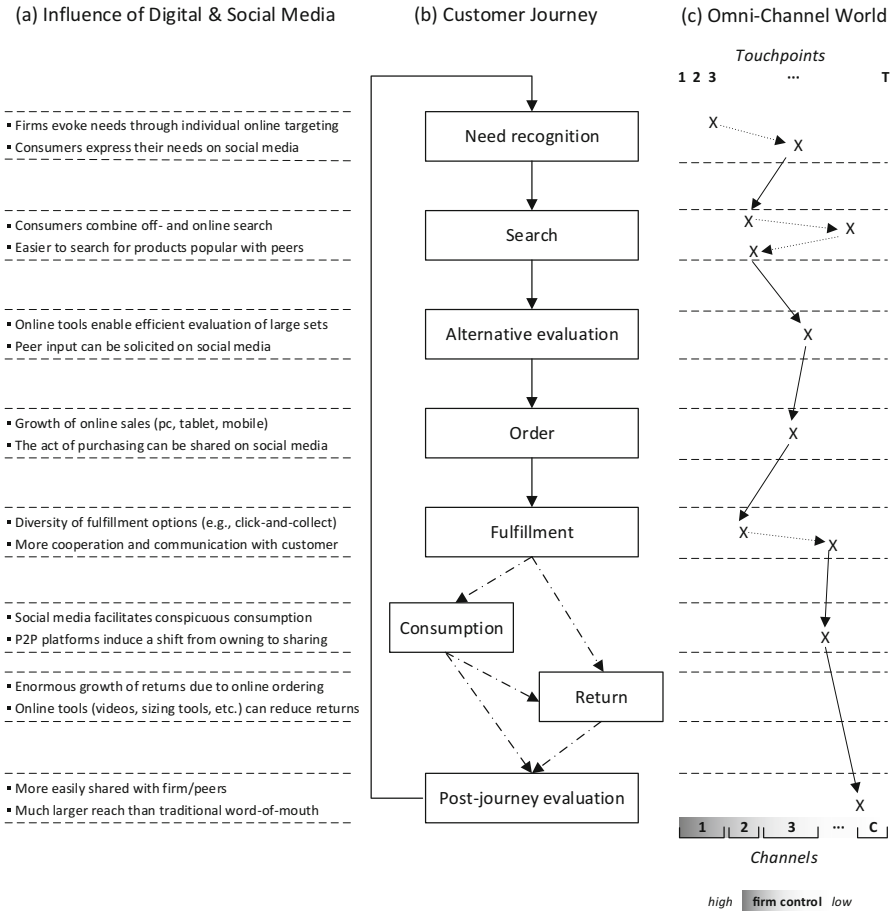

Fig. 1 Omnichannel customer journey. *Notes.* The central panel (**b**) depicts the customer journey as a sequence of eight stages. Bijmolt et al. (2018) introduced this is an omnichannel adaptation of the traditional Engel–Blackwell–Miniard model of consumer decision making (Engel et al. 1986). The dotdash arrows illustrate three potential routes from fulfillment to post-journey evaluation, depending on whether or not consumption and return of the good takes place. Panel (**c**) on the right illustrates how customers move from touchpoint to touchpoint, both within (dotted arrows) and between (solid arrows) decision stages. To the extent that touchpoints are associated with different channels the journey moves across channels as well. Channels vary in the level of firm control. The feedback loop from post-journey evaluation signifies how current journeys may affect later ones. The feedback could be to any stage of the future journey. For ease of exposition we have just drawn one. Finally, panel (**a**) on the left provides examples how digital and social media have affected the nature of each stage

of Bijmolt et al. (2018). It consists of three panels. The middle panel (b) represents the central component of the conceptual model. It depicts the different stages of the omnichannel consumer decision-making process. The panel to the right (c) illustrates how consumers move between different touchpoints, both between and

within the different decision-making stages. Panel (a), on the left, illustrates how the advent of digital and social media has affected consumer behavior in each stage.

Following Bijmolt et al. (2018), panel b depicts the omnichannel customer journey as a sequence of eight stages, starting with *Need recognition* and ending with *Post-journey evaluation*. Compared to the traditional model of consumer decision making, represented by the Engel–Blackwell–Miniard model (Engel et al. 1986), this conceptual model of the omnichannel customer journey differs in four places: (1) the *Purchase* stage has been relabelled into the *Order* stage to reflect that, increasingly and especially online, products do not immediately change hands when a transaction is made, (2) in between the *Order* and *Consumption* stages an additional stage, *Fulfillment*, is added to acknowledge the increasing diversity and need for coordination with the consumer when it comes to order fulfillment, (3) *Return* is added as an additional (but optional) stage since returning behavior has become much more prevalent in the omnichannel world, and (4) the last stage was relabelled from *Post-consumption evaluation* to *Post-journey evaluation* to reflect that the final evaluation no longer simply pertains to the product, but also includes the seller and logistics provider. For more elaboration on how this adaptation differs from the standard model, we refer the interested reader to Bijmolt et al. (2018).

The omnichannel nature of consumer decision making has resulted in customer journeys along an increasing number of touchpoints that, owing to technology, follow each other in rapid succession (Kitewheel 2018). The rise of smartphone usage enables many consumers to have several touchpoints at arm's length (e.g., apps, social media, firm website, price comparison site, etc.), even allowing consumers to interact with multiple touchpoints at once (e.g., checking online prices while visiting a physical store). The resulting journey across multiple touchpoints is illustrated in panel (c), on the right. The advent of first digital and later social media has resulted in a diversity of touchpoints in each decision-making stage. This has profoundly affected consumer behavior in each stage, but also the way that consumers move across the stages. Panel (a), on the left, provides some examples of how digital and social media have altered the customer journey.

2.2 Omnichannel Firm Strategy

The acceleration of omnichannel customer journeys has been fuelled by technological advancements and channel proliferation. Moreover, customer journeys are more and more interconnected, both over time for a given consumer (e.g., past experience with a website speeds up future journeys) and across consumers (deliberations and outcomes at each stage can instantaneously be shared with peers, even before completing the full journey). Consequently, the process has also been depicted as a circular one (rather than linear), with different spheres of (peer) influence along the way. However, when experts talk about a non-linear journey, they do not seem to refer to panel b in Fig. 1, those stages still follow each other in that order. Rather, they refer to panel c; whereas traditionally consumers would stay within a given

channel throughout their journey (e.g., search at store, evaluate at store, order at store), nowadays their journeys are characterized by a plethora of channels.

We use the term omnichannel retail *evolution* because it extends the move from single channel to multi-channel retail. In a single-channel setup, the firm only sells through a single channel (e.g., brick-and-mortar stores or online). In a multi-channel strategy, the firm interacts with consumers through multiple channels. However, there is little to no coordination between the different channels. In many ways, the different channels are used to serve different customers (e.g., customers who prefer to buy from the physical store vs. those that like to buy online). By contrast, in an omnichannel strategy the firm tries to establish a seamless customer journey across different touchpoints. In other words, compared to multi-channel the firm assumes consumers may visit different touchpoints along their journey versus different consumers visiting different touchpoints. This intra-consumer exposure to different touchpoints requires firm coordination of resources and marketing mix activity across all relevant touchpoints. In the remainder of this chapter, we focus on the coordination with respect to the assortment. In doing so, we refer back to Fig. 1 when discussing what challenges the omnichannel nature of consumer decision making poses on such coordinated assortment planning. First, we formally define omnichannel assortment planning in the next section.

3 Omnichannel Assortment Planning

A firm's omnichannel strategy is successful when it fully integrates all channels to provide a seamless experience to customers throughout their journey (Rigby 2011; Brynjolfsson et al. 2013; Verhoef et al. 2015). To provide such a fully integrated experience, coordination across channels and touchpoints, and across different journey stages is essential (Bijmolt et al. 2018). This also holds for the notion of assortment planning. All aspects of assortment planning have to be coordinated to facilitate the seamless experience. More formally, we define omnichannel assortment planning as follows[2]:

> Omnichannel assortment planning is the process of coordinating all aspects of the assortment (composition, layout, pricing, inventory levels, etc.) across channels to facilitate a seamless consumer experience across all consumer touchpoints.

Like other aspects of an omnichannel strategy, success in omnichannel assortment planning requires careful coordination between the marketing and operations functions of the firm (Saghiri et al. 2017; Bijmolt et al. 2018) An approach that considers both the demand-side (marketing) and supply-side (operations) perspective in every assortment-related design decision is advocated. In addition, it requires an elaborate understanding of the relevant (variety of) customer journey(s).

[2]Due to space limitations we will not discuss the pricing dimension very elaborately in this chapter.

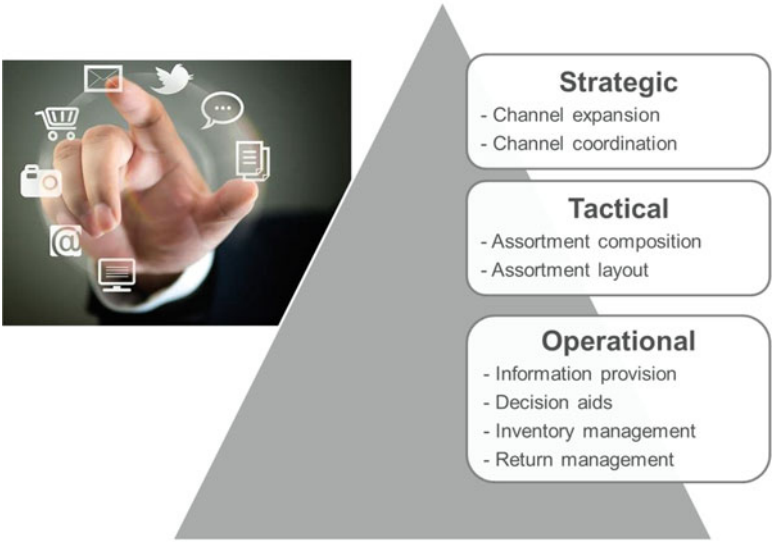

Fig. 2 Challenges in omnichannel assortment planning

Firms should capitalize on this understanding by combining data, across channels, touchpoints, and consumer decision-making stages to improve customer experience with the whole process and increase firm metrics along the way.

The traditional single-channel assortment planning process is already quite complex and relatively understudied in the marketing and operations literature (Rooderkerk 2007; Kök et al. 2008; Mantrala et al. 2009; Ailawadi et al. 2010). Omnichannel assortment planning further complicates this by introducing coordination issues across channels, which represent all sorts of challenges to firms with omnichannel ambitions. We divide these challenges into three types: *strategic*, *tactical*, and *operational* challenges. Figure 2 summarizes the three types of omnichannel assortment challenges. The next sections elaborate on all of these challenges.

4 Strategic Challenges

The most important decisions for a firm at a strategic level are (a) whether to expand the product offerings to new channels and (b) the optimal type of coordination between the different channels when it comes to the offered assortment(s). Next, we discuss these two challenges in turn.

4.1 Channel Expansion

Today's omnichannel customer journeys are characterized by the increasingly rapid succession of various touchpoints (McKinsey 2017). These touchpoints may involve channels not owned by the firm (Baxendale et al. 2015). This poses a risk to firms; part of the customer journey is outside firm control. Throughout their journey consumers may decide not to (re)visit a firm's channel; for example, when checking online prices of a product encountered in a physical store, the consumer may decide to buy it from a competitor's website. One way for a firm to address this risk is to expand its presence into channels that are new to the firm. Here, we focus on channels that facilitate exposure to the firm's assortment and ordering from it.

4.1.1 Showrooming and Webrooming

To explain the potential of channel expansion, we first highlight two forms of channel-switching behavior within customer journeys that are central to omnichannel retailing. These behaviors, showrooming and webrooming (Verhoef et al. 2007), pertain to switching between offline and online channels somewhere in between the search and order stage (Fig. 1). Showrooming describes behavior in which consumers gather information at a physical store, but order the product online (Sevitt and Samuel 2013; Neslin et al. 2014). The reverse behavior is webrooming, in which consumers research products online before visiting a physical store for a final evaluation and purchasing (Sevitt and Samuel 2013).

Consumers showroom because they expect to find lower prices online or dislike waiting for service in stores (Gensler et al. 2017). Store stockouts also stimulate this behavior (eMarketer 2014). Webrooming, the most popular of the two channel-switching behaviors (The Harris Poll 2014), is driven by the desire not to pay for shipment, the ability to touch and feel the product before purchase, having the option of returning the item to the store if needed, and not wanting to wait for delivery (Cayan 2014).

4.1.2 Reactions of Traditional Players

Showrooming may be detrimental to firms that have physical stores, but no (significant) online presence. This can even drive a firm out of business, as witnessed by the bankruptcies of Borders, Radioshack, and most recently Toys "R" US. Ways to fight showroom behavior include price matching (only possible with high volumes, Business Insider (2013)) or improving in-store customer service (Huffington Post 2017). In addition, it may be necessary to maintain higher inventory levels in order to guarantee immediate delivery, something that is hard to match online. From an assortment perspective traditional players could also carry exclusive products that cannot be found online (Knowledge@Wharton 2012), a strategy practiced by Target

and Best Buy (Chain Store Guide 2013). A more desperate attempt of traditional players to fight off online retail has been to trim the number of stores to remain profitable. This strategy has led established retailers such as Abercrombie & Fitch (CNBC 2018), Barnes & Noble (CNN 2018), Gap (USA Today 2017), Kmart, Macy's, and Sears (NPR 2018) to close a substantial fraction of their stores.

However, if you can't beat them you can always (attempt to) join them. To deal with showrooming behavior many traditional players have expanded into the online domain. Walmart's strategic partnership with Microsoft to further compete with Amazon best illustrates this kind of firm reaction (Microsoft 2018). Firms could also choose to run their online operations on the existing platform of a pure player. This strategy is pursued by the German holding Media Markt Saturn Retail Group. The German webshops of their Media Markt and Saturn chains both run on the eBay platform (Media Markt Saturn Retail Group 2015). In this setup, at the expense of some profit loss and ceding some control, the traditional retailer is able to quickly scale-up its offerings to online channels. In doing so, it benefits from the vast online experience of the pure player and taps into customer segments not (yet) visiting its stores. Kranzbühler et al. (2018) show that, as long as the outsourced touchpoint is satisfactory to consumers, the focal brand is evaluated more favorably when it works together with a strong rather than weak brand.

4.1.3 Reactions of Pure Online Players

Online retailers without a physical presence may face a serious threat if consumers webroom on their website, but purchase at a competitor's physical stores. Realization of this threat has led to several, originally, pure players opening up physical stores, including two of the three world's largest e-commerce companies, Amazon and the Alibaba Group (Forbes 2017a). Amazon has opened up the Amazon Books stores, the checkout-free Amazon Go stores, and acquired the WholeFoods grocery chain. Meanwhile, Alibaba is accelerating the roll-out of its highly innovative Hema supermarket chain (AdAge 2018) and struck a partnership with Bailian, with 4700 outlets in 200 cities one of the largest retailers in terms of store numbers worldwide (Forbes 2017a). Pure players' ventures into the physical world are not restricted to full blown stores. A popular alternative is the showroom, which has no or limited inventory, but serves to have consumers touch and feel the product, obtain advice, determine their appropriate size (in case of fashion) among others. Here too, outsourcing is an option. Founded in 2015, b8ta introduced an innovative retail-as-a-service model (Forbes 2017b). Firms can rent a dedicated amount of floor space and manage each aspect of their in-store marketing communication remotely and in real-time (b8ta 2018). b8ta does not make any money from product sales, but from the partnerships with the products' makers and the analytics they provide them regarding consumer engagement with their products. They currently run nine flagship locations and 70 shop-in-shops (for Macy's and Lowe's) across the USA.

Beyond increased demand, pure online players opening up physical channels may also experience operational benefits. In a study of US based online-first retailer Warby Parker opening up showrooms, Bell et al. (2017) provide empirical proof for both demand-side (marketing) and supply-side (operational) benefits. The showrooms not only increased sales in the trading area but also reduced returns. With click-and-collect on the rise stores can also double as pick-up locations. In addition, firms can use their physical outlets to deal with the enormous amounts of returns originating from online purchases. It is less costly to handle these in stores than by mail. Moreover, the option to return to a store is something consumers value when choosing between retailers (Gallino et al. 2018).

4.1.4 Blurring the Lines Between Showrooming and Webrooming

The preceding discussion on research shopping, a term used to describe both showrooming and webrooming (Verhoef et al. 2007), treats the online and offline channels as distinct, yet interrelated, ones. However, the lines between the offline and online world are increasingly blurred in the eyes of consumers (Bijmolt et al. 2018). Later generation shoppers approach offline and online channels as one and the same. This is further fuelled by increasing consumer adoption of smartphones, especially in China and India.

With many online touchpoints at arms length (web, app, social) consumers can seamlessly integrate the different channels and stages of the research shopping process. Examples include online price comparison while being inside a store or monitoring online reviews while evaluating products encountered offline. Consequently, it seems better to talk about "omnirooming." More and more apps come out that are designed to facilitate this type of shopping behavior. A good example is the Vivino wine app shown in Fig. 3, which lets you read wine facts and user reviews by simply making an in-app picture of a wine label or list.

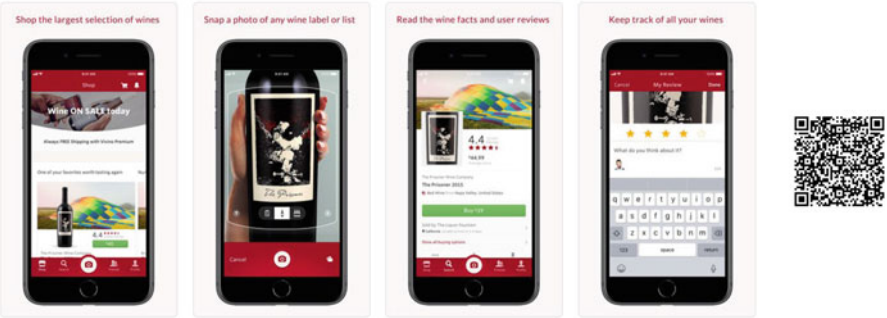

Fig. 3 Vivino wine app. *Notes.* Click or scan the QR code to launch a video introducing the Vivino app. Courtesy of Vivino

4.1.5 Blurring the Lines Between Channels

Not only on the consumer side are things increasingly blurred. Firms are opening up hybrid channels that mix characteristics of the offline and online world. For example, Amazon and Alibaba have incorporated various "online" technologies in their physical stores, including automatic checkouts and QR codes for additional product information. A state-of-the-art example is the Tmall × Intersport store in Beijing; by integrating many technologies from Alibaba's e-commerce platform the lines between the offline and online world are blurred inside the store. These developments also result in a blurring of store formats. Showrooms are typically equipped with terminals that allow for online ordering. And owing to the rising expectations with respect to delivery speed, an increasing number of stores are designed for click-and-collect purposes. For example, IKEA is opening up so-called order and collection points. These stores are a lot smaller than their regular counterparts, but located closer to consumers, in large city centers such as London, Oslo, and Stockholm. As a consequence, they only carry a fraction of the retailer's full product portfolio. An even more extreme case is the new Media Markt Digital store in Barcelona (see Fig. 4). It hardly carries any products on the shop floor. However, it serves as a collection point and can immediately fulfill orders placed on touch screens for a range of 5000 SKUs. The products are picked from inventory by robots. This definitely changes the concept of an assortment, present and absent at the same time.

More and more firms are experimenting with pop-up stores. These stores have a temporary nature, are located in high traffic areas, and typically much smaller

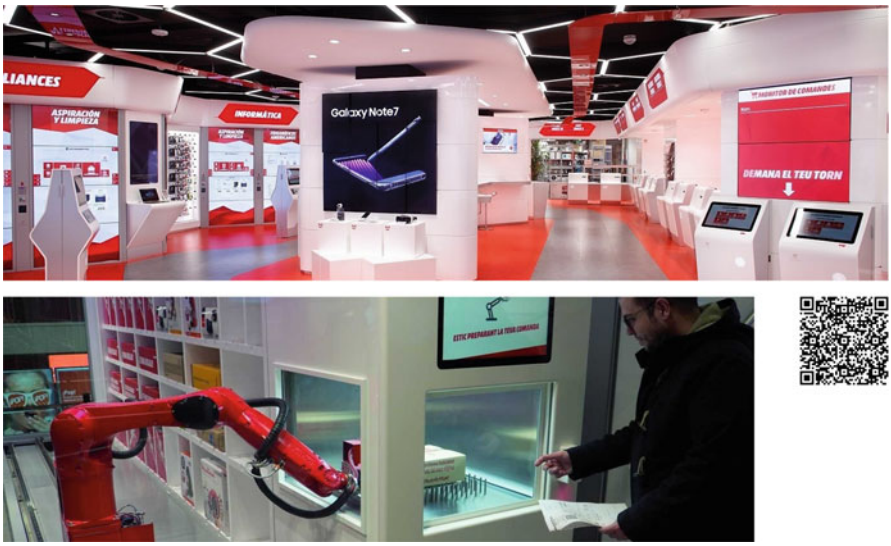

Fig. 4 Media Markt Digital store in Barcelona. *Notes.* The top figure shows the shop floor. The bottom figure shows how a robotic arm picks and item for customer collection. Click or scan the QR code to launch a video that takes you on a tour of the store. Courtesy of Media Markt

Fig. 5 Tommy Hilfiger pop-up shop on the beach of Zandvoort in The Netherlands. *Notes.* Courtesy of Tommy Hilfiger

than a regular store. Reasons for opening up a pop-up store include experimentation with a physical store format for pure players, engaging a new customer segment, and creating the perception of scarcity (Shopify 2016). Due to their size, pop-up stores typically only carry a very limited assortment that is centered on one or a few product lines. They can be used to support the introduction of a new product (line). They have also proven to be an effective instrument for firms exploring a foreign market (Picot-Coupey 2014). In many ways one could interpret the world of physical stores as a foreign market to pure players. Zalando, a top-10 pure player and one of the largest in fashion, has opened up its Zalon pop-up store concept in cities such as Berlin and Vienna (Zalando 2017). As the example in Fig. 5 shows, pop-ups can provide an excellent fit with both time of the year (Summer) and location (the beach).

Another interesting channel is the so-called virtual (grocery) store. Pioneered by Tesco's Homeplus supermarket chain in South Korea, this format literally brings the store to the people (Business Today 2015). It consists of highly realistic poster shelves that are displayed in crowded public places such as subway stations. Using an app consumers can scan the QR codes of the depicted products to put them in their online basket. Next, consumers can order for the selected items to be delivered at home. The store was tailored to the local situation; South Korean consumers are very hard working and have little time to shop. With 900K downloads the Homeplus app became the most popular shopping app around the time of the introduction. The new channel mainly served as a goal to create consumer awareness of Homeplus' online ordering app. Figure 6 shows an adaptation of this concept by Dutch supermarket chain Jumbo.

4.2 Channel Coordination

An important aspect of channel coordination is deciding on the desired/feasible level of assortment integration across the available channels. Inspired by Emrich et al. (2015) and Bertrandie and Zielke (2017) we classify the different types of assortment integration visually in Fig. 7.

Fig. 6 Jumbo's virtual grocery store. *Notes*. The top panel shows Jumbo's virtual grocery store, located at a bus station in Utrecht, The Netherlands. The bottom panels show how a consumer fills his online basket by scanning the barcodes of products with the Jumbo app. Courtesy of Distrifood

In the "no integration" case, there is no overlap at all between the off- and online assortments. This only seems to make sense when a firm serves very different customer segments with very different preferences through the different channels. However, in the omnichannel world, this seems a theoretical option at best.

In the "full integration" case the two assortments are exactly the same. This seems beneficial because it avoids consumer confusion (Bertrandie and Zielke 2017). Several studies argue that full integration is preferred over no integration (Neslin and Shankar 2009; Berry et al. 2010). However, for reasons we will elaborate on below it may be very hard to achieve full integration.

Alternatively, firms can engage in "asymmetric integration," in which there is partial overlap between the off- and online assortments. In a series of experimental studies Bertrandie and Zielke (2017) find that asymmetric integration leads to less choice overload and choice confusion than full integration. There are three different forms of asymmetric integration. In the first configuration, labelled (a), the online assortment represents a subset of the offline assortment. This is typically the case when a traditional retailer or brand starts an online channel. To limit complexity and learn fast, they start with a subset of their full assortment. There may also be other motivations to restrict a product's availability to the physical channel. For example, when a firm considers an item to be a significant driver of store traffic, and believes its exclusive physical presence may generate so-called halo effects (buying other products next to the one the store is visited for, Ailawadi et al. (2006)). This is in line with the finding that consumers buy less on impulse online than in a store

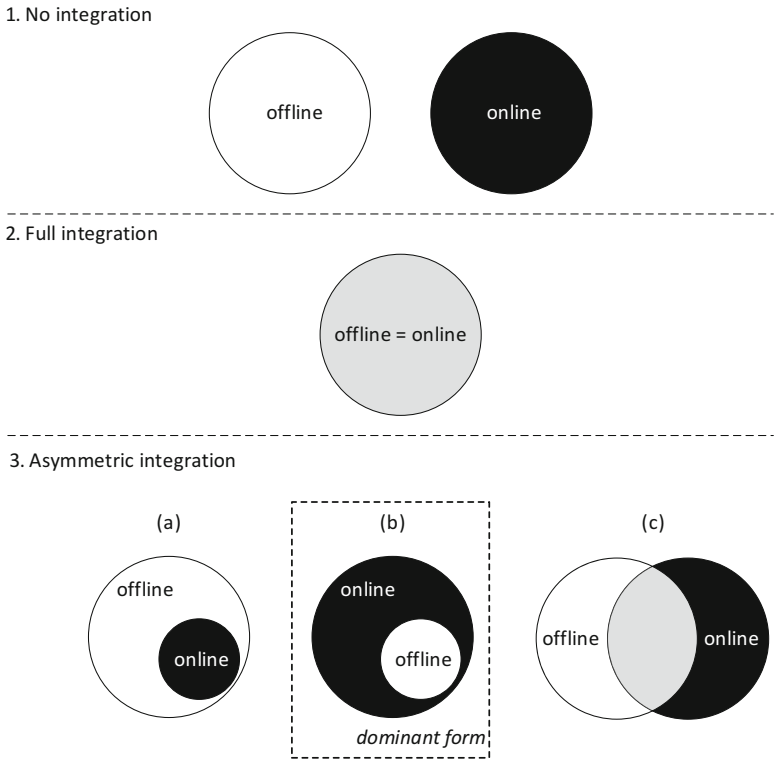

Fig. 7 Types of assortment integration

(Business Insider UK 2017). Another reason may be that certain products require in-person explanation that is hard to provide online. Without the explanation these products have a much lower chance to be bought and a higher chance to be returned. For instance, a representative of a large European pure player that recently opened up physical stores told us that a significant fraction of expensive televisions are returned. The firm had learned that the main reason was disappointment with the sound. When a return is made in store, the firm's salespeople explain that this not specific for the focal product but a more general trait of televisions. They then recommend adding a soundbar, and typically achieve in not only annihilating the return, but making a cross-sell at the same time.

The second configuration, (b), is the exact opposite. Here the online assortment contains its offline counterpart plus more. Reasons to do so include offline shelf space scarcity (Quelch and Kenny 1994; Kurtuluş and Toktay 2011), alleviating consumer confusion, and operational efficiencies (Nielsen 2010). An important consideration here is the so-called long-tail effect (Brynjolfsson et al. 2006, 2011). This refers to the finding that, increasingly, demand is dispersed over more different products, meaning that a large subset of the assortment only sells very little. Keeping

these slow moving items in stock in every physical store is very costly. That is where online comes in. Here one can keep a centralized (across stores) stock that is much smaller than the combined stock the individual stores would have to keep. This form of asymmetric assortment integration is the most frequently occurring one (Bertrandie and Zielke 2017).

Finally, there is configuration (c), in which both channels overlap, but both have their unique items. This applies when the motivations for keeping certain products offline but not online and the reverse for other products hold at the same time. We expect this to see this form more frequently, perhaps even more than configuration (b).

5 Tactical Challenges

Two important tactical dimensions of assortment are the composition and the layout of the assortment. In an omnichannel setting firms typically have the freedom to decide on these features per channel, while wanting to coordinate across them. In addition, the advent of online channels (web and mobile) has increased the potential for *personalization* ("customizing assortment dimensions to the individual consumer") and *contextualization* ("adjusting assortment dimensions based on contextual factors such as time, location, and weather").

5.1 Assortment Composition

In the last decade, the topic of assortment optimization has received an increasing amount of attention in the marketing and operations literature (for reviews please see Kök et al. (2008), Pentico (2008), Mantrala et al. (2009), Hübner and Kuhn (2012), Mou et al. (2017)). However, much of this growing literature stream focuses on a single physical store channel. In this section, we first discuss how a cross-channel transfer from methodologies and insights could benefit the quality of the assortments in each channel. Next, we discuss the coordination of the assortment composition across channels.

5.1.1 Transferring Methods and Learnings: From Offline to Online and Back

Optimizing the composition of a store assortment in isolation is very complex. It is even argued that no dominant solution exists in academia or business (Mantrala et al. 2009; Hübner and Kuhn 2012). In theory, the most promising techniques for offline assortment optimization could be transferred to online settings. Surprisingly, research investigating the potential of doing so is still lacking. This could have

something to do with the added complexity of online settings, in which the number of products is much higher and items could move much slower than in the offline grocery settings that are typically studied in the assortment planning literature. It could also have something to do with the perceived absence of space constraints in the online world. When one could offer everything, why choose? Well, for starters because some retailers keep a substantial portion of their assortment in inventory to guarantee fast delivery. Even though online space is "free," space in distribution centers is not. Moreover, in the era of overchoice (Schwartz 2004), several retailers believe that, instead of selling everything under the "Amazon model," being a curator is a better option. For example, leading Dutch omnichannel retailer Coolblue (2018) recently came out with a video explaining that they would offer fewer products in a set of categories. Marijn van der Weele, head of pricing and assortment at Coolblue, motivated this move by stating that Coolblue is committed to help consumers find the product they desire easier and faster. Using data, Coolblue argues, it can already weed out the products that are not worth the consumer's time (and money).

A prerequisite to successful assortment planning is detailed knowledge of consumer preferences. What product features do consumers prefer, what trade-offs do they make, and how much are they willing to pay? The accumulated knowledge should result in an accurate prediction model for so-called transferable (portion of a product's sales that other products in the assortment would gain if it were to be deleted) vs. non-transferable demand (sales that would be lost if a particular product were to be deleted). State-of-the-art methods for estimating this demand decomposition either use panel data (Kök and Fisher 2007) or store-level scanner data (Rooderkerk et al. 2013; Sinha et al. 2013). These methods rely on assortment variation, over time and between stores, and promotional activity to figure out which products compete and which ones don't. As such, these models only use data pertaining to the order stage of the customer journey. In addition, they rely on sufficient product rotation to be able to estimate the model parameters.

Currently, most online assortments only display variation over time (not across consumers). Moreover, they may include a lot of slow-moving items. However, online channels can also capture valuable information about the stages preceding the order stage, most notably search and evaluation of alternatives (see Fig. 1). Data can be collected on how consumers filter alternatives (i.e., how they construct the consideration set) and which alternatives they study more closely, potentially even directly compare (i.e., the composition of the consideration set). Analyzing these data results in valuable insights about consumer preferences. For example, existing research has leveraged online search data to map competitive relations between products (Kim et al. 2011; Ringel and Skiera 2016). Traditional offline choice models (implicitly) assume that consumers consider all product alternatives when making their choices by, for instance, adopting a compensatory model of decision making. In online settings, where the number of alternatives is much larger, this may be a hard sell. Fortunately, there is a stream of papers modeling consumer choices using consider-then-choose models (see Hauser (2014) for an overview) that seem to better describe online settings. A recent paper by Aouad et al. (2015) applies

this idea to assortment planning. However, typically the consideration set is not observed. This problem can be solved by using data augmentation in the estimation algorithm (e.g., Gilbride and Allenby (2004)). The benefit of online environments is that they can actually keep track of the consideration set, reducing the uncertainty around preference estimates. It is also easier to collect information about post-order data online. Customer reviews are more abundant in online settings than in physical retail. And returns data can be more easily linked to individual customers. The learnings from the online channels should be transferred to the offline channels, as long as potential differences in the preferences of the off- and online customer base are acknowledged. For instance, online reviews and returns data can be used to rationalize offline assortments. Retailers could even stimulate consumers that buy in store to write an online review.

In contrast to offline settings, online channels (web and mobile) allow for (more) personalization and contextualization of the product offerings shown to a consumer. Firms with an online presence could take the notion of curation to the next level, by preselecting a subset of their assortment for an individual website visitor. Clicksteam, order, and return data from previous visits, to the focal and other categories, could be leveraged to aid in this process. An innovative example of personalization comes from Japan. Several years ago, Acure introduced its New Generation vending machines (Fig. 8), which are equipped with a 47 in. touch screen, a camera, and facial recognition software. With these tools the machine estimates the gender and age of the person standing in front of it. Based on the weather (contextual) and consumer demographics (personal), the machine displays a specific assortment.

When using an app or visiting a website on their smartphone, consumers, typically and unknowingly, share a variety of things, including location, whether they are on Wi-Fi or not, remaining battery power, etc. These data could all be factored in to offer contextual assortments. An example is the campaign that Blue Mango Interactive designed to help Dutch pharmacy chain Kruidvat sell its Solait suncare products; combining multiple data feeds including location, bathing places,

Fig. 8 Acure's Next Generation vending machine. *Notes.* Courtesy of Acure

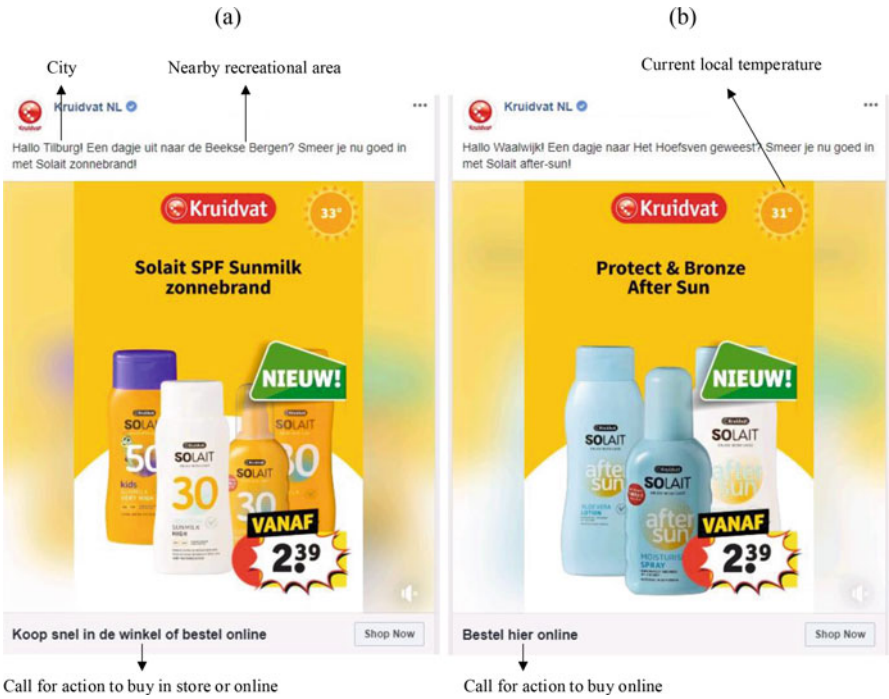

Fig. 9 Social media campaign for Kruidvat Solait sun lotion and after sun. (**a**) Daytime version (during store opening hours). (**b**) Nighttime version (after store opening hours). *Notes.* Courtesy of Blue Mango Interactive

and weather they made a dynamic video for social media (for screenshots see Fig. 9). The video would mention the city the person was in and refer to a well-known recreational area nearby (themepark, beach, etc.). Moreover, it would incorporate the current temperature at the consumer's location. During daytime (panel (a) in Fig. 9) it would show Solait sunscreen products and during the evening the brand's after sun lotion (panel b). In addition, the bottom of the screen would encourage the consumer to buy the product in-store (only during daytime) or online. Effectively, another example of what Stephens (2017) in his book calls "the store as media."

With every advance in technology, we believe personalized and contextualized assortments represent a tremendous opportunity for firms, but more research is needed on how to best unlock their potential. Recent work on personalizing assortments online investigated some of that potential. Bernstein et al. (2015) study customizing assortment decisions for each online visitor based on supply limitations and present a case study at a fashion retailer where online customer preferences are estimated based on past offline purchases (as an example of cross-channel learning).

5.1.2 Coordinating Assortment Composition Across Channels

An important part of omnichannel assortment planning is the cross-channel coordination of the assortment composition, as touched upon in Sect. 4.2. Here we discuss the tactical execution of asymmetrically integrated assortments, the most common form of assortment integration (c.f. Fig. 7).

The first step in coordinating the assortment composition is to acknowledge the role of each channel in the omnichannel journey. When a store serves as a showroom for certain items, these products may not sell well in the store, but their absence may make consumers delay their purchase (to visit a competing store that does carry the item) or even worse, buy them somewhere else. Dzyabura and Jagabathula (2017) show that substantial profit gains can be realized when accounting for showroom behavior while optimizing the composition of an offline assortment. Similarly, it may be compelling to remove a product from the website, or put it in a less prominent position, when online sales are low. However, the website may serve as an information portal, consulted by webrooming consumers before they purchase the item in one of the retailer's physical stores. To account for cross-channel effects data have to be integrated across different channels and touchpoints within the firm. It requires a clear mapping of the most typical customer journeys. This also means that existing metrics, such as yield per square meter/foot, may no longer be the most relevant ones. A showroom may score very bad on this metric, while being successful in converting browsers to online buyers in the firm's online channels. Stephens (2017) argues that stores should focus less on (in-store) conversion, and put more emphasis on generating memorable consumer experiences and collecting insightful data on consumer behavior instead.

The second step is to determine which products fit best in both channels or only in one of the channels by leveraging data across all channels. For instance, an omnichannel firm may encounter a product with a relatively high number of online views, but corresponding conversion to be rather low. If webrooming can be ruled out the next question is what stops people from buying it? Strong competitors, unattractive pricing, or consumer uncertainty regarding (the deliverance of) its benefits? Here the store comes in. Instead of simply eliminating the product, the retailer could give it more (room) in the store. Its salespeople could document the types of questions that consumers ask about the product to figure out whether pricing is off or whether more information should be provided (online). A challenge when combining data from different channels, say online and offline, is the finding that consumer behavior and preferences may vary with the channel. For example, Dzyabura et al. (2019) find discrepancies between how consumers evaluate products "live" versus online. This implies that online evaluations in market research may have limited predictability for in-store preferences.

Following the popularity of click-and-collect (also called Buy Online, Pickup in Store) many stores now also double as collection point or distribution center as we already saw in the Media Markt Digital example (Fig. 4). To make room for these activities, the size of the physical assortment is much smaller than in a conventional store. In the Media Markt example, only one third of the space was

reserved for the assortment. The scarcity of product space is likely to continue; more and more room will be devoted to media and technology accompanying each product (e.g., interactive screens, videos, etc.). This makes it even more challenging to determine which products to carry. Stephens (2017) argues that we are headed for a so-called replenishment economy, in which staple products such as laundry detergent and toilet paper will be ordered automatically. The internet-of-things and rise of connected devices, which facilitate machine-to-machine ordering, will stimulate this further. This may result in the shop floor being reserved to inspire consumers, provide more product information, stimulate impulse purchases, provide demonstrations, and build a brand community. The goal is more and more to build unique in-store experiences. An example is the rebranding of the Apple stores into what its SVP of retail Angela Ahrendts calls town squares (Business Insider 2016), places for the Apple community to meet.

When the online assortment is much larger than the offline equivalent, managing the long tail becomes an important challenge. Ultimately, the length and composition of the tail is a balancing act between margin and inventory costs, something we'll discuss later in Sect. 6.3 on inventory management. Products with slow in-store rotation can be moved online, when there is no significant amount of showrooming involved. Technological advancements allow retailers to move products online, while they still retain a "quasi-physical" presence in the store. For instance, the Japanese clothing retailer Uniqlo opened up a magical mirror in its San Francisco store (Fig. 10). Dressed in certain garments users could ask the mirror to depict them wearing the item in a selected different color. Next, the item in the preferred order could be ordered online or bought directly, when available. This allowed Uniqlo to greatly reduce its in-store inventory, normally consisting of many size-color combinations.

Finally, there is an increasing trend of consumers co-creating products with firms. This trend will be stimulated by continued improvements in 3D printing technology. This will have a profound effect on the design of stores and websites. Websites

Fig. 10 UNIQLO's Magic Mirror. *Notes.* Click or scan the QR code to launch a video explaining the magic mirror. Courtesy of trendhunter.com

catering to this trend will allow consumers to orient themselves with respect to the different design options, while offering increasing levels of customization. For a truly personalized approach, consumers will visit the store to create the product alongside one of the store associates. They may wait for the result in case it involves something that can be printed fast, return to the store for pick-up or have it shipped to their home address. Similar, more low-tech formats are already around us. A good example is Converse's flagship stores in New York and Santa Monica, where consumers can use a combination of interactive screens and help from store employees to design customized sneakers.

5.2 Assortment Layout

Offline assortments typically have a very different layout than online ones, even when correcting for their different size and composition. Physical assortments are typically organized by brand and/or functional attributes such as type (e.g., t-shirt vs. sweater in fashion) or package type (e.g., cans versus bottles in supermarkets). Online assortments, on the other hand, come across as relatively unorganized. This seems inconsistent with the (offline) finding that perceptions of variety are higher for organized displays when assortments are large (as they typically are online) (Kahn and Wansink 2004). But perhaps online retailers trust that consumers will use filters to severely limit the number of alternatives up for closer inspection, reducing the need for organization. Moreover, online assortments typically provide consumers the option to sort the assortment by themselves. However, online filtering options are far from perfect (Baymard Institute 2015) and sorting options are typically restricted to brand, price level, and popularity. These may not always cover the most relevant dimensions for every consumer. In addition, whereas offline assortments are typically organized on multiple dimensions simultaneously (e.g., first brand, then size), we are not aware of such options online.

The limited organization of online assortments is surprising as more options for customization exist online than in offline settings. Kahn (2017) argues that firms should use visual design features such as organization structure, categorization, and filtering to help consumers with a fluent processing of the large online assortments. Building on the work by Morales et al. (2005), Rooderkerk and Lehmann (2018) show across one in-store field study and two online lab studies that a higher congruency ("fit") between the assortment organization and the consumer's internal organization leads to more favorable assortment perceptions (higher variety, lower complexity), which translates to higher conversion rates and satisfaction with the chosen item. Whereas it may be too obtrusive to directly measure internal categorizations during shopping by means of a survey, in an online environment they could be inferred from past filtering, sorting, and browsing behavior in the same, or similar, categories. For instance, suppose a consumer filters t-shirts based on color and/or compares different t-shirts with the same color. When the same customer visits the sweater category in the future, the online retailer could by default organize the sweaters by color.

Besides personalization, online channels also provide opportunities for contextual layouts. An important contextual factor is the device that is used. One can imagine that, depending on whether a smartphone, tablet, or desktop is used, in conjunction with the screen size, a different assortment layout is advisable. For example, for smaller mobile screens it may be better to present a smaller number of alternatives at once. With more and more search (and order) behavior taking place on smartphones, the decision what to put on the first screen is very important. It is a hybrid of a composition and layout decision. The difference between these two dimensions is blurring in online settings.

There is a lot of opportunity for cross-channel learnings with respect to layout. Whereas a physical store is one big qualitative laboratory, a website and app provide us with a lot of quantitative data on product search and evaluation. Where possible, learnings should be transferred beyond channel boundaries. For example, online filtering and sorting data could provide valuable insights on how to organize in-store assortments. Firms should also look at user generated content on social channels. Social media allows users to curate content; for example, adding hash tags below product pictorials. These data provide valuable insights into how consumers group products inside their heads. Observing these media teaches us that consumers regularly group products differently (e.g., by fabric or material in case of interior decoration) than firms do (by function for interior decoration). Figure 11 provides an example of Pinterest. The left panel shows how a consumer has grouped several interior design items based on shared material (copper), rather than on shared functionality. There are firms that seem to have taken their inspiration from these kinds of categorizations. For instance, the panel on the right depicts the Pinterest page of Curver, a leading name in household products, for its Knit collection. This collection contains items, across traditional categories, that share the use of knitted textiles as common feature. The same "cross-category" collection is also presented as such on the Curver website (Fig. 12). Note that categorizations need not be attribute-based, they can also be benefit-based (Lamberton and Diehl 2013).

With the increasing adoption of the showroom model and a push for more experiential shopping, many stores are expected to contain a smaller number of categories and carry fewer products per category. The products that are present will have more space and be surrounded by digital facings such as (interactive) information displays. Moreover, as the Media Markt example showed, the remaining products will be accessible through in-store (or smartphone) screens (only).

6 Operational Challenges

An ideal omnichannel context enables a smooth transfer of information and goods across channels. However, achieving this poses many operational challenges, which we will discuss next. First, companies need to think about how to facilitate cross-channel information provision, while striving for consistency in communication. Second, they should think about ways to help consumers make decisions, by

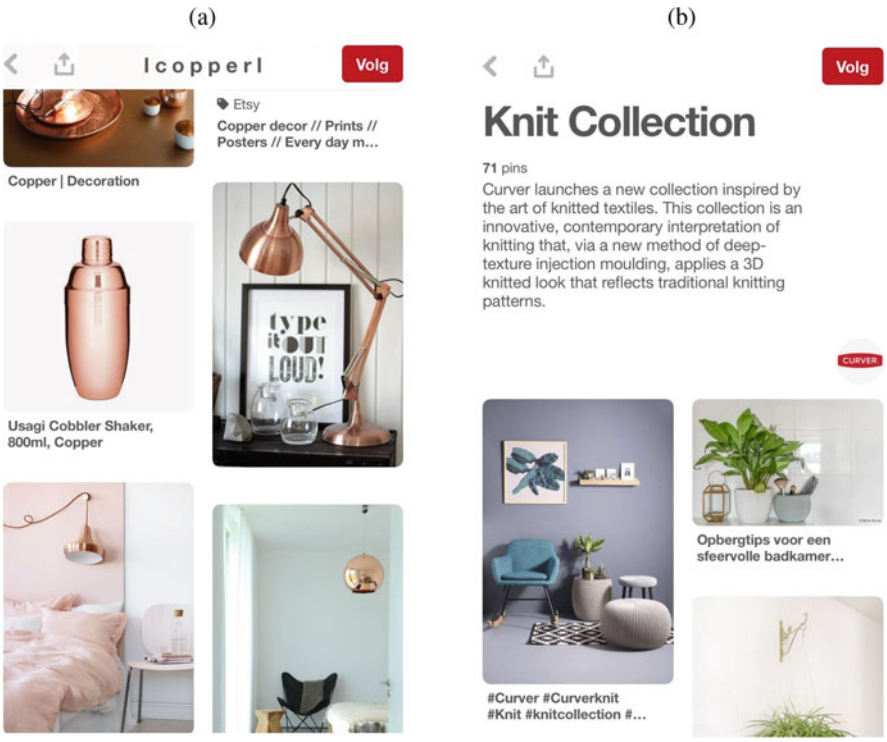

Fig. 11 Pinterest boards. *Notes.* Panel (**a**) shows the board of an individual Pinterest user, which groups all sorts of decorative items based on the shared characteristic of copper as material. Panel (**b**) depicts a Pinterest board of the Curver firm that shows a "cross-category" collection of items made of knitted material

providing decision aids. Third, they need to think about the best way to manage omnichannel inventory, considering that (ordered) products can or may have to be moved across channels. Finally, the channel from which is bought need not be the same in which it is (preferably) returned. Firms need to balance consumer flexibility with operational excellence, or preferably achieve both at the same time. Next, we elaborate on each of these operational challenges.

6.1 Information Provision

The omnichannel environment challenges firms to provide accurate cross-channel information to consumers. This information needs to be consistent across different channels. For example, a product description provided through online channels should be in line with the information provided on the shelf or by salespeople in store.

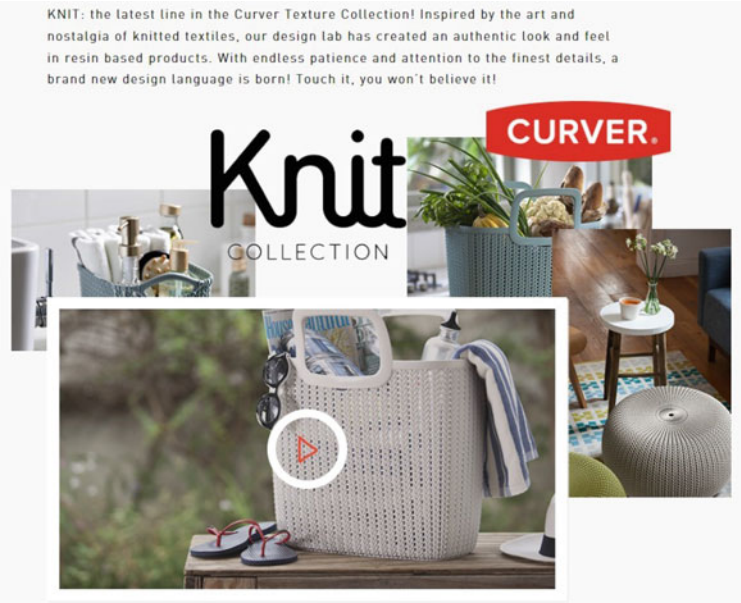

Fig. 12 The KNIT collection on Curver's website. *Notes.* Courtesy of Curver

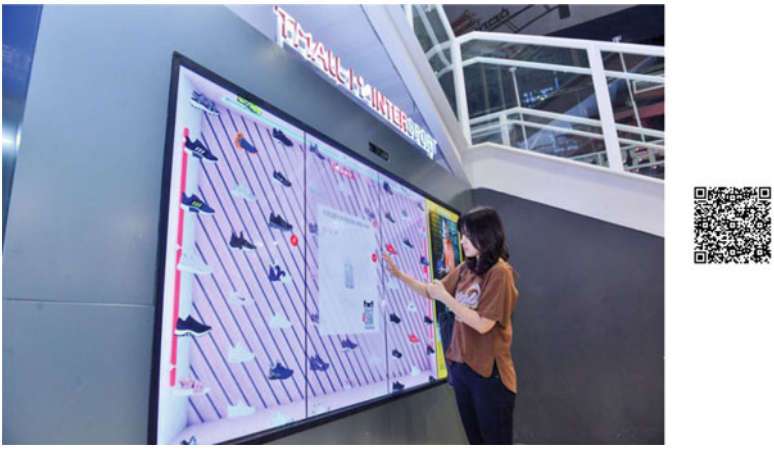

Fig. 13 Cloud Shelf in Tmall × Intersport store in Beijing. *Notes.* Click or scan the QR code to launch a video that takes you on a tour of the store. Courtesy of Alibaba

The first bit of crucial information is the cross-channel availability of products. When offering certain products online only (e.g., asymmetric integration (b) and (c) in Fig. 7), shops could relay this information to in-store consumers using browsing and order kiosks. Figure 13 depicts an innovative example; the so-called Cloud Shelf in Intersport's innovative flagship store in Beijing, in partnership with

Alibaba's Tmall. Customers can browse through all products offered by Intersport, including those not on display in the store. A customer can immediately order a selected item using an QR code. Firms could also offer in-store-only products (e.g., asymmetric integration (a) and (c) in Fig. 7). In this case, the online channel would, besides serving as direct ordering point for online available products, also service as an online catalogue for store-only items. To ensure truly omnichannel information provision, firms increasingly also indicate the stores in which these products are available and the corresponding inventory levels. However, it appears to be challenging for firms to provide accurate inventory level information (Lifehacker 2017). A reliable IT environment and sufficient in-store personnel are necessary to provide reliable information on store-level inventory levels.

In addition to learning about assortments, omnichannel consumers seek and integrate information about the products in a firm's assortment. Firms could satisfy this need for information aggregation by facilitating the (simultaneous) use of information available at different channels, or by even directly integrating the information into the focal channel. For example, the aforementioned Chinese supermarket chain Hema provides easy access to additional product information via QR codes. Retailers have also started to make product information available through the use of augmented or mixed reality, typically through the use of apps that can be used in-store or at home (Shopify 2018).

However, the technology behind augmented and mixed reality can still be perceived as too obtrusive, either requiring the user to put on specific glasses or download an app onto their smartphone. COOP Italia, Italy's largest supermarket chain, has recently opened up the "Supermarket of the Future" in Milan (Fig. 14). In collaboration with Accenture, and based on the work of MIT Professor Carlo Ratti, it offers a range of augmented information in the least obtrusive way. For instance, products are exhibited on large interactive tables. A simple hand movement initiates the display of product information on a monitor above; the augmented labels display nutritional value, allergens, and waste disposal instructions. The augmented experience is enabled by sensors that interpret the customer's gestures.

A source of information that consumers are actively seeking is that of their peers. In fact, in their book Simonson and Rosen (2014) argue that consumers' buying decisions are increasingly influenced by other people and information services (**O**) rather than by the information that is given to them by marketers (**M**). Together, with prior preferences (**P**) these two sources of information make up what the authors call the influence mix (= **P + M + O**), in contrast to the traditional marketing mix.

Many firms are aware of the increasing influence of **O**. Online reviews are abundant, also on firm-controlled channels. Moreover, firms have begun to experiment with providing the information of others at the point-of-sales. A low-key way to do so is to print an average review score on the shelf tag. With the advent of electronic shelf labels this kind of information can be more easily provided and updated. Figure 15 shows how C&A used clothing hangers with a digital screen to communicate the real-time number of Facebook likes the product had received online.

Fig. 14 COOP Italia's supermarket of the future in Milan. *Notes.* Click or scan the QR code to launch a video that takes you on a tour of the store. Courtesy by COOP Italia

6.2 Decision Aids

In his book Dough Stephens (2017) recounts an anecdote how, when shopping in a store for a bathroom faucet, he and his wife felt totally overwhelmed by the dozens of options, while being used to making choices from much larger sets of alternatives online. Stephens blames this on the information vacuum in the store. In the previous section, we have discussed ways to fill in this vacuum. However, another reason why choosing online may seem a whole lot easier than offline, despite the much larger assortment, is the presence of (interactive) decision aids; online decision aids come in three shapes: (1) tools to quickly decide on the most suitable (sub)category to search in, (2) tools to construct a consideration set (a set of alternatives the

Fig. 15 C&A Fashion Like campaign. *Notes.* Click or scan the QR code to launch a video on the campaign. Courtesy of C&A

consumer seriously considers for purchase, Hauser and Wernerfelt (1990)), and (3) tools to compare the alternatives in the choice set. The first type could include a clear description of what each subcategory means (e.g., the difference between compact cameras, hybrid cameras, and DSLRs) or point you to one based on your answers to a few questions. The second type includes interactive options such as filtering (eliminating alternatives) and sorting (changing the layout) that allow one to quickly zoom in on a set of alternatives that have the potential to satisfy the consumer's needs. The third and last type includes the comparison option available in many online shops. Using an alternative by attribute format, it allows the shopper to compare alternatives on a (limited) set of characteristics. Regularly, the option is available to only highlight the differences. This helps consumers determine the preferred option from their consideration set. Häubl and Trifts (2000) showed that use of such a comparison matrix resulted in higher quality consideration sets and decisions.

A successful omnichannel execution boils down to combining the best of each channel. For example, retailers could refer their store visitors to their website or app to help them choose. On their online channels they could add a "present-in-focal-store filter." Using geofencing the app/website would determine the store the consumer is in when applying the filter. Retailers could also adapt some of the online decision aids to the offline world. Figure 16 shows how the German DIY retailer Hornbach has adopted the comparison matrix, used on its website, in its physical stores. The left panel shows the online comparison matrix for three pressure washers of the Kärcher brand. The right panel shows a similar matrix for the Kärcher products carried in one of its stores. In store a matrix printed in poster format is placed above the shelves carrying the corresponding products.

Following their online counterparts decision aids in physical environments can also be made interactive. A good example is provided by Fig. 17, which shows the so-called digital advisor for adhesives and sealants from leading manufacturer

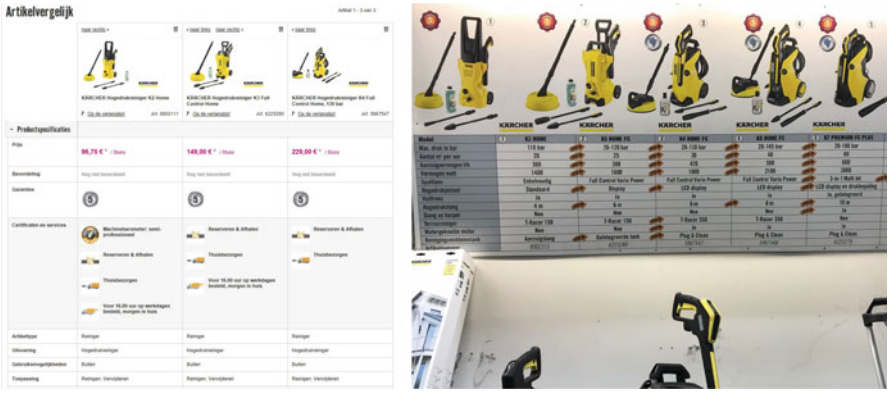

Fig. 16 Online vs. offline comparison matrix for pressure washers. *Notes.* Both panels show DIY retailer Hornbach's alternative by attribute comparison matrix to help consumers choose between Kärcher pressure washers. The left panel depicts the comparison matrix on the website. The right panel shows a similar comparison tool in one of Hornbach's physical stores in The Netherlands

Fig. 17 Bison on-shelf digital advisor for adhesives and sealants. *Notes.* The digital advisor is in Dutch. Panel (**a**) shows the tool mounted on the shelf. Panel (**b**) shows one the questions that is asked to provide the advice; this particular one asks about the type of surface involved. Panel (**c**) shows an example of an advice. Panel (**d**) shows the location of the recommended product on the shelf. Courtesy of Bolton Adhesives

Bison. By answering a series of questions, such as the type of material involved, the digital recommendation agent quickly zooms in on the most suitable product to satisfy the consumer need. It also indicates where the recommended product can be found on the shelf. This implementation marries the best of both channels, ease of online product selection with immediate availability in store.

6.3 Inventory Management

As summarized within Section 2.1 above and in Bell et al. (2014), customers engage in various forms of omnichannel behavior, including research offline buy online (showrooming), research online buy offline (webrooming), buy online pick-up in store (BOPS or click-and-collect), order in-store for home delivery (ship-from a store or a fulfillment center), and so on.

As part of the first stage of omnichannel evolution, retailers invested in supply chain and in-store technologies that enabled and supported various forms of omnichannel customer behavior. As of 2013, more than 64% of retailers have implemented BOPS (Retail Systems Research 2013). Furthermore, many retailers such as Macy's and Walmart leveraged their store network to fulfill their online orders with same-day and next-day delivery from store options (The Wall Street Journal 2015). Target, for example, fulfilled 30% of its online orders from stores as of 2016 (The Wall Street Journal 2016).

Retail inventory management has traditionally focused on forecasting, buying, and replenishment decisions at two levels: forecasting and buying at the centralized chain level, and forecasting, allocation, and replenishment at store (or depot) level. A fundamental assumption behind almost all predictive and prescriptive modeling has been that customer demand and its fulfillment occurred at the same location, i.e., at one of the physical stores or at an online store and its corresponding fulfillment centers. Hence, sales data at each location/channel have been segregated from other locations, indicating a separate demand stream for each location. That, in turn, implies inventories planned for each location to be dedicated to that demand stream. Omnichannel customer behavior violates that fundamental assumption, making it very difficult to untangle the different demand streams and identify the true sources of demand. Firstly, there may be very limited data records as a consequence of showrooming or webrooming behavior. The retailer only observes the purchase at the online channel, or the store, respectively. While the click-and-collect path is clearer, in other cases of omnichannel behavior, the retailer only observes the purchase transaction but not the path leading to it. In aggregate, the retailer sees the sum of the sales from all types of flow ending at one location as the demand for that location, and the click-and collect history. Thus, it is not at all clear how one should forecast the true demand of the stores and click-and-collect data for each store.

Furthermore, retailers are looking for an answer on how to plan the inventory of each store. Should we keep excess inventory to meet all omnichannel demand? That may lead to duplication of demand and inventories. Another challenge arises from

endogeneity: ship-from-store demand is endogenous as it depends on how much inventory stores have at the time the customer places the order and to which store(s) the retailer directs the customer demand.

Consistent with most commercial advice, the recent trend in industry has been to push more inventory to stores and use them as fulfillment centers (The Wall Street Journal 2015). Target is a good example of this trend, as they have shifted more inventory to stores to cover for fulfillment from store and BOPS; they report improved offline in-stock performance (The Wall Street Journal 2016). From a forecasting and pooling perspective that approach presents significant challenges. Firstly, the store inventory may be depleted by online demand and may not be sufficient to cover local offline demand at times. Secondly, pushing more inventory to stores implies keeping less inventory at centralized distribution centers. That, in turn, may create significant inventory imbalances at stores and, at the end of the season, higher out-of-stocks, higher inter-store transfers, and potentially higher markdowns.

Academic research has focused on various aspects of these challenges. One area of focus is inventory policy optimization. Alishah et al. (2015) present an analytical model in which a retailer decides for a short life-cycle product how much inventory to carry at the stores and the distribution center and how to ration DC inventory as the season evolves. They find that integrated decision making yields significant profitability benefits. Govindarajan et al. (2017) consider a similar problem but focus on optimizing which store to fulfill from in a multi-store network. They develop a heuristic that integrates initial inventory decisions with fulfillment dynamics and report that it outperforms decentralized myopic strategies. Fulfillment is usually directed from stores that have underperforming inventory as the underlying dynamics of the problem is similar to the transshipment literature (Rudi et al. 2001).

Academic research has been largely silent on the challenges of forecasting the demand streams of the various omnichannel flow types listed above. The inventory optimization papers assume known demand distributions for each stream. Unfortunately, without a sound and working forecasting methodology of percentages of customer types of BOPS, store fulfillment, those that will accept ship-to-home in case of a store stockout, optimal initial inventory decisions for the store and DC network remains largely a theoretical exercise; It informs us about the directional changes that we might expect to see in practice, but falls short of providing a basis for operational decision support for retailers. Forecasting omnichannel flows is a largely open area for researchers as well as industry practitioners. Omnichannel behavior also presents opportunities that simplify forecasting in some ways. A recent example is Huang and Van Mieghem (2014) utilizing clickstream data to predict offline orders, reducing backorder and holding costs by a significant margin.

Another area of focus for academic research has been studying retailers' strategic fulfillment choices among alternative omnichannel structures and tactical decisions within those structures. Gao and Su (2016a) note that BOPS has the following negative effect. Stockouts of fast-selling items are effectively announced on the website and that reduces store traffic, resulting in lower profitability. Rabinovich

et al. (2018) present an econometric analysis of the impact of in-store fulfillment option to customers using field data. They find that removal of store fulfillment fees results in a significant revenue loss as the gains from increased sales revenue may not cover the loss from the fees.

Logistics cost considerations may have interesting implications for different product types. Using stores as warehouses (store fulfillment) results in increasing store operations costs significantly. Store fulfillment (receive, pack, and ship) cost may be up to three times higher (The Wall Street Journal 2012). Higher logistics costs and inefficiency of stores relative to warehouses may result in margin erosion (Dealerscope 2014) for bulky items and shipment from online DCs directly to customers' homes may be very expensive relative to BOPS. Walmart recently announced that items that are too expensive to ship are no longer offered as part of their online assortment (The Wall Street Journal 2018).

There is no clear evidence in the industry that inventory turns have generally improved as a result of omnichannel integration. In summary, retailers have created the technical infrastructure to fulfill omnichannel behavior of customers and may have potential pooling and logistics flexibilities as a result, but they have not yet figured out how to optimize their assortments and inventory policies to profitably deliver their promises to customers.

6.4 Return Management

Returns are very critical in earning the business and loyalty of customers. At the same time, returns have always posed significant challenges to the retailers due to cost of handling and re-packaging, reverse logistics, and lost revenues. In the online world, returns account for one third of total internet sales (The Wall Street Journal 2013), amplifying the significance of those challenges. One of the reasons for the relatively high return rates for online purchases is the lower amount of information availability about the product quality, fit, and performance, as customers may not have the advantage of touching and test the product as they do in stores. This especially holds for experience goods (Hong and Pavlou 2014).

Forbes (2018) lists a variety of approaches that retailers use to reduce both the return rates and the cost of returns in an omnichannel world. In Sect. 4, we have discussed physical and virtual show-rooms as a mechanism to reduce the information availability gap and thus serve to decrease the return rates. Gao and Su (2016b) create an analytical model representing consumers information gathering process in showrooms and stores and find that showrooms may not always increase profitability: they may reduce store patronage and thus increase returns and have the reverse effect. Facilitating consumer reviews may be another way to reduce returns. The availability of more reviews and the presence of more "helpful" reviews reduces returns (Sahoo et al. 2018). However, overly positive reviews may actually induce more returns (Minnema et al. 2016).

Generally, online shoppers find in-store returns the cheapest and most convenient (Gallino et al. 2018). Accepting returns of online sales in stores increases store handling costs, but it also brings about significant benefits: increased store traffic of customers with a willingness to buy a product in the retailer's categories clearly creates opportunities for the retailer to re-sell, cross-sell, and upsell to the customer.

Another strategic opportunity regarding returns is utilizing the returns data for analytics about the customer and the merchandise. Retailers can identify problematic merchandise and designs early on and for future seasons based on the returns. In addition, retailers can create tools and processes to help the customer to a more fulfilling shopping experience, lower returns, and a higher overall satisfaction, as discussed in Sect. 4.1 above.

7 Discussion

In this chapter, we have discussed various aspects of omnichannel assortment planning. As in traditional channels, assortment planning starts with understanding the customer journey and consumer preferences. In an omnichannel world, customer behavior is multiple orders of magnitude more complex than customer behavior in the offline world. Complexity arises from the fact that both information flows (product evaluation, feedback to sellers, and other customers) and physical product flows (fulfillment, returns) occur across channels with no predetermined structure. As customer behavior is constantly evolving, retailers and academics are trying to catch up: to understand the customers' need for different forms of informational and physical flow, and to provide them with better fulfillment of those needs. Most advanced retailers see this as an opportunity to gain a competitive advantage and strengthen their relationship with customers. We have reviewed these new challenges from the perspective of assortment planning, and the industry's solutions to those challenges, be it new retail services, new technologies serving the customers or servicing retailers, and new business models.

At a strategic level, the most critical issue is the integration and coordination of physical and online channels. Showrooming and webrooming along with a multitude of mobile and online apps enable retailers to serve customers' information and fulfillment needs for all forms of customer journey flows across multiple channels.

At a tactical level, assortment composition and layout are the two critical dimensions of assortment planning. Here, the existence of an omnichannel world creates opportunities for transfer-learning of customer preferences across channels. The online space also creates more opportunities to personalize both assortment composition and layout for each customer and/or dynamically change assortment as something changes in the environment.

At an operational level, demand forecasting, inventory management and fulfillment, and return management are evolving to serve the omnichannel demands of the customers.

In the transition to the omnichannel world, it seems to us that the technology has quickly evolved and caught up with customer demands both in the customer-facing marketing and operational capabilities, and the back-end supply chain capabilities. On the other hand, retailers are still in the experimentation stage of identifying the right methodology to address the challenges discussed in this chapter. It is worth noting that the profitable and sustainable solutions for each retailer may be unique to its own idiosyncratic position in the market, demands of its customer base, and its supply chain challenges.

Finally, as the industry is rapidly evolving, academic research in marketing and operations management can provide a tremendous contribution to the world of omnichannel assortment planning. In our discussion, we have referred to the small number of papers available in this nascent research area. However, more work is needed in all aspects of omnichannel assortment planning. Descriptive/empirical studies can develop methodologies to measure the impact of many real experiments that are ongoing at retailers. Retailers would benefit from a rigorous evaluation of their natural and planned experiments. Predictive models are direly needed for forecasting complex demand flows across channels and estimating customer response to assortment or service changes in a competitive market. Prescriptive models, both stylistic and practice-oriented, are needed to create guidelines or decision support for optimizing assortments at each channel for each customer.

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